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Floristic composition at biodiversity protection area in Lubuk Kakap, District of Ketapang, West Kalimantan

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ABSTRACT

Budiharta S (2010) Floristic composition at biodiversity protection area in Lubuk Kakap, District of Ketapang, West Kalimantan. Biodiversitas 11: 151-156. A study on floristic composition has been conducted at biodiversity protection area (Kawasan Perlindungan Plasma Nutfah, KPPN) of PT. Suka Jaya Makmur in Lubuk Kakap, District of Ketapang, West Kalimantan. Two sampling methods were used: Point-Quarter sampling (Quadrant method) of 50 m was applied to class of tree, and 2x2 m^2 plot sampling to class of sapling. Of 20 sampling units, 48 species of tree (belong to 27 genera and 13 families) and 94 species of sapling (belong to 54 genera and 28 families) were recorded. Shannon-Wiener diversity index (H') were 3.54 and 3.49 for tree and sapling respectively, while Pielou evenness index (J') were 0.91 and 0.77 for tree and sapling respectively. Forest ecosystem in this area can be classified as lowland ever wet tropical rain forest which dominated by dipterocarps species. Species of sapling with the highest importance value index were *Shorea laevis, Hopea dryobalanoides* and *Shorea sandakanensis,* while that of tree included *Dipterocarpus caudiferus, Shorea laevis* and *Dryobalanops* sp. The floristic composition at family level showed comparatively similar pattern with that at other sites in Kalimantan although composition at species level was different.

Key words: biodiversity protection area, dipterocarpaceae, floristic composition, High Conservation Value Forest (HCVF), production landscape.

INTRODUCTION

Indonesia is one of 17 mega-biodiverse countries (Mittermeier et al. 1997), but is facing a rapid loss of biodiversity (Sodhi et al. 2004). In terms of floristic richness, Indonesia ranks fifth in the world and contains more than 38,000 plant species with 20,000 of these identified as endemic species (Bappenas 2003). In just 50 years, Indonesia has lost as much as 50% of forest cover with cover being reduced from 162.29 million hectares in 1950 to 86 million hectares in 2003 (FWI/GFW 2002; Indonesian Ministry of Forestry 2005). The major causes of deforestation in Indonesia are timber extraction, local population migration, and forest conversion to agricultural lands, plantation areas and mining sites (FWI/GFW 2002; Bappenas 2003). Even though the Indonesian government has officially preserved as much as 23.89 million hectares (12.5% of total land) as protected areas (WRI 2003), the pressures on biodiversity are still high since the reserved areas are threatened by forest fires, illegal logging, mining, and oil palm plantation establishment that reduce their effective size by more than 50% (Curran et al. 2004; Fuller et al. 2004; Gaveau et al. 2007).

Considering that conventional conservation strategy by preserving primary forest as protected area has not made optimal contribution, there is an opportunity for conservation beyond strictly protecting forest (Wilson et al. 2010). Production forests, which account for more than half of Indonesia's forests, can be maximized as potential contributors for biological conservation (FWI/GFW 2002; Meijaard et al. 2005). Well-managed logging practices in production forest which produces certified timber will benefit not only for business but also for conservation (Meijaard and Sheil 2007). One of such practices is setting aside High Conservation Value Forest (HCVF) areas within timber concession areas.

Biodiversity protection area (Kawasan Perlindungan Plasma Nutfah/KPPN) can be classified as high conservation value forest due to its importance in protecting wildlife. The Decree of Indonesian Ministry of Forestry stated that the establishment of biodiversity protection area is aimed to preserve plant and animal biodiversity in their natural habitat (*in situ*) and should be retained in every production forests (Indonesian Ministry of Forestry 1998). This preservation has important value not only for ecological functions and scientific activities but also for local communities to fulfill their ritual and medicinal needs (Meijaard et al. 2005).

The aim of this study was to investigate species richness, evenness and dominancy of two classes of plant (i.e. tree and sapling) at biodiversity protection area in a timber concession area. Therefore, the most important species and families for both plant classes are revealed. The floristic composition of trees was also compared to that at other sites in Kalimantan based on previous studies to analyze the general pattern of plant biogeography of the island.

MATERIALS AND METHODS

The study was carried out at biodiversity protection area of PT. Suka Jaya Makmur, a forest concession company (Hak Pengusahaan Hutan/HPH) belongs to Alas Kusuma Group. It is located in Lubuk Kakap, sub-District Hulu Sungai, District of Ketapang, West Kalimantan and positioned at S 01°14.978' and E 111°07.940 (Figure 1). The study site is a virgin forest, surrounded by logged over forests, with approximately 300 hectares in the extent and covers hilly (up to 60% in elevation) area with an altitude of 178 m above sea level. It has the 'A' climate type (Schmidt-Fergusson) with annual rainfall of 1500-3000 mm/year (the highest level in December) and tropical wet months between October and March. The soil types of Yellow Red Podsolic, Latosol and Litosol dominate almost all landscape.

On its timber management, PT. Suka Jaya Makmur implements Indonesian Selective Cutting and Planting System (Tebang Pilih Tanam Indonesia/TPTI). This system mandates the company only to cut trees with minimum dbh (diameter at breast high) 50 cm and to plant commercial tree species on logged over areas subsequently. Therefore, from the silvicultural aspects, the existence of KPPN is very important as a source of seeds and seedlings.

At glance, a number of emergent trees, with more than 40 m in height, are distinguishable from the lower canopy. These are mostly dominated by dipterocarp species such as bengkirai (*Shorea laevis)*, keruing *(Dipterocarpus* spp.), and meranti (*Shorea* spp.) and also small number from other families such as durian (*Durio* spp.) and kempas (*Koompassia malaccensis*). The second canopy layer with average height of 20-30 m is occupied by species from various families such as kulim (*Scorodocarpus borneensis*), medang-medangan (*Litsea* spp., *Cryptocarya* spp.) and ubar (*Syzygium* spp.). Several ground layer species potential as medicine can be found at the study site, for instances gambir (*Uncaria gambir*), bemban (*Donax cannaeformis*), sirih (*Piper* spp.) and bemali darah (*Leea amabilis*). There are many orchids that occupy the site including species from genus *Appendicula*, *Bulbophyllum*, *Dendrobium*, *Eria*, and *Thrixspermum*. In addition to being inhabited by many commercially and ecologically important plants, the area is home to charismatic animals such as Malayan Sun Bear (*Helarctos malayanus*), orangutan (*Pongo pygmaeus*), owa (*Hylobates moloch*), deer (*Cervus* spp.) and rangkong (Bucerotidae).

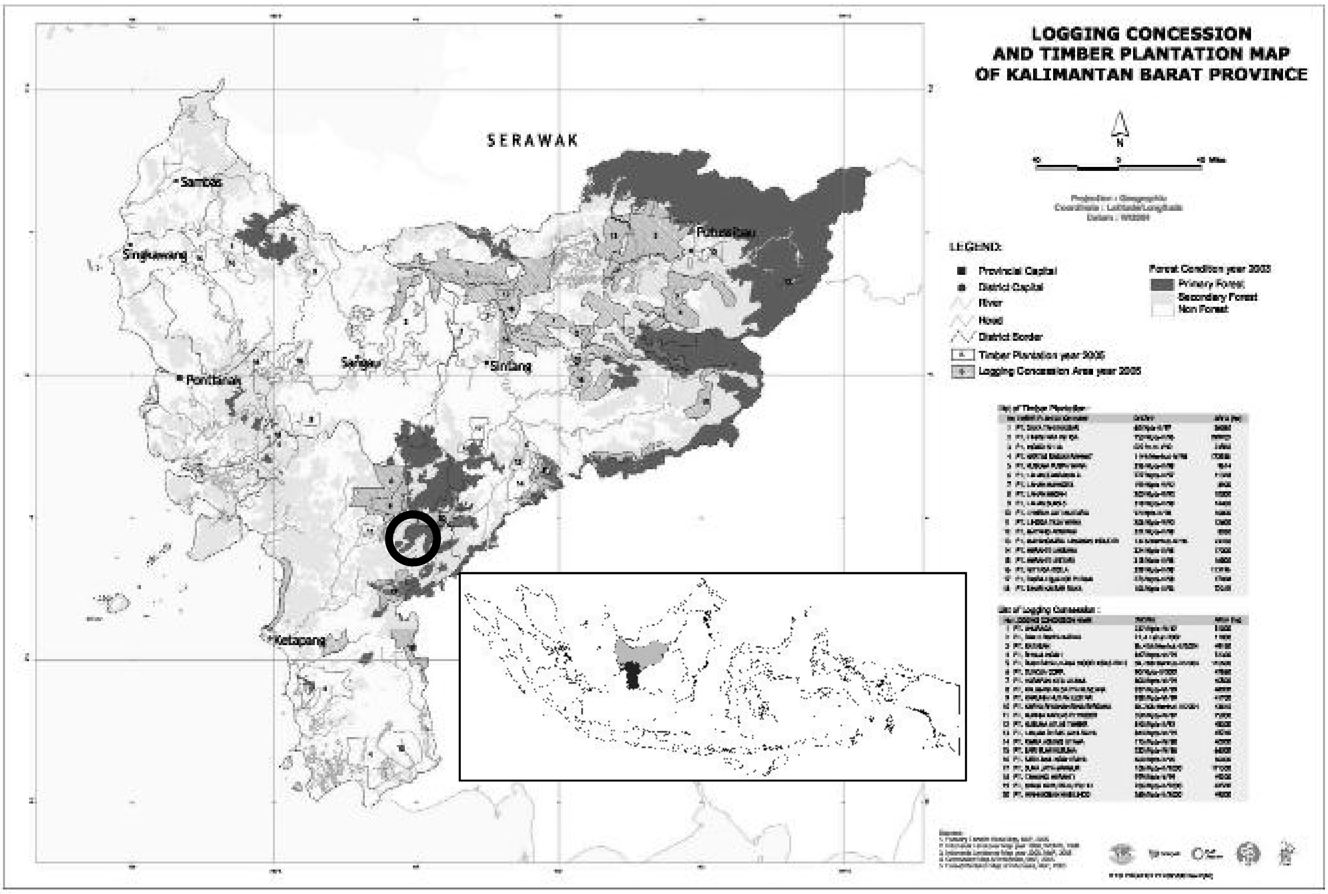

Figure 1. Location of study site within forest concession areas of PT. Suka Jaya Makmur, Ketapang, West Kalimantan (blank circle).

In this study we used two sampling methods for two classes of plant. Point-Quarter sampling (Quadrant method) of 50 m in distance was applied to trees with dbh more than 10 cm, while 2x2 m plot was applied to saplings with dbh between 2 and 10 cm. As many as 20 sampling units were taken. All species were then recorded in spreadsheets in order to calculate its relative density (RD) and relative frequency (RF). Only to trees, we also measured diameter and height in order to calculate their relative coverage/dominance (RC). According to Cottam and Curtis (1956), we calculated those three parameters as:

$$RD = \frac{\textit{Number of individuals of a taxon}}{\textit{Total number of individuals}} \times 100$$

$$RF = \frac{\textit{Number of plots containing a taxon}}{\textit{Total frequencies of all taxa}} \times 100$$

$$RC = \frac{\textit{Basal area of a taxon}}{\textit{Total basal area of taxa}} \times 100$$

By adding those three parameters, we determined Important Value index (IV) for each species. Shannon-Wiener diversity index (H') and Pielou evenness index (J') were calculated to analyze species richness and its distribution pattern (Ludwig and Reynolds 1988). H' was computed as:

$H' = -\Sigma\, pi \ln pi;\ pi = ni/N,$

while J' was computed as:

$J' = H'/\ln S$

ni = number of individual from species-*i*
N = total number of individual
S = number of species

RESULTS AND DISCUSSION

Floristic composition of saplings

Of 20 sampling units, 48 species of tree (belong to 27 genera and 13 families) and 94 species of sapling (belong to 54 genera and 28 families) were recorded. For sapling, *Shorea laevis* was the most important species, in term of its abundance and frequency (Figure 2). As many as 92 saplings of *S. laevis* were recorded, resulting in approximately 11500 plants per hectare. Even though *Hopea dryobalanoides* ranked

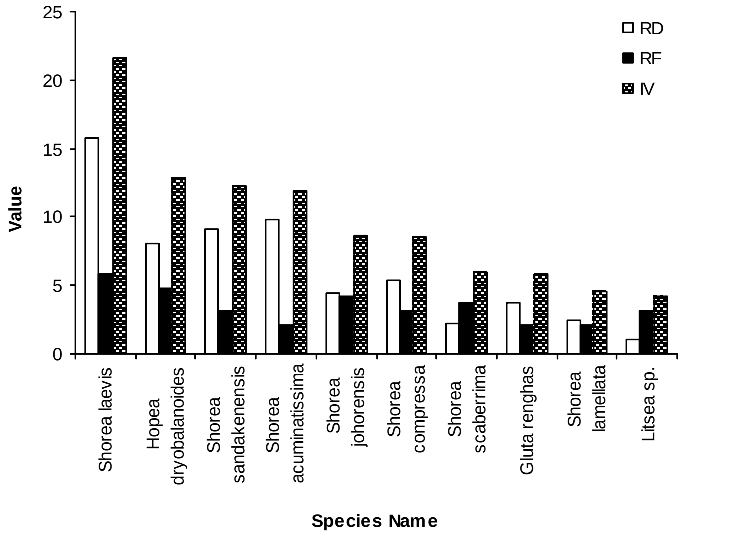

Figure 2. Ten most important species for sapling. Importance Value (IV) is sum of Relative Density (RD) and Relative Frequency (RF) of each species.

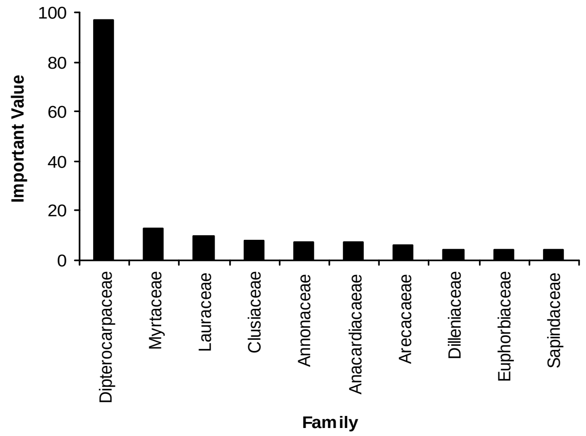

Figure 3. Ten most important families for sapling. Family Importance Value is sum of Importance Value of all species contained in a single family.

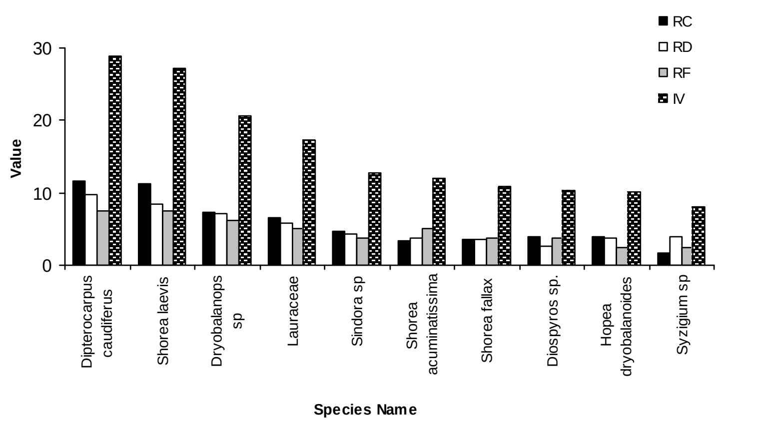

Figure 4. Ten most important species for tree. Importance Value (IV) is sum of Relative Density (RD), Relative Frequency (RF) and Relative Coverage (RC) of each species. 'Lauraceae' refers to a morphospecies that we were not able to identify.

fourth in the number of plants (5875 plants per ha) compared to *Shorea sandakanensis* and *S. acuminatissima* (6625 and 7125 plants per ha respectively), it was the second most important species due to the higher frequency of plots (nine plots compared to six and four plots respectively). Genus of *Shorea* dominated the study site with seven species from this genus were listed in the top ten most important species. Dipterocarpaceae was the most important family for sapling followed by Myrtaceae and Lauraceae (Figure 3). The gaps of Important Value between Dipterocarpaceae and other families were very wide showing the dominancy of this family. At the study site, Dipterocarpaceae also had the highest number of species contained in a single family with 17 species (i.e. from genus of *Shorea*, *Dipterocarpus*, *Hopea* and *Vatica*) followed by Myrtaceae with eight species (i.e. from genus of *Syzygium*, *Memecylon* and *Tristania*), Clusiaceae with seven species (i.e. from genus of *Calophyllum* and *Garcinia*), Annonaceae with six species (i.e. from genus of *Polyalthia*, *Desmos* and *Uvaria*) and Lauraceae with six species (i.e. from genus of *Litsea*, *Dehaasia* and *Cryptocarya*).

Floristic composition of trees

Different from that of sapling, the floristic composition of tree at biodiversity protection area of PT. Suka Jaya Makmur was dominated by *Dipterocarpus caudiferus* (keruing) while *Shorea laevis* (bangkirai) ranked second (Figure 4). *Dryobalanops* sp. (kapur) appeared as the third most important tree species followed by a 'morphospecies' from Lauraceae family and *Sindora* sp. In mixed dipterocarp forest, species richness and density are not necessarily correlated with the successful growth and development of seedlings (Ashton 1998). The difference of floristic composition between sapling and tree is probably caused by the difference in mast flowering and fruiting frequencies which influence the survival of seedling. For instance, dipterocarp species that fruit frequently, such as *Shorea*, tend to have shorter-lived seedlings than species which fruit occasionally, such as *Hopea* (Fox 1973).

Shorea laevis (bangkirai) was distinguishable from other trees as primary emergent tree which can reach 60 m tall and up to 240 cm in diameter. Although it ranked second after *Dipterocarpus caudiferus,* in some areas nearby, *S. laevis* was very dominant in which local people name the place as 'Bukit Bangkirai'. In addition, *D. caudiferus* also acted as emergent trees which can reach 50 m in height and 160 cm in diameter. Despite their dominancy in basal area and number of individual, spatial configuration of both *S. laevis* and *D. caudiferus* tended to be clumped than dispersed. This fact is in accordance with Soerianegara and Lemmens (1994) view that both species are usually found in group on clay soils in mixed dipterocarp forest on undulating land and hillsides below 800 m asl.

In term of the most important families for tree, Dipterocarpaceae ranked first followed by Lauraceae and Fabaceae (Figure 5). The number of tree species belonging to Dipterocarpaceae family was 20 species (i.e. from genera of *Shorea*, *Dipterocarpus*, *Dryobalanops* and *Hopea*). In addition, Lauraceae were represented by six species (i.e. from genus *Eusideroxylon*, *Litsea* and *Cryptocarya*), Myrtaceae had five species (i.e. from genus *Syzygium*, *Tristania* and *Tristaniopsis*), and Fabaceae had four species (i.e. from genus *Sindora, Koompassia* and *Dialium*).

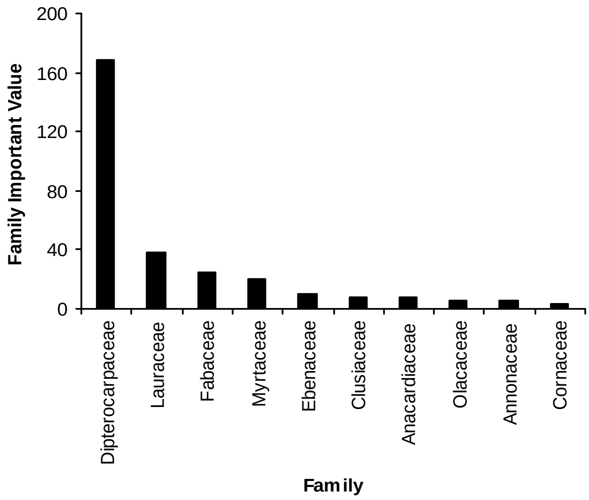

Figure 5. Ten most important families for tree. Family Importance Value is sum of Importance Value of all species contained in a single family.

In addition to the dominant *S. laevis* and *D. caudiferus*, other dipterocarps species recorded at the study site (e.g. *Shorea acuminatissima*, *S. fallax*, *S. leprosula*, *S. stenoptera*, *S. hopeifolia*, *S. compressa*, *S. ovalis*, *S. pinanga*, *S. smithiana*, and *S. scaberrima*) were those that commonly found in lowland ever wet tropical rain forest. These species will be at the most abundant and richest condition if situated at thick layer and well-drained soils (Soerianegara and Lemmens 1994). In contrast, other species from dipterocarpaceae family common in other ecosystem types were not found at study site, such as *S. materialis, S. coriacea* and *S. venulosa* (dipterocarp species in heath forest); *S. falcifera, S. geniculata, S. curtisii, S. flemmichii* and *S. rugosa* (dipterocarp species in sandy soil); and *S. albida, S. balangeran, S. macrantha, S. platycarpa,* and *S. teysmanniana* (dipterocarp species in peat swamp forest).

Diversity and evenness index

Shannon-Wiener diversity index (H') for both plant classes was categorized as high with H' of 3.54 for tree and 3.49 for sapling. Nonetheless, the diversity index of tree at the study site was much lower than that at sample plot on primary forest in Barito Ulu, Central Kalimantan with H' was 4.17 (Brearley et al. 2004). Comparative study on floristic composition across Borneo showed that the diversity in western part of Borneo is the lowest among all areas of the island (Slik et al. 2003). This low index is presumably caused by mid-domain effect of the island and the lately reforested landscape in western Borneo (approximately 10000 years ago) (Slik et al. 2003). Mid-domain effect can be defined that in the absence of environmental constraints, species diversity is at the highest in the centre of geographical areas, in which most taxa distribution will overlap (Laurie and Solander 2002). In Borneo, this means that the highest taxa diversity can be found in central part of the island, while diversity will be at the least along its edges, including at this study site.

In contrast, Pielou evenness index (J') at the study area were categorized as very low (0.91 and 0.77 for tree and sapling respectively) referring that species were not evenly dispersed and tended to be clumped. The J' value of trees at the study site was even lower than that in sub-montane forest in Gunung Gede-Pangrango National Parks (1.95) which categorized as low (Arrijani et al. 2006). This clumping was probably due to the poor ability of dipterocarp species, particularly the dominant ones, to sprout their seeds extensively (Ashton 1998; Condit et al. 2000). The clumpiness can also be caused by 'limited parent fecundity' which means the number of seedlings is not enough to cover all the space, even if seed dispersal is not limited (Webb and Peart 2001). This limitation in fecundity is related to previous explanation that particular dipterocarp species have lower survival rates which make the regenerated plants tend to concentrate nearby the parent trees due to a larger number of seeds pooled than other location with further distance.

Comparison to other sites in Kalimantan

In general, the floristic composition at the biodiversity protection area of PT. Suka Jaya Makmur, Ketapang had relatively similar pattern with that in other areas in Kalimantan (Table 1). Across the island, Dipterocarpaceae dominated the plant community except at three sites located in eastern Kalimantan (i.e. Sungai Wain, Wanariset and Lempake) which were dominated by Euphorbiaceae. At this study site, the little difference was that Euphorbiaceae was excluded as dominant families (rank 13), while in the other areas it ranked first or second. The low rank of Euphorbiaceae at this study site is probably due to the small number of sampling units that have been made, which can lead to false negative interpretation. Another rationale was that the study site, which is in close proximity to Gunung Palung National Park (GPNP), has been isolated from other Bornean tree population for potentially millions of year (Cannon and Manos 2003). This isolation has made the plant community at this study site evolve differently from that at other areas in Borneo.

Even though Dipterocarpaceae is consistently dominant in many areas in Borneo, the floristic composition in species level varies across different locations. For instances, a study by Cannon and Leighton (2004) in Gunung Palung National Park, Ketapang showed a different list of dominant dipterocarp species (e.g. *Dipterocarpus sublamellatus*, *Shorea crassa* and *S. quadrinervis*) while it is located in relatively close distance to our study site and has similar habitat type (well-drained and undulated lowland). This difference is probably caused by the limited capacity of seed to migrate across landscapes which leads to the independent evolution of each community, resulting in high levels of *gamma* diversity (Cannon and Leighton 2004).

CONCLUSION

Plant diversity at biodiversity protection area of PT. Suka Jaya Makmur, Ketapang was categorized as high with Shannon-Wiener diversity index (H') of 3.54 and 3.49 for tree and sapling respectively. In addition, species distribution tended to be clumped as indicated by the very low Pielou evenness index (J') either for tree (0.91) or sapling (0.77). Dipterocarpaceae was the most important family for both plant classes with *Shorea laevis* and *Dipterocarpus caudiferus* as the most important species for sapling and tree respectively. Comparison to other sites in Kalimantan showed that floristic composition at family level was relatively similar although composition at species level was clearly different. Despite being inhabited by

Table 1. Comparative rank of the most important families at various sites in Kalimantan based on Importance Value, except for Barito Ulu, Lempake, Sangai, Sungai Wain and Wanariset, which are based on number of species.

Families	BPA SJM	Sungai Wain[1]	Wanariset[2]	Lempake[3]	Apo Kayan[4]	ITCI[4]	Sangai[5]	Barito Ulu[6]	Across Borneo[7]
Dipterocarpaceae	1	5	2	6	1	1	1	1	1
Lauraceae	2	2	2	3	5		4	9	5
Fabaceae	3	7				10			
Myrtaceae	4	4			4	3	3		3
Ebenaceae	5							7	9
Clusiaceae	6								
Anacardiaceae	7	10				7		3	8
Olacaceae	8						9		
Annonaceae	9	8	8	2	10	9	8		10
Cornaceae	10								
Bombacaceae	11					6			
Moraceae	12				9				
Euphorbiaceae	13	1	1	1	2	2	2	2	2
Myristicaceae		3	5	7			5	4	6
Fagaceae		5			3	8			
Burseraceae		8	6	8	5	5	10	5	7
Meliaceae			4	5				7	
Sapotaceae			5	9	7	4		9	4
Rubiaceae			8	4					
Polygalaceae					8				
Verbenaceae							6		
Flacourtiaceae							7		
Thymelaceae								5	

Note: [1] = Sidiyasa; [2] = Kartawinata et al. (1981); [3] = Riswan (1987); [4] = van Valkenburg (1997); [5] = Wilkie et al. (2004); [6] = Brearley et al. (2004); [7] = Slik et al. (2003).

various dipterocarps species, other important tree species such as *Durio* spp., and *Koompassia* spp. can be found. Results of this study strengthen the importance of KPPN as High Conservation Value Forest (HCVF) and should be retained in production forest landscapes since it possesses highly ecological and economical values.

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