

**KUMPULAN PENGURUSAN KAYU KAYAN
TERENGGANU SDN BHD
(KPKKT)**

**SUMMARY
OF FINDINGS FROM GROWTH AND
YIELDS STUDIES IN MANAGED MIXED
DIPTEROCARP FORESTS OF DUNGUN
TIMBER COMPLEX (DTC),
TERENGGANU, MALAYSIA**

By

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EXECUTIVE SUMMARY

The richness, diversity and complexity of the Malaysian tropical rain forests (TRFs) in terms of their floristic and faunal compositions are beyond any doubt. They grow and coexist in such dynamic way that enthralles both the manager and researcher. The Mixed Dipterocarp Forest (MDF) of Dungun Timber Complex (DTC) which is under the continuous and successful management of the *Kumpulan Pengurusan Kayu Kayan Terengganu* (KPKKT) since nearly 30 years ago typifies such TRF ecosystem with its own peculiarity. Under the Malaysian Selective Management System (SMS) being practiced, timber trees within licensed compartments which have attained sizes exceeding certain minimum diameter limits, are carefully identified, marked, felled and extracted by skilled operators, following the dictates of Directional Felling (DF) and Reduced Impact Logging (RIL), along with the necessary environmental mitigation measures. These result in residual stands that were generally found to retain their structural and floristic integrity, much in the same way as in the pre-logging condition, and bear the promises of second growth forests. The challenge now remains in how to maintain consistently high growth rates for the Potential Crop Trees (PCTs) of which nearly 60 percent were in the 30 - <45 cm DBH size class and nearly 30 percent in the 45 - < 60 cm DBH class. Our study also revealed that based on the data gathered and analysed from 18 of the 70 Permanent Sample Plots (PSPs) within DTC, the PCT stock comprised, on average, at least 19 Dipterocarp and 74 Non-Dipterocarp tree species and genera of 30cm DBH and larger. The different species and genera co-exist in such dynamic balance and form at least 11 forest sub-types dominated mostly by the genus *Syzigium* (Kelat) and family *Dipterocarpaceae*. Other identified species/ genera which showed some degrees of abundance and dominance included: Simpoh (*Dillenia* sp.), Medang (*Lauraceae*), Rengas (*Mangifera* spp, *Melanochylla* spp.), Kasai (*Pometia* sp.), Perah (*Elateriospermum* tapos), Penarahan (*Myristicaceae*) Nyatuh (*Palaquium* spp.) and Minyak beruk. Such an immense mix of tree species is being meticulously handled and the forest's multiple resources sustainably managed by KPKKT under the guidance and supervision of the Forestry Department. On top of that the series

of audits regularly conducted by SIRIM/ SCS (Scientific Certification System) under the aegis of the Forest Stewardship Council (FSC) as well as MTCS (Malaysian Timber Certification System) also help to ensure adherence to strict protocols on sustainable management and conservation. DTC was successfully certified by FSC as a well-managed forest in 2008. Our findings also indicate that the trees' growth rates in terms of diameter p.a.i. were found to be generally reasonably high and within sight of the targets set by SMS. In order to achieve consistently high growth rates for the tree obviously calls for some proactive, well thought out and aggressive silvicultural measures on the standing trees and their habitats, over the entire rotation of 30 years. Currently the mean dpai for Dipterocarp tree species stands at 0.82 cm/tree/year as against 0.81cm/tree/year for the Non-Dipterocarps. These preliminary findings justify a longer monitoring of the Growth and Yield PSPs and further in-depth analyses of the data collected. Also other associated and relevant research undertakings are needed in order to further understand the growth behaviour and recovery of the trees and regeneration within the second growth stands managed under SMS.

The following line of actions is recommended for KPKKT to take in this regard:

1. Expand and strengthen the company's in-house capability in growth and yield research through proper training and consistent efforts in this field.
2. Extend the re-measurement exercise of the PSPs to as many years as possible and to extend the study so as to cover all the 70 PSPs within DTC.
3. Keep maintaining all the plots to ensure their accessibility, integrity and consistency, as well as the identity of the trees and regeneration being measured.
4. KPKKT to allocate appropriate budget and manpower and plan sufficiently ahead to ensure a successful accomplishment of the G & Y research and monitoring.
5. Attempts to be made by KPKKT to update its knowledge in the light of the new findings such as from the GY PSPs and to integrate these knowledge and information into the Forest Management Plan (FMP) and relevant decision-making process.

ABBREVIATIONS:

DBH	Diameter at Breast Height
DF	Directional Felling
DTC	Dungun Timber Complex
Dpai	Periodic mean annual diameter increment
FMP	Forest Management Plan
FSC	Forest Stewardship Council
GY, G&Y	Growth and Yields
KPKKT	Kumpulan Pengurusan Kayu Kayan Terengganu Sdn Bhd
MDF	Mixed Dipterocarp Forest
p.a.i	Periodic (Mean) Annual Increment
PCT	Potential Crop Tree
PSP	Permanent Sample Plot
RIL	Reduced Impact Logging
SCS	Scientific Certification System
SFM	Sustainable Forest Management
SIRIM	Standard and Industrial Research Institute of Malaysia
SMS	Selective Management System
TRF	Tropical Rain Forest

SUMMARY

OF FINDINGS FROM GROWTH AND YIELDS STUDIES IN MANAGED MIXED DIPTEROCARP FORESTS OF DUNGUN TIMBER COMPLEX (DTC), TERENGGANU, MALAYSIA

1.0 Introduction and Background

This Report presents summaries of the analyses conducted on 18 out of a total of 70 long-term Permanent (Growth & Yield) Sample Plots (PSPs) that had been systematically established during recent years by KPKKT in various parts of its Dungun Timber Complex (DTC) forest concession. The latter covers a total of 108,900ha of managed natural mixed dipterocarp forest in the forest districts of South Terengganu and West Terengganu, Malaysia, and has been under the care of KPKKT since 1983. DTC was officially certified as a “well-managed forest” by the internationally-renown Forest Stewardship Council (FSC) in 2008 after KPKKT as its managers had successfully met all the 9 principles and 47 criteria (P&C) of forest certification under the FSC standard. Of the 9 principles, Principle 8 “Monitoring and Evaluation” contains 5 Criteria which require a regular and consistent monitoring and documentation of all operations conducted in DTC by KPKKT. These include the changes that might be taking place and affect the forest growth and environment, economics of operations as well as the ecology and forest-dependent communities (*i.e.* environmental and social impacts).

In the field of forest growth and yield (GY), all of the series of activities conducted under the PSP programme were organised by KPKKT as part of its continued efforts to see to it that DTC continues to remain certified as such, and with added value in terms of its contribution to the science and understanding of tropical forestry and management.

The first measurement of the 70 plots was made in 2006, *i.e.* at the time of their establishment, but the second measurement which involved just 18 of them, was

conducted only in 2010/2011, *i.e.* after a lapse of about 4 years. The 18 PSPs referred to are as shown in **Table 1**.

Table 1: List of KPKKT's Growth and Yield PSPs Covered by this Report.

No.	PSP No.	No.	PSP no.	No.	PSP no.
1	31	7	66	13	93
2	38	8	69	14	107
3	54	9	75	15	113
4	60	10	80	16	122
5	62	11	86	17	126
6	63	12	88	18	149

As a responsible forest management company which has been managing DTC for the past 30 years based on the Sustainable Forest Management (SFM) principle, KPKKT is very well aware and concerned with the condition and recovery of the selectively-logged timber stands and their ability to re-grow and recover over time within the time frame stipulated under the Malaysian Selective Management System (SMS). Concomitantly, knowledge on the growth and yields of the trees; either growing singly or in groups, is viewed as indispensable by KPKKT management and must be understood in order to enable the concerned parties/individuals to appreciate the issues at hands and, whether the current approaches to the management and silviculture of the logged mixed dipterocarp forests had been sound or otherwise, all these years. Data and findings from the GY research will be incorporated into the Forest Management Plan which will be revised at regular intervals and translated into action as and when appropriate.

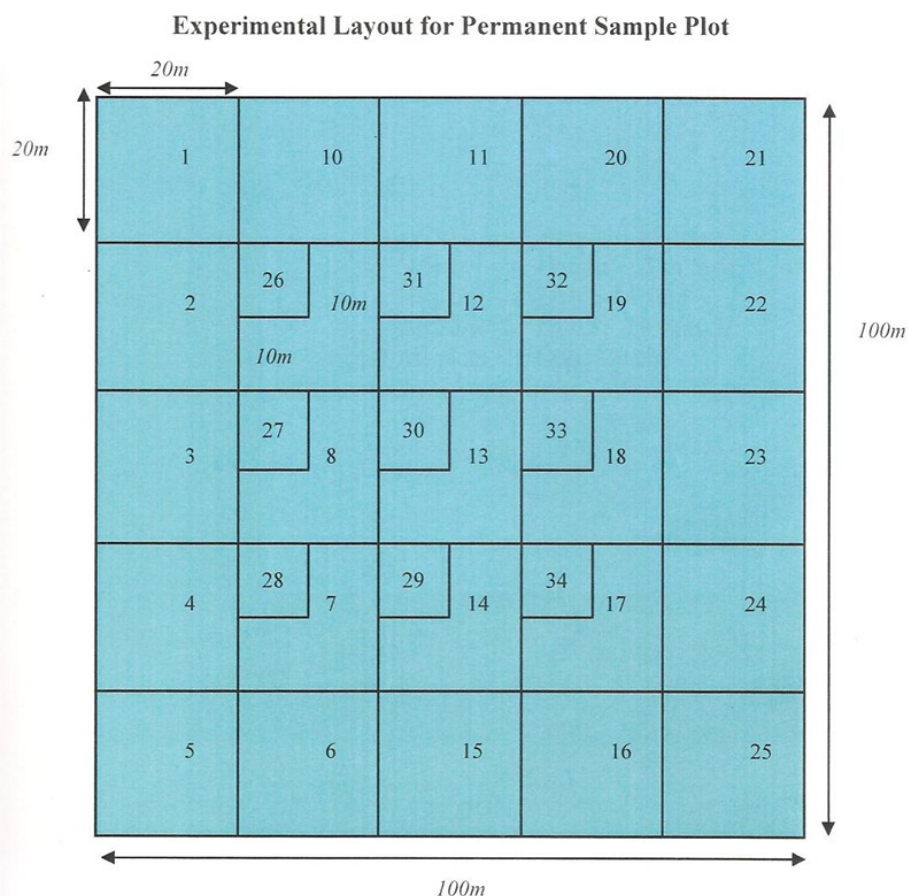
The main aspects covered in this Report include:

- (1) Population Dynamics and changes in species composition and tree population structure that might had taken place during the study period. This covers issues such as tree recruitment, mortality, number and percentage of trees (both by species and size classes), expressed as per ha.
- (2) Diameter growth of standing trees, expressed as “periodic annual increment (p.a.i.)” of diameter at breast height (DBH), either as single species, or in groups (species and size classes).

2.0 Constraints and Limitations

During the commission of this Consultancy, problems of accessibility, incessant weather and hence increased costs have remained the main challenges against a successful re-measurement, maintenance and reporting of the said PSPs. Under the circumstance and after much deliberation, it was finally decided in 2010 that for a start, only 18 of the PSPs would be re-measured and analysed. This means the re-measurement and maintenance exercises that were conducted during 2010 were undertaken when the plots concerned were 4 years in age. **Fig. 1** depicts the general layout of the PSP together with details of measurement instruction.

Fig. 1



Measurement specifications according to plot size

Plot size	Measurement
20m x 20m	All trees > 30cm dbh
20m x 20m	Big poles 15 – 29.9 cm dbh
10m x 10m	Small poles 5 – 14.9 cm dbh

3.0 Summary of Results And Discussion

3.1 Population Dynamics

A detailed examination of all the 18 plots and the second growth forest stands around them revealed the unmistakable general characteristics of DTC which is mixed dipterocarp forest rich in the following tree species (arranged according to order of abundance): Kelat > Dipterocarps > Simpoh, Medang > Kasai, Perah, Minyak beruk, Penarahan and Nyatuh. In terms of species consociations, the different species and forest vegetation form alliances or forest sub-types in the following combinations (the most abundant species/ species groups being mentioned first):

- (1) Kelat – Simpoh,
- (2) Dipterocarps – Kelat,
- (3) Mixed Kelat,
- (4) Kelat – Dipterocarps – Medang,
- (5) Dipterocarps – Kelat – Simpoh,
- (6) Kelat – Dipterocarps – Rengas,
- (7) Kasai – Medang,
- (8) Dipterocarps – Kelat – Perah,
- (9) Kelat – Dipterocarps – Minyak beruk,
- (10) Kelat – Dipterocarps – Penarahan,
- (11) Kelat – Dipterocarps – Nyatuh.

In other words, the second growth forest of DTC still maintains a reasonable presence and dominance of dipterocarps, *i.e.*, after having been successfully subjected to the dictates of the Malaysian Selective Management System (SMS) since almost three decades now. Along with the dipterocarps, the long list of the non-dipterocarp tree species remain the major contributors to the species richness and biodiversity of the tropical rain forest as well as the immense challenge of managing it. **Table 2** summarises the different forest sub-types that could be discerned in the forest area based on the data collected, whilst **Table 3** and **Table 4** summarise the tree population distribution in the different PSPs according major species groupings, dipterocarps and non-dipterocarps, as well as by sizes classes respectively.

Table 2.

**Summary of Forest Vegetation Sub-Types And Population Dynamics
 In The Different PSPs.**

PSP No.	Forest Vegetation Sub-type	Main Non-Dipterocarp Spp. & Percentage of Grand Total			Main Dipterocarp Spp. & Percentage			Total, No. of trees/ha & (%)		Grand Total, trees/ha
		1	2	3	1	2	3	Non-Dip	Dip	
31	Kelat - Simpoh	Kelat, 47.06%	Simpoh, 14.71%	Medang, 5.88%	MTRD, 1.47%	MTPA & Resak @ 0.74% each		132 (97.06%)	4 (2.94%)	136
38	Dipterocarp - Kelat	Kelat, 20.00%	Petaling, 7.50%	Rambutan & Rengas @ 5.00% each	MTLG, 5.83%	MTSP, 5.00%	Balau, 4.17%	89 (74.17%)	31 (25.83%)	120
54	Mixed Kelat	Kelat, 16.67%	Berangan, 9.52%	Medang, 7.14%	MTSP 3.57%	MTML & MRW @ 2.38% each		75 (89.29%)	9 (10.71%)	84
60	Kelat – Dipt - Medang	Kelat, 23.30%	Medang, 10.68%	Melunak, 4.85%				83 (81.37%)	19 (18.63%)	102
62	Dipterocarp - Kelat	Kelat, 15.25%	Mahang & Medang @ 5.93% each		MRW, 7.63%	KR, 4.24%	Balau, MTKP @ 3.39% each	91 (77.12%)	27 (22.28%)	118
63	Dipterocarp - Kelat	Kelat, 24.79%	Medang, 5.98%	Merpauh, Bekak, NY @ 5.13% ea.	DH, 7.69%	Balau, 5.98%	MTML, 3.42%	84 (71.79%)	33 (28.21%)	117
66	Dipt. – Klt - Simpoh	Kelat, 16.85%	Simpoh, 12.36%	Kempas, 6.74%	MTTB, 7.87%	DH, 6.74%	MTNM, 5.62%	64 (71.91%)	25 (28.09%)	89
69	Klt – Dipt - Rengas	Kelat, 23.58%	Rengas, 13.21%	Bitis, 7.55%	MTSY, 6.60%	MTML, 2.83%	MTSP, 1.89%	87 (82.08%)	19 (17.92%)	106
75	Klt – Dipt. - Ludai	Kelat, 22.03%	Ludai, 13.56%	Mempening, 8.47%	Balau, 5.08%	MTTB, 5.08%	Keruing, 3.39%	48 (81.36%)	11 (18.64%)	59
80	Dipteroc – Kelat -Medang	Kelat, 22.22%	Medang, 20.63%	Sesenduk, 7.94%	Balau, 6.35%	MTLG, 4.76%	RSK, MTML, KLD @ 3.18% ea.	48 (76.19%)	15 (23.81%)	63
86	Kelat - Simpoh	Kelat, 22.76%	Simpoh, 22.07%	Membuloh, 7.59%	MTPA, 1.38%	Resak & MTML @ 0.69% each		141 (97.24%)	4 (2.76%)	145
88	Kelat - Dipterocarp	Kelat, 25.25%	Nyatoh, M.Beruk @ 7.07% ea.	Bintangor, 6.06%	Balau, 6.06%	MTSP & Damar Hitam @ 4.04% ea.		76 (76.77%)	23 (23.23%)	99
93	Kasai - Medang	Kasai, 28.82%	Medang, 15.25%	Mahang, 8.48%	Keruing, 5.08%	MTTB, MTSP, MTKP, MSW, Chengal, Balau @ 1.70% ea.		50 (84.76%)	9 (15.25%)	59
107	Kelat – Dipterocarp - Medang	Kelat, 47.15%	Medang, 11.3%	Penarahan, 4.07%	MTSP, 5.69%	Keladan, 4.88%	MTTB, 1.63%	107 (86.99%)	16 (13.01%)	123
113	Dipterocarp – Kelat - Perah	Kelat, 19.63%	Perah, 11.21%	Minyak Beruk, 5.61%	MTSP & MTPA @ 3.74% each		MTNM, 2.80%	84 (78.51%)	23 (21.50%)	107
122	Kelat – Dipt. – M. Beruk	Kelat, 39.39%	Minyak beruk, 7.58%	RGS, NY, Merpauh, MD, K.Arang, Bitis @ 4.55% each	MTML, 4.55%	Keruing & Damar hitam @ 3.03% each		59 (89.39%)	7 (10.61%)	66
126	Kelat – PN – Dipteroc.	Kelat, 41.4%	Penarahan, 15.31%	Medang, 6.12%	MTKP, 3.06%	MTSP, MTSMH, MTLG @ 2.04% ea.		89 (90.82%)	9 (9.18%)	98
149	Klt – NY - Dipterocarp	Kelat, 19.77%	Nyatoh, 10.47%	Merpauh & Kldg @ 6.98% each	MTML, 6.98%	MTTB & MTPA @ 1.16% each		78 (90.70%)	8 (9.30%)	86
Mean								82.50 (83.57%)	16.22 (16.43%)	98.72

Table 3.

Summary of Population Distribution of Trees >30cm DBH by
 Species Groups in PSPs.

No	PSP No.	Total No. of Trees/ha	Non- Dipterocarps		Dipterocarps	
			No/ha	%	No/ha	%
1	31	136	132	97.06	4	2.94
2	38	120	89	74.17	31	25.84
3	54	84	75	89.29	9	10.71
4	60	102	83	81.37	19	18.63
5	62	118	91	77.12	27	22.28
6	63	117	84	71.79	33	28.21
7	66	89	64	71.91	25	28.09
8	69	106	87	82.08	19	17.92
9	75	59	48	81.36	11	18.64
10	80	63	48	76.19	15	23.81
11	86	145	141	97.24	4	2.76
12	88	99	76	76.77	23	23.23
13	93	59	50	84.76	9	15.25
14	107	123	107	86.99	16	13.01
15	113	107	84	78.51	23	21.50
16	122	66	59	89.39	7	10.61
17	126	98	89	90.82	9	9.18
18	149	86	78	90.70	8	9.30
Mean		187.05	82.50	83.20	16.22	16.77
Max		145	141	97.24	33	28.21
Min		59	48	71.79	4	2.76
Std. Deviation		25.88	25.56	8.02	9.19	7.99

Table 4.

Summary of Population Distribution By Size Classes, 2010

No	PSP No	DBH Class, cm										Total	
		>30<45		45<60		60<75		75<90		90++			
		No/ha	%	No/ha	%	No/ha	%	No/ha	%	No/ha	%	No/ha	%
1	31	64	47.06	43	31.62	18	5.15	7	5.15	4	2.94	136	100
2	38	71	49.58	29	30.25	10	10.92	4	3.36	5	4.17	119	100
3	54	44	52.38	32	38.10	5	5.95	3	3.57	0	0.00	84	100
4	60	68	66.02	26	25.24	8	7.77	0	0.00	1	0.97	103	100
5	62	71	60.17	23	19.49	23	19.49	1	0.85	0	0.00	118	100
6	63	70	59.83	27	23.08	11	9.40	6	5.13	3	2.56	117	100
7	66	42	47.19	24	26.97	13	14.61	3	3.37	7	7.87	89	100
8	69	60	56.60	31	29.25	12	11.32	3	2.83	0	0.00	106	100
9	75	30	50.85	19	32.20	7	11.86	3	5.09	0	0.00	59	100
10	80	49	77.78	11	17.46	3	4.76	0	0.00	0	0.00	63	100
11	86	93	64.14	40	27.59	9	6.21	2	1.38	1	0.69	145	100
12	88	68	68.69	21	21.21	8	8.08	2	2.02	0	0.00	99	100
13	93	28	47.46	16	27.12	6	10.17	4	6.78	5	8.48	59	100
14	107	54	43.90	50	40.66	14	11.38	4	3.25	1	0.81	123	100
15	113	63	58.88	33	30.84	7	6.54	4	3.74	0	0.00	107	100
16	122	42	63.64	21	31.82	2	3.03	1	1.51	0	0.00	66	100
17	126	45	45.92	30	30.61	13	13.27	9	9.18	1	1.02	98	100
18	149	59	68.61	17	19.77	5	5.81	4	4.65	1	1.16	86	100
Mean		56.06	57.15	27.78	27.96	9.83	9.21	3.33	3.44	1.61	1.70	98.78	100
Max		93	77.78	50	40.66	23	19.49	9	9.18	7	8.48	145	100
Min		28	43.90	11	17.46	2	3.03	0	0.00	0	0.00	59	100
Std Dev.		16.08	9.69	10.14	6.23	5.35	4.11	2.33	2.36	2.20	2.64	25.89	0

In what follows, the vegetation characteristics and population dynamics of the TRF within DTC are described individually, PSP by PSP. For more detailed description, please refer to the **Annex** of this Report.

PSP31

Forest sub-type: Due to the presence of a strong species consociation between Kelat and Simpoh in this PSP and the surrounding forest ecosystem, it is safe to identify them into the **Kelat-Simpoh** forest subtype. Kelat by itself made up at least 47% by numbers in this PSP to be followed by Simpoh at 14.71%. PSP31 can be said to be well-stocked with a total population of 136 nos./ha of trees of 30.0cm DBH ++, spread over at least 23 species/ species groups. The third and fourth most common species were Medang and Membuluh at 5.88% and 5.15% respectively in that order of abundance. Dipterocarp species were way in the realm of the minorities at only 2.94% by number. Both Kelat and Simpoh were found to grow at about 1.0cm/yr whereas Medang recorded a diameter p.a.i. of 0.90cm/yr. As a whole the Non-Dipterocarp tree species exhibit a higher growth rate of 1.00cm/y as compared to the Dipterocarps (0.76cm/yr). The total mean p.a.i. for diameter for all trees within PSP31 was 0.99cm/yr.

PSP54

A close study at the species composition of PSP54 revealed that, apart from Kelat which predominates at 16.67% representation, other species such as Dipterocarps, Berangan, Medang, Mahang, Merpauh and Petaling were present in such numbers (ranging from 10.71% to 5.95%), but were not large enough so as to allow them to characterize the forest landscape. Under the circumstance, the forest stands within this PSP and its surroundings can therefore be termed as "**Mixed Kelat**" forest subtype. The total tree population of 84 nos/ha of trees of 30.0cm DBH +++ were spread over a total of 27 species/ species groups, 50 – 63 % of which were in the 30<45cm DBH size class.

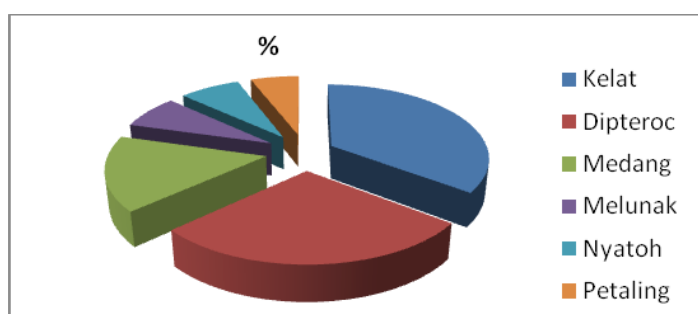
Tree growth rates were encouraging with dpai of 0.88cm/year overall, 0.89cm/yr for Dipterocarps and 0.88 cm/yr for Non-Dipterocarps.

PSP60

The timber stand within and in the vicinity of **PSP60** can be categorized as belonging to the **Kelat-Dipterocarp-Medang** forest sub-type. The second growth stand is characterized by a preponderance of young trees of <45cm DBH in size which constituted 67% of the standing trees. The average dpai was found to be extremely low at 0.16cm/tree/year indicating a severely depleted state of the soil, possibly due to the erosion that took place following previous logging. Under the circumstance, soil treatment and enrichment operation is advised by way of soil stabilization measures and planting of nitrogen-fixing plants and cover crops.

Fig. 17. PSP 60:
Six Most Common Species

Species	%	No/ha
Kelat	23.3	24
Dipterocarps	18.45	19
Medang	10.68	11
Melunak	4.85	5
Nyatoh	4.85	5
Petaling	3.88	4



PSP62

Dipterocarp species seemed to hold sway in PSP62 being present at 22.28% (or 27 trees/ha), out of a total population of 118 nos/ha of trees of 30.0cm DBH and larger. Next came Kelat at 15.25% as the second most abundant species. Other major species in this PSP included Mahang and Medang (both 5.93% each) and Merpauh and Penarahan (both 5.09% each). The total number of tree species identified within this PSP was 35 (including 6 species from the Dipterocarp family). In the final analysis, the species-rich forest ecosystem in this area can be identified as belonging to the **Dipterocarp – Kelat subtype**. As usual, as a result of logging, most remaining trees were of the smaller timber tree sizes, *i.e.* within the 30 – 60cm DBH

classes. Except for only one individual in the 75<90cm DBH class, there was none found in the 90.00cm ++ size class.

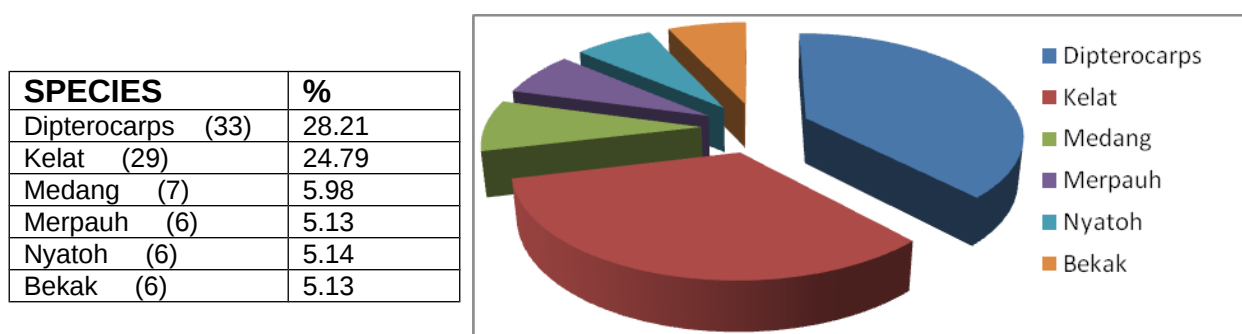
Trees' mean diameter periodic annual increment (dpai) was high at 0.92cm, in which Dipterocarp trees grew slightly faster at 0.94cm/yr than Non-Dipterocarp trees at 0.91cm/year.

In general, this PSP can serve as an excellent example of a mixed dipterocarp forest stand that has been managed sustainably under the Malaysian SMS.

PSP63

This is another *Dipterocarp – Kelat forest consociation/ subtype* in which the two groups of species constituted a total of 53% of the standing trees by numbers. Tree growth rates were high at an average rate of 0.92cm/tree/yr.

Fig. 23. Percentage Distribution of Major Species in PSP63.

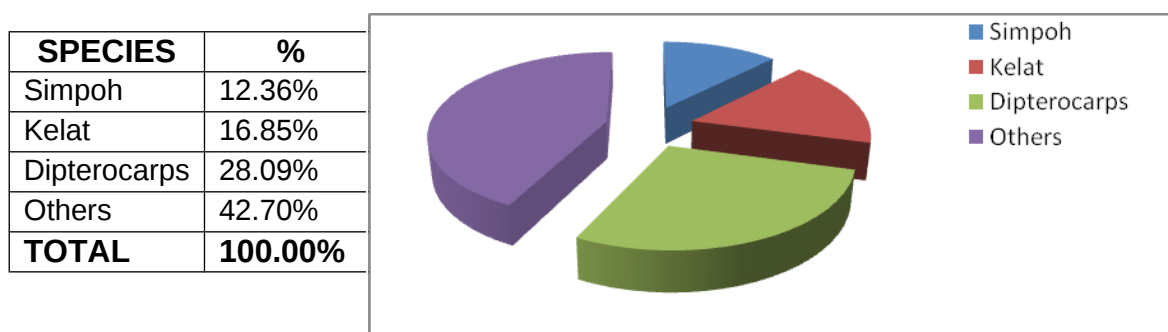


Notes: Evidence on the ground points to the fact that this forest belongs to the *Dipterocarp – Kelat – Simpoh* forest sub-type. Average growth rate for all species combined was 0.87cm/yr, of which Dipterocarps registered a rate of 0.99cm/year.

Fig. 29. Proportional Distribution of Major Timber Species (% of Total) in PSP66



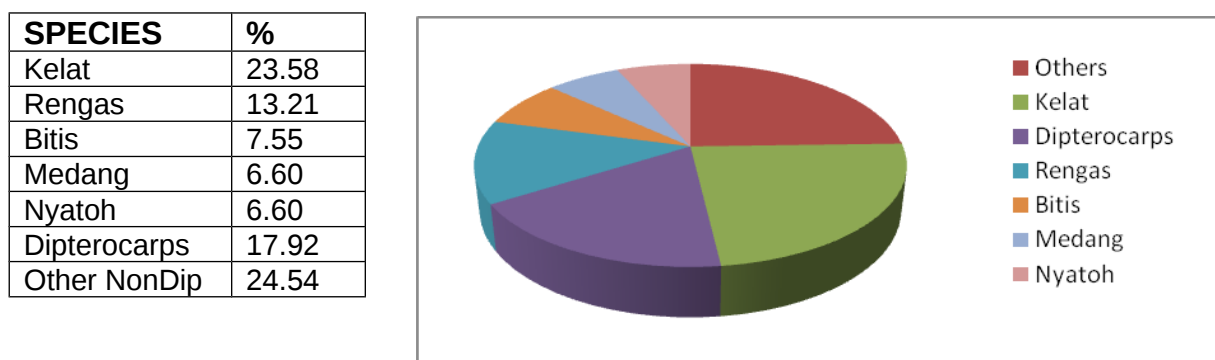
Fig. 30. Proportional Distribution of Major Timber Groups in PSP66.



PSP69

A **Kelat – Dipterocarp - Rengas** forest subtype in which other common species include Bitis, Medang and Nyatuh. Average growth rate of the trees was 0.92cm/yr, including the two major groups: Dipterocarps and Non-Dipterocarps.

Fig. 35. Percentage Distribution of Major Tree Species PSP69



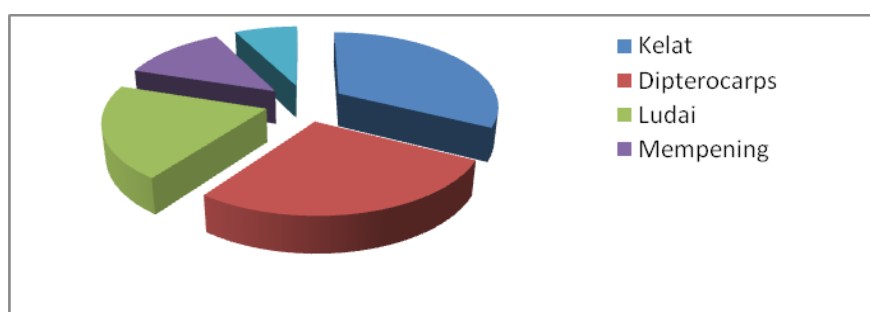
PSP 75

This is a **Kelat- Dipterocarp- Ludai** forest subtype with a significant presence of Mempening. The total population of trees of 30.0cm DBH ++ was only 59 trees/ha spread over 25 species/ species groups making it quite poor in terms of stocking, in addition to being less diverse if compared with other forest subtypes within DTC. Dipterocarp species constituted 18.64%, just behind Kelat at 22.03%, in terms of abundance. The presence of Ludai which is a secondary species as the third common species in the PSP indicated the severity of logging operation that took place in the area before the establishment of the plot. In terms of stand structure, trees within the 30<45cm DBH class constituted 50 – 60% of the total standing individuals followed by those within the 45<60cm DBH class at 28 -32%.

Periodic annual diameter increment was encouraging at 0.81cm/tree/year for all trees with Dipterocarps growing faster at 0.87cm/yr and Non-Dipterocarps 0.80cm/year.

Fig. 39. Percentage Distribution of Major Species/ Species Groups in PSP75

Species	%
Kelat	22.03
Dipterocarps	18.64
Ludai	13.56
Mempening	8.47
Petaling	5.08



PSP80

Without doubt this was among the poorest plots in the PSP series established by KPKKT so far, with only 63 nos./ha of trees of 30.0cm DBH and larger of which nearly a quarter were Dipterocarps (23.81% by numbers). This was followed by the

Non-Dipterocarps Kelat and Medang at 22.22% and 20.63% respectively in that order, which enabled the stand to be categorized as ***Dipterocarp – Kelat - Medang*** forest subtype. Apart from that Sesenduk formed the next most common species at 7.94% while other species occurred in much smaller numbers. The total tree biodiversity was low, counting at only 19 species/ species groups, about 80% of which were confined within the 30<45cm DBH group. There was no tree above 71cm in DBH.

In spite of the above and the relatively open canopy layer, the growth rates of the standing trees were found to be among the lowest in the PSP series, with an average of 0.28cm/yr – believed to be due to the low fertility of the soil. Dipterocarp trees were found to grow lower than the Non-Dipterocarps, *i.e.* 0.17cm/yr vs 0.31cm/yr. Such findings provide a very big challenge to KPKKT as managers of DTC, in an effort to increase growth and yields and sustain timber production from the area over the entire coming cutting cycle.

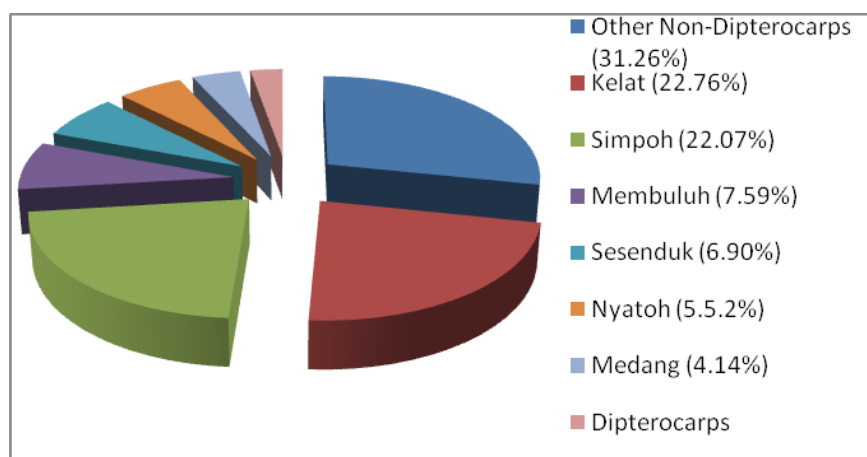
PSP86

The composition of Dipterocarp trees within this PSP was very low at 2.76% only or 4 individuals out of a total of 145 trees/ha. However, despite this seemingly large number and crowded environment, about 75% of the trees of 30cm ++ DBH belongs to the lowest sized class, *i.e.* 30<45cm DBH, in 2006. And a great majority of the timber species was of the low value species. Kelat species were present at 22.76% followed closely by Simpoh at 22.07%, as well as Membuluh, Sesenduk, Nyatuh and Medang at 7.59%, 6.90%, 5.52% and 4.14% respectively, in that order. Altogether the 6 species mentioned made up a total of 68.98% of the total standing individuals. Consequently, this gives the impression that the forests here belong to the ***Kelat-Simpoh subtype*** and are probably good for conservation purposes (as High Conservation Value Forest – HCVF), especially more so with the presence of at least 28 species/ species groups which included such fruit and fodder trees as Rambutan, Bangkung, Kandis, Kedondong, and Simpoh.

Under the circumstance, the forest in this PSP and its immediate vicinity are not good for commercial timber production purposes unless appropriate silvicultural actions are taken to bring them to a productive level again. This would involve a good measure of thinning operations followed by under-planting with higher-value commercial species. This was possible given the fertile and well-drained condition of the soil capable of yielding average periodic diameter growth rates (d.p.a.i.) for the trees at 0.89cm/year (Dipterocarp trees: 1.46cm/year and Non-Dipterocarp trees: 0.87cm/yr). In terms of DBH size classes, trees within the 30<45cm group grew the fastest at 0.92cm/yr.

SPECIES/ SP GRP	%
Other Non-Dipterocarps	31.26%
Kelat	22.76%
Simpoh	22.07%
Membuluh	7.59%
Sesenduk	6.90%
Nyatoh	5.52%
Medang	4.14%
Dipterocarps	2.76%
TOTAL	100.00%

Fig. 45b. Composition of Major Tree Species/ Species Groups in PSP86.



PSP88

With a population of 99/ha of trees of 30.0cm DBH and above, PSP88 was rich in biodiversity with at least 31 tree species/ species groups. As usual, Kelat species

formed the majority with 25.25% followed by Dipterocarp species at 23.23%. Next most abundant species were Nyatoh and Minyak beruk both of which came as distant third at 7.07%.

Structurally, majority of the trees (72.72% in 2006) were within the 30<45cm DBH size class which were marginally reduced by 4.04% to 68.69% in 2010 to grow into the next DBH Class. This was due to the surprisingly low growth of the trees in all size classes. Overall, the trees were found to grow at an average of 0.35cm/year, of which Dipterocarps registered a diameter p.a.i of 0.33cm/year, *i.e.* lower than the Non-Dipterocarps at 0.36cm/year. Trees within size class 45<60cm DBH were found to grow the lowest at an average of 0.24cm/year.

Such findings should send serious alarms to the parties concerned particularly KPKKT management and State Forestry authority as well as researchers who seek to maintain consistently high growth rates of the trees. Further investigations must be carried out to establish the underlying reasons for the dismal growth performance; which could be attributed to the soil type and fertility status, drainage pattern, species consociation, or other factors. Of greatest concern here is, why did Dipterocarp trees show lower growth rates compared to the Non-Dipterocarps in this particular plot?

Fig. 50. Percentage Distribution of Major Tree Species/ Species Groups

Species/ Sp Gp.	%
Medang	5.05%
Bintangor	6.06%
Balau	6.06%
Minyak beruk	7.07%
Nyatoh	7.07%
Kelat	25.25%
Dipterocarps	23.23%
Others	20.21%

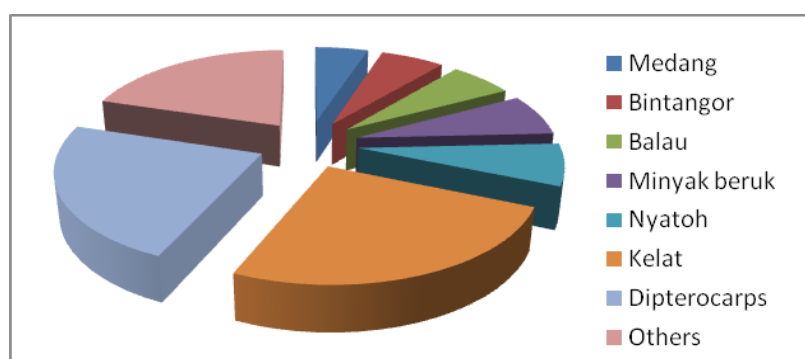
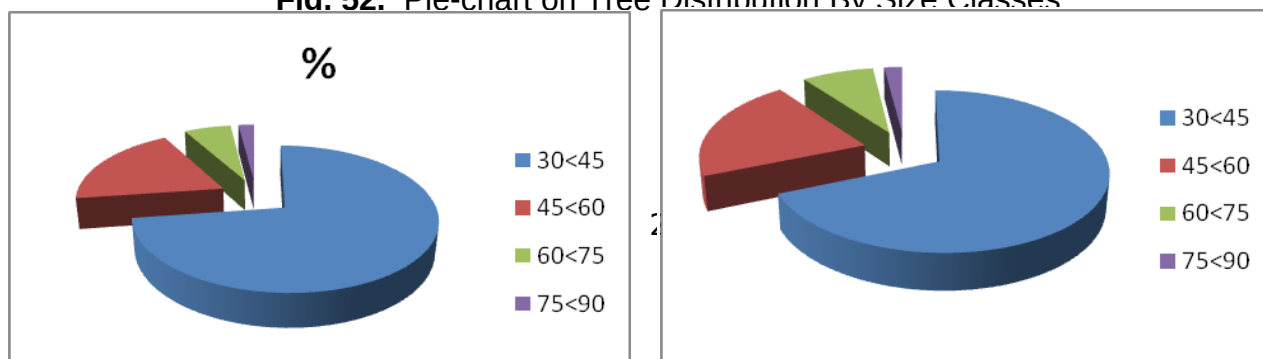


Fig. 52. Pie-chart on Tree Distribution By Size Classes



PSP93

With a total population of only 59/ha of trees of 30.0cm DBH and above, PSP93 and the forest it represents both of which lie in the valley bottom, are clearly in a rather poor stocking with similarly low species diversity. This was coupled by the fact that trees of 30<45cm DBH class constituted nearly 60% of the total standing tree population in 2006, but had since reduced by 11.86% to 47.46% in 2010 as a result of growth into larger size classes. Due to its location, a majority (28.81%) of the trees were Kasai, followed by Medang (15.25%), Mahang (8.48%), and Melunak and Gapis (both 5.08% respectively). Dipterocarps which were represented by Balau, Chengal, Mersawa, Meranti kepong, Meranti sarang punai, Meranti tembaga and Keruing stood at a respectable 15.25%.

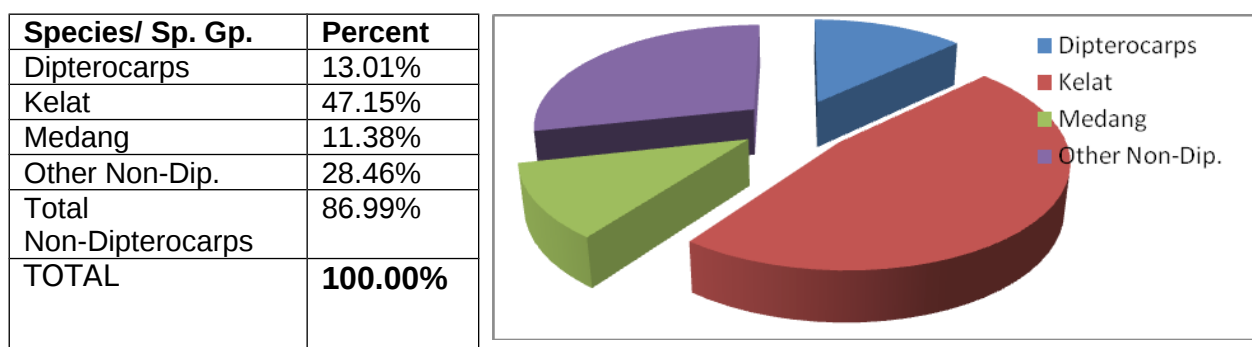
In terms of growth behaviour, due to the relatively open condition, all trees seemed to show high growth rates with an average of 0.95cm/yr. Dipterocarps were found to grow at 1.04cm/yr and Non-Dipterocarps at 0.93cm/year.

PSP 107

The forest in PSP107 and its surrounding fall under the ***Kelat-Dipterocarp-Medang subtype*** in which Kelat predominates overwhelmingly at 47.15% by numbers followed by Dipterocarps at 13.01% and Medang at 11.38%, thus giving a total of 71.56%. Under the circumstance, "Other Non-Dipterocarps" could only muster a

presence of 28.46% which consist of 18 other tree species. The result is a PSP which is less diverse in terms of tree species as compared to other PSPs. Among the Dipterocarp species, Meranti sarang punai and Keladan were present at 5.69% and 4.88% respectively, whereas amongst the Non-Dipterocarps, Penarahan was present at 4.07%. In terms of size structure, trees within the 30<45cm DBH class were present at 58.54% in 2006 which were reduced by 14.64 to 43.90% in 2010 as a results of growth. Similarly, trees in other size classes also grew accordingly. Dipterocarp trees grew at 0.95cm/year, higher than, the Non-Dipterocarps at 0.91cm/yr, and together they yield an average general growth rate of 0.91cm/year for all trees.

Fig. 60. PSP107 - Proportional Distribution of Major Species/ Sp. Gp.

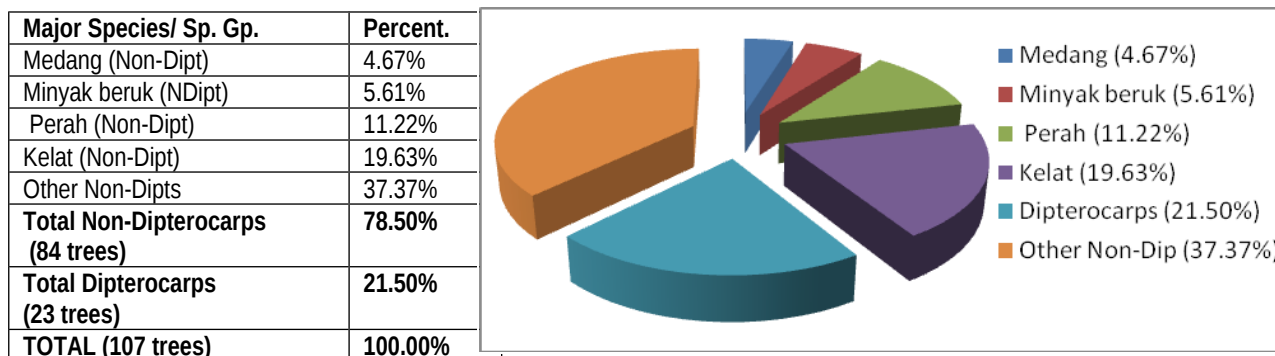


PSP113

Richly endowed with at least 41 timber species/ species groups and 107/ha of trees of 30.0 cm DBH++ in size, the mixed dipterocarp forest stand within and in the immediate vicinity of PSP113 can be categorized as ***Dipterocarp-Kelat-Perah*** forest subtype. Other species being found here included Minyak beruk, Medang, Bintangor, etc (see Table 1/113 & Fig. 65). Dipterocarp species constituted 21.50%, followed by Kelat and Perah at 19.63% and 11.21% respectively, of the total tree population. There was no tree above 90.0cm DBH in size. On the other hand the trees within the 30<45cm DBH class constituted about 72% of the standing tree population, which subsequently reduced by about 13% to 59% four years later due to the grow that took place in the intervening years. Trees in other size classes also experienced similar growth phenomenon. As a whole, trees within PSP113 grew at

0.83cm/year with Dipterocarps growing higher at 0.91cm/yr compared to Non-Dipterocarps at 0.80cm/year.

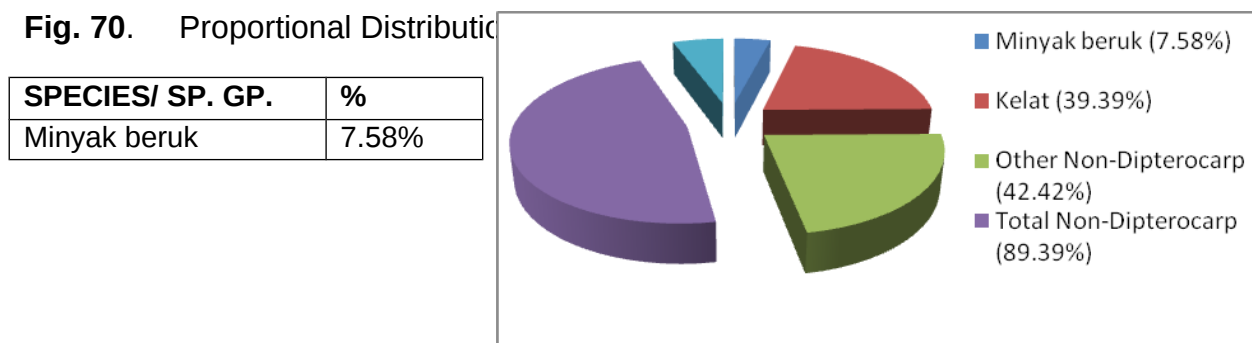
Fig. 66. Composition of Major Tree Species/ Species Groups In PSP113.



PSP122

The total number of standing trees of 30cm DBH ++ in this PSP was only 66 trees/ha from only 19 species/ species groups indicating it having sustained quite a severe impact of the previous land use (i.e timber harvesting). Dipterocarp species formed 10.61% of the population, whereas among the Non-Dipterocarps, Kelat species constituted 39.39% followed by Minyak beruk at 7.58%. It is therefore safe to describe the timber stand within this PSP and areas with similar species consociation of the **Kelat-Dipterocarp-Minyak beruk** subtype. Other important timber species in this area were Rengas, Nyatoh, Merpauh, Medang, Kayu arang and Bitis. The state of regeneration of the stand within PSP122 can be seen in the high percentage of trees of 30<45cm DBH size class which was 77.27% in 2006 and shifted to 63.64% in 2010 and trees within the 45<60cm DBH class shifted from 19.70% in 2006 to 31.82% in 2010. However, trees within the 75cm DBH group and above were absent altogether. There was no mortality among the trees during the period. Nevertheless, despite the rather open and spacious growing condition, the diameter growth rate was only 0.88cm/yr of which Dipterocarps grew at 0.90cm/yr whereas the Non-Dipterocarp species added 0.87cm/yr over the said period.

Fig. 70. Proportional Distribution of Major Tree Species/ Species Groups In PSP122.

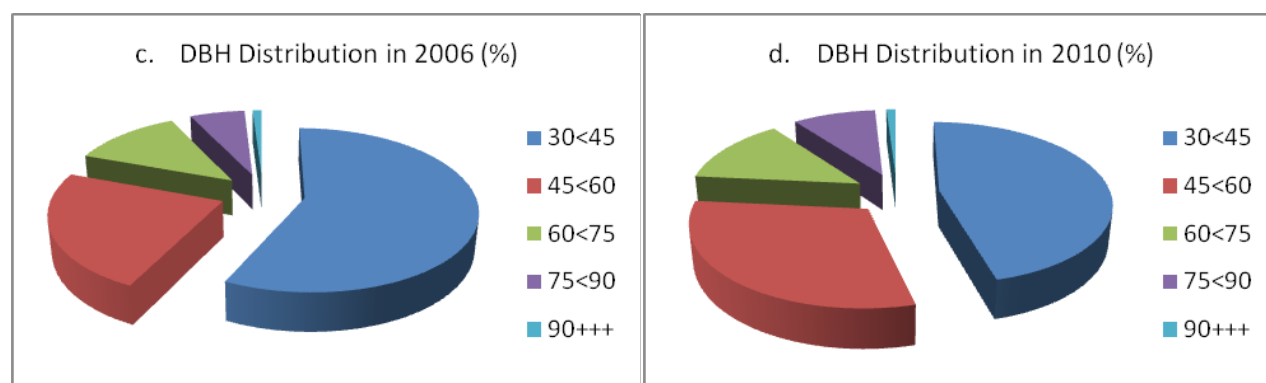
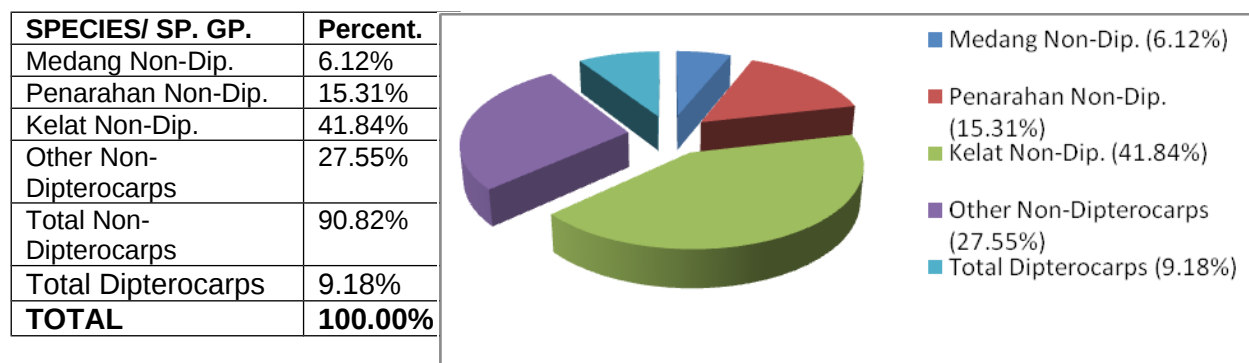


Kelat	39.39%
Other Non-Dipterocarp	42.42%
Total Non-Diptero	89.39%
Total Dipterocarp	10.61%
TOTAL	100.00%

PSP126

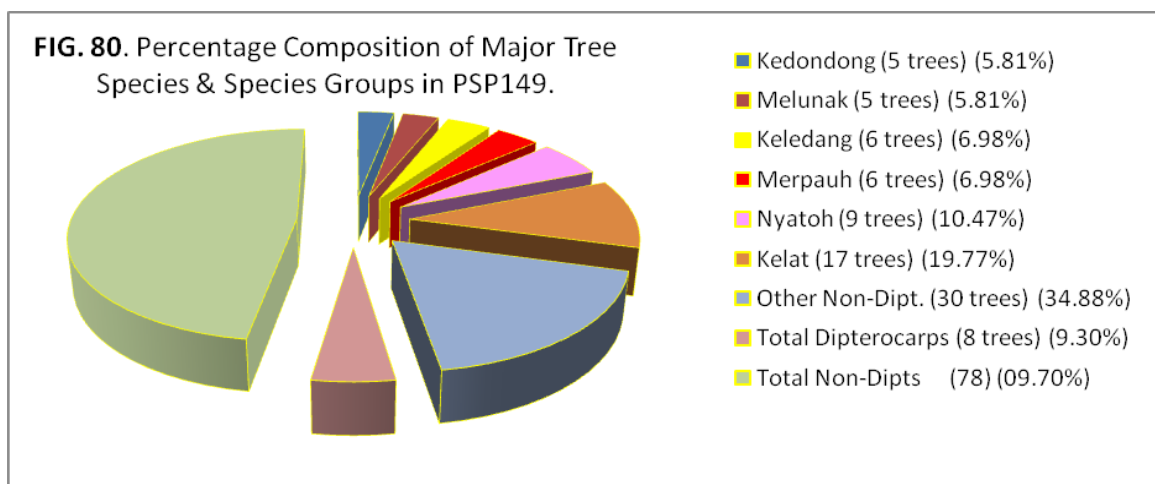
The timber stands within and in the vicinity of PSP126 are characterized by an overwhelming presence of Kelat (41.84%) and Penarahan (15.31%) species with a respectable presence of Medang (6.12%) – all of which make up to 63.27% of the total tree population by numbers. With the presence of Dipterocarps at 9.18%, the whole stand can be classified into the ***Kelat-Penarahan-Dipterocarp*** forest subtype. In terms of size distribution, trees within the 30<45cm DBH class constituted 57.15% in 2006 which subsequently shifted to 45.92% in 2010 as a result of a reasonably rapid growth. Similar trends were also observed in the other DBH size classes. The mean diameter p.a.i. for all trees were 0.85cm/y in which Dipterocarps registered 0.90cm and Non-Dipterocarps 0.90cm/yr. Of the total population, only Mahang (*Macaranga spp.*) showed a dpai of greater than 1.0cm/tree/year.

Fig. 75. Percentage Distribution of Major Species/ Species Groups in PSP126.

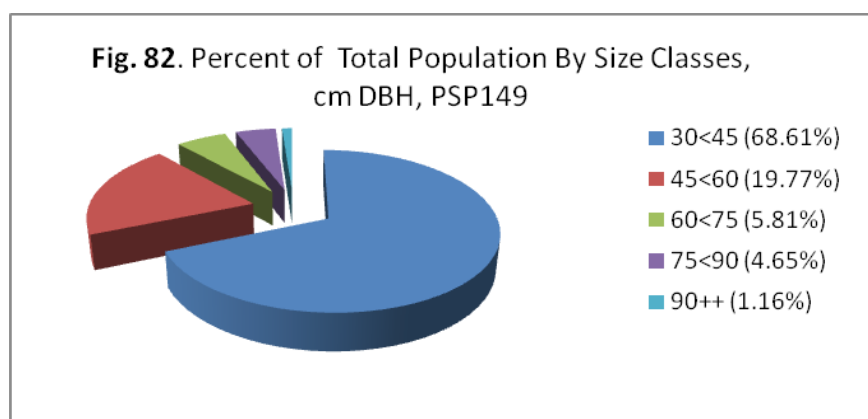


PSP 149

The timber stands within and in the immediate vicinity of PSP149 can be categorized into the Kelat-Nyatoh-Dipterocarp forest subtype with significant presence of Keledang and Merpauh. There were a total of 24 species/ group of tree species in this PSP with Dipterocarps accounting for 9.3% only of the total tree population by numbers. In terms of stand structure, trees within the 30<45cm DBH size class constituted nearly 70% of the total population. The mean diameter p.a.i. for all trees was 0.91cm/year with dipterocarps registering a slightly growth rate (0.98cm/yr) over non-dipterocarps (0.92cm/yr). Tree species showing dpai of 1.00cm/yr and higher were: Meranti paang, Durian, kembang semangkuk, Mempisang, Merbatu, Pelong, and Penarahan.



DBH (2006)	%
30<45	68.61%
45<60	19.77%
60<75	5.81%
75<90	4.65%
90++	1.16%
Total	100.00%



3.2 Diameter Growth Rates

Some ideas on the periodic annual increment in the diameter at breast height (dpai) of the trees of 30cm DBH and above in the 18 PSPs have been presented above. A more detailed description on this vital component of forest growth and yields can be obtained from the following Tables 5 through to 12, which reveal some very interested results and patterns.

3.2.1 Periodic Annual Diameter Increment By DBH Classes

Generally the dpai for the trees of 30cm DBH and above vary little with the different size classes, ranging from 0.81cm/tree/yr for trees below 60cm DBH to 0.87cm/tree/yr for those above 75 cm in DBH. This is to be expected in a TRF stand managed according to the selection felling system. The average dpai for all trees in all PSPs combined was 0.81cm which represented a wide range of dpai values from as low as 0.16cm/tree/yr (PSP60) to as high as 1.01cm/tree/year (PSP38).

3.2.2 Periodic Annual Diameter Increment By Species

Table 11 shows that the 18 PSPs contain no less than a total of 19 species of dipterocarps and 74 species of non-dipterocarps, each of which exhibit their own peculiarities in terms of growth behaviour. Among the dipterocarp species which had a mean dpai of 0.82cm/tree/yr, Balau, Damar hitam, Keruing, Resak and the Merantis held sway with reasonably good representations. The merantis in particular deserve mention for their ability to maintain dpai in excess of 1.00cm/tree/yr, e.g. Meranti paang (1.36cm), Meranti tembaga (1.05cm) along with Mersawa (1.28cm).

Among the non-dipterocarp species, Kelat, Simpoh, Medang, Nyatuh, Penarahan, Kedondong, Rengas, Merpauh and Melunak dominate, each with a representation of 30 or more individuals in all the PSPs combined. The dpai of all the individual non-dipterocarp tree species are as summarised in **Table 12** in which yields a mean value of 0.81cm/tree/year.

More detailed analyses of the data are shown in **Annex** to this report.

4.0 Summary And Recommendations

From the foregoing, the following can be deduced of the Growth and Yield research conducted by KPKKT in DTC, *i.e.* based on the 4-year data collected and analysed from the 18 PSPs :

1. Due to the extremely heterogeneous nature of the species and size compositions of the TRF in DTC, the multitude of tree species coexist in various consociations which could be identified into at least 11 forest sub-types of which 10 were characterized by the dominance of Kelat (genus *Syzigium*), followed closely by the Dipterocarpaceae family.
2. To a certain degree, the Selective Management System (SMS) as practiced by KPKKT in DTC had managed to maintain the structural balance of the standing stock of the second growth forest in terms of the proportional balance (*i.e.* percentage distribution) of Dipterocarp and Non-Dipterocarp tree species, and the different size (DBH) classes.
3. During the early stages of the second growth forest, nearly 60% of the standing trees were in the 30-45cm DBH class, followed by 28% in the 45-60cm DBH class. This provides both the challenge and opportunity for the forest manager to rehabilitate and make sure a consistently high growth rates of the young potential crop trees (PCT), in keeping with the dictates of the Selective Management System (SMS).
4. Tree growth rates in terms of diameter p.a.i. were found to be generally reasonably high and within sight of the targets set by SMS. However some proactive and aggressive silvicultural measures are obviously needed in order to maintain a consistently high diameter increment of the standing trees over the entire rotation of 30 years.
5. The mean dpai for Dipterocarp tree species was 0.82 cm/tree/year as against 0.81cm/tree/year for the Non-Dipterocarps.
6. These preliminary findings justify a longer monitoring of the Growth and Yield PSPs and further in-depth analyses of the data. Also other associated and relevant research undertakings are obviously needed in order to further

elucidate and understand the growth behaviour and recovery of the trees and regeneration within the second growth stands managed under SMS.

The following line of actions is recommended for KPKKT in this regard:

6. Expand and strengthen the company's in-house capability in growth and yield research through proper training and consistent efforts in this field.
7. Extend the re-measurement exercise of the PSPs to as many years as possible so as to cover all the 70 PSPs within DTC.
8. Keep maintaining all the plots to ensure their accessibility and integrity, as well as the identity of the trees and regeneration being measured.
9. Keep re-measuring the PSPs according to a frequency that has been laid down by commonly established protocols on G & Y studies.
10. Ensure a well-kept and well-maintained database and hard copies of the field data, record and information.
11. Collaborate with appropriate forestry research institutions such as FRIM and the relevant universities in order to circumvent the problem of shortage of qualified staff, time and other resources.
12. Integrate the G & Y findings into KPKKT's Forest Management Plan and relevant decision-making process.
13. Allocate appropriate budget and manpower and plan sufficiently ahead to ensure a successful conduct the G & Y research and monitoring.

Table 5.

Periodic Annual Increment for Diameter at Breast Height (dpai) by Size Classes

No	PSP No	DBH Class, cm										Total	
		>30<45		45<60		60<75		75<90		90++			
		No/ha	dpai	No/ha	dpai	No/ha	dpai	No/ha	dpai	No/ha	dpai	No/ha	dpai
1	31	64	1.06	43	0.87	18	1.04	7	1.03	4	1.00	136	0.99
2	38	71	0.99	29	1.04	10	1.13	4	0.94	5	1.04	119	1.01
3	54	53	0.91	24	0.82	4	0.89	3	0.78	0	0	84	0.88
4	60	69	0.15	26	0.17	7	0.13	0	0	1	0.3	103	0.16
5	62	71	0.91	23	0.93	23	0.94	1	0.95	0	0	118	0.92
6	63	80	0.92	23	0.97	10	0.84	3	0.80	1	0.97	117	0.92
7	66	51	0.91	16	0.81	12	0.84	3	0.78	7	0.84	89	0.87
8	69	74	0.93	23	0.95	8	0.90	1	0.88	0	0	106	0.93
9	75	36	0.79	17	0.85	3	0.78	3	0.78	0	0	59	0.81
10	80	52	0.29	8	0.27	3	0.10	0	0	0	0	63	0.28
11	86	107	0.92	25	0.89	8	0.73	2	0.60	1	0.02	143	0.89
12	88	72	0.38	19	0.24	6	0.35	2	0.46	0	0	99	0.35
13	93	35	0.94	11	0.94	4	1.07	6	0.97	3	0.85	59	0.95
14	107	72	0.93	37	0.88	10	0.87	3	0.96	1	1.03	123	0.91
15	113	77	0.81	23	0.86	4	0.88	3	0.95	0	0	107	0.83
16	122	51	0.89	13	0.80	2	1.01	0	0	0	0	66	0.88
17	126	56	0.87	23	0.82	12	0.85	6	0.84	1	0.80	98	0.85
18	149	49	0.91	14	1.00	4	0.94	4	0.91	1	1.00	72	0.93
	Mean	63.66	0.81	22.06	0.81	8.22	0.84	3.40	0.87	1.39	0.87	97.83	0.81

Table 6. Summary of dpai By DBH Classes For 18 PSPs.

Parameter		Diameter at-breast Height (DBH) Classes, cm					All Sizes
		30<45	45<60	60<75	75 <90	90++	
Tree Description Based on 18 PSPs	Total No. of Trees	1,140	397	148	51	25	1,761
	Average No. of trees/ha	63.33	22.06	8.22	3.40	1.39	97.83
	Maximum	107	43	23	7	7	143
	Minimum	35	8	2	0	0	59
	Std. Dev.	17.378	8.680	5.547	1.765	2.033	26.246
DBH Periodic mean annual increment, dpai cm/tree/yr	Dpai, cm/tree/yr	0.81	0.81	0.84	0.87	0.87	0.81
	Dpai max	1.06	1.04	1.13	1.03	1.04	1.01
	Dpai min	0.15	0.17	0.10	0.46	0.02	0.16
	Std. Dev.	0.255	0.266	0.297	0.152	0.346	0.253

Table 7 :
 Diameter p.a.i of Dipterocarp Trees >30cm DBH For PSP Nos.
 31, 38, 54, 60, 62, 63, 66, 69, 75.

No	Diptero -carp Spp.	PERMANENT SAMPLE PLOTS (PSP)																	
		31		38		54		60		62		63		66		69		75	
		No	d	No	d	No	d	No	d	No	d	No	d	No	d	No	d	No	d
1	RSK	1	0.95	1	0.90									1	0.80	2	0.93		
2	MTRD	2	1.04	1	1.28	1	0.95					3	0.92						
3	MTPA	1	1.25																
4	MWN			2	1.10	2	0.83							1	0.95				
5	BLU			5	1.05							7	1.01	1	0.75	1	1.00	3	0.91
6	DH			3	0.97							9	0.92	6	0.79			1	0.77
7	KPR			1	1.00														
8	KR			3	1.06	1	0.75							3	0.82	2	0.89	2	0.79
9	MTLG			7	1.08														
10	MTML			2	1.21	2	1.03					4	0.92				3	0.95	
11	MTSP			6	0.95	3	0.75					4	0.94	1	1.00	2	0.91		
12	MTKP											3	0.90					1	0.82
13	MTSMH											3	1.01				1	0.95	
14	MTNM													5	0.89			1	1.03
15	MTTB													7	1.36			3	0.87
16	MTSY															7	0.90		
17	MSW															1	1.18		
18	KLD																		
19	CGL																		

Table 8.
 Diameter p.a.i of Dipterocarp Tree Species in PSP Nos:
 80, 86, 88, 93, 107, 113, 122, 126, 149

No	Dipter- ocarp Spp	PERMANENT SAMPLE PLOTS (PSP)																	
		80		86		88		93		107		113		122		126		149	
		No	d	No	d	No	d	No	d	No	d	No	d	No	d	No	d	No	d
1	RSK	2	0.08	1	0.73	1	0.18					3	0.80						
2	MTRD					2	0.73					2	0.99						
3	MTPA			2	2.26							4	0.99					1	1.13
4	MWN					1	0.03												
5	BLU	4	0.38			6	0.28	1	0.92			1	0.70						
6	DH					4	0.36					2	0.84	2	1.10				
7	KPR																		
8	KR							3	1.06					2	0.81				
9	MTLG	3	0.13													2	0.91		
10	MTML	2	0.09	1	0.78	1	0.05					1	0.88	3	0.82			6	0.96
11	MTSP					4	0.43	1	1.08	7	0.93	4	0.99			2	0.90		
12	MTKP	1	0.13			2	0.30	1	1.08			1	0.85			3	0.97		
13	MTSMH					2	0.25									2	0.80		
14	MTNM									1	1.03	3	0.94						
15	MTTB	1	0.07					1	1.08	2	1.00	2	0.82					1	0.90
16	MTSY																		
17	MSW							1	1.38										
18	KLD	2	0.05							6	0.94								
19	CGL							1	0.70										

Table 9.

Summary of dpai. of Non-Dipterocarp Tree Species For PSP Nos:
 31, 38, 54, 60, 62, 63, 66, 69, 75.

NO	NON-DIPT SPP	PERMANENT SAMPLE PLOT (PSP)																	
		31		38		54		60		62		63		66		69		75	
		#	d	#	d	#	d	#	d	#	d	#	d	#	d	#	d	#	d
1	Kelat	64	1.02	24	1.00	14	0.88	24	0.18	18	0.97	29	0.88	15	0.83	25	1.00	13	0.75
2	Simpoh	20	1.07	1	1.05			1	0.07					11	0.88				
3	Medang	8	0.90	3	1.07	6	1.10	11	0.15	7	0.87	7	0.91	3	0.75	7	0.90	2	0.70
4	Membuluh	7	1.00													1	0.95	1	0.82
5	Rambutan	6	0.98	6	0.90	3	0.93			2	0.95								
6	Sesenduk	5	0.96							1	0.92	1	0.90	1	1.00	1	0.90	1	1.05
7	Melunak	3	0.88					5	0.21			4	0.90	1	1.00				
8	Nyatuh	3	0.81	3	1.05			5	0.15	2	0.90	6	0.91	5	0.73	7	0.91	2	0.81
9	Petai	3	0.94	1	0.85			1	0.23									1	0.73
10	Bintangor	2	1.01			2	0.73	1	0.10	3	0.98	1	1.00	1	0.80	1	0.93		
11	Pelawan	2	0.96																
12	Bekak	1	0.98									6	0.89					1	0.73
13	Kem. semangkuk	1	1.08	2	1.11	2	0.93	3	0.21	3	0.83	1	0.92			1	1.10	1	0.98
14	Kempas	1	1.15	2	1.15			2	0.11	1	0.88	1	0.75	6	0.74				
15	Kulim	1	0.80	2	1.04									1	0.85				
16	Kungkur	1	0.63			1	0.70					1	0.80						
17	Mempe-ning	1	0.88					3	0.07									5	0.88
18	Penarahan	1	1.05	2	1.01	2	0.71			6	0.92	1	0.83	2	0.81	3	1.00	1	0.73
19	Tinjau Belukar	1	0.82											1	0.68				
20	Petaling	1	1.05	9	0.92	5	0.91	4	0.08									3	0.73
21	Berangan			1	1.05	8	0.79	2	0.10	4	0.97	1	0.80	1	0.95				
22	Dedap			1	1.18	1	0.78	1	0.30										
23	Jangkang			1	1.08					1	0.93								
24	Kayu arang			3	0.95			2	0.18			1	0.80					2	0.71
25	Kasai			2	0.96	1	1.03												
26	Kandis			1	0.63							1	0.80	2	0.86			1	0.90
27	Kandis			4	1.09	3	0.93	3	0.17	4	0.93	2	0.88	3	1.11	5	0.88		
28	KerANJI			1	0.98	1	0.70	1	0.07	1	0.90								
29	Minyak Beruk			1	0.85	1	0.78	3	0.22	2	0.88	1	0.82			2	0.94		
30	Mata ulat			3	1.12			2	0.20	4	0.66	1	0.83	1	0.85	1	0.90		
31	Mahang			2	0.61	5	0.81			7	0.92							1	0.98
32	Mempisang			1	1.05					2	0.99			1	1.03	3	0.85	1	0.70
33	Merbau			1	1.05	1	0.80	2	0.09	2	0.95								
34	Meribut			1	1.10														
35	Misc			1	1.05														

36	Penaga			2	1.04					2	0.81	2	1.04	2	0.63	1	0.88		
37	Petai Meranti			1	0.97														
38	Putat			1		1	0.73					1	1.63			2	0.84		
39	Rengas			6	1.11	4	0.72	3	0.17	2	0.96	3	0.87	1	0.68	14	0.90	1	0.80
40	Jenjulung					1	0.88												
41	Kekatang					1	1.05												
42	Keledang					1	0.70			1	0.85								
43	Kerdas					1	0.73												
44	Mengku- lang					1	0.82			1	0.98			1	0.70	3	0.86		
45	Merpauh					5	1.12			6	0.91	6	0.88	1	0.75				
46	Perah					3	0.88	1	0.03										
47	Sepetir					1	0.98												
48	Gerong- gang							1	0.13					2	0.83				
49	Ludai							1	0.15									8	0.82
50	Tempinis							1	0.28	2	0.91								
51	Bitis									1	1.05	2	0.84			8	0.88		
52	Jelutung									1	1.00	1	2.45						
53	Pelong									1	0.98								
54	Merbatu									4	0.91								
55	Durian											2	0.89			1	0.92		
56	Ramin											1	1.03						
57	Teren- tang											1	0.88						
58	Pulai											1	0.90						
59	Meraga											1	0.88						
60	Kelum- pang															1	1.03		
61	Pauh kijag																	1	0.75
62	Tampoi																	1	0.82
63	Dedali																	1	0.92
64	Bang- kung																		
65	Perupok																		
66	Gapis																		
67	Kelem- payan																		
68	Kepa- yang																		
69	Kubin																		
70	Melembu																		
71	Nipis kulit																		
72	Damar minyak																		
73	Ara Btih																		
74	Terap																		

Table 10.

Summary of dpai of Non-Dipterocarp Tree Species in PSP Nos.
80, 86, 88,93,107,113,122, 126 and 149

NO	NON-DIPT SPECIES	PERMANENT SAMPLE PLOT (PSP)																	
		80		86		88		93		107		113		122		126		149	
		No	D	No	D	No	D	No	D	No	D	No	D	No	D	No	D	No	D
1	Kelat	14	0.10	33	0.90	25	0.27	2	0.94	58	0.89	21	0.80	26	0.92	41	0.83	14	0.80
2	Simpoh	3	0.17	32	0.85					4	0.99								
3	Medang	13	0.37	6	0.87	5	0.50	9	0.96	14	0.94	5	0.88	3	0.80	6	0.90	4	0.99
4	Membuluh	1	0.20	11	0.87					1	0.95	1	0.93					4	0.91
5	Rambutan			3	0.98	1	0.10			3	0.89			1	1.00				
6	Ssesenduk	5	1.33	10	0.97													3	0.97
7	Melunak			2	0.85	4	0.53	3	0.80			1	0.80			2	0.99	5	0.90
8	Nyatuh			8	1.18	7	0.61			3	0.89	2	0.84	3	0.76	2	0.90	5	0.91
9	Petai											1	0.70			1	0.95		
10	Bintangor			5	0.77	6	0.31			1	0.95	4	0.81	1	1.00				
11	Pelawan																		
12	Bekak			1	0.73														
13	Kembang semangkuk									1	0.90							1	1.08
14	Kempas					3	0.73					2	0.64						
15	Kulim											2	0.85			1	0.98		
16	Kungkur																		
17	Mempening	1	0.13			1	0.53	1	0.77			2	0.86						
18	Penarahan	2	0.13	1	0.02	1	0.32	1	1.03	5	0.84	1	0.85			15	0.85	1	1.03
19	Tinjau Belukar																		
20	Petaling	1	0.13									1	0.68	2	0.94	1	0.70		
21	Berangan	3	0.13	1	0.70	1	0.33			2	0.91	1	0.73			2	0.69	2	0.89
22	Dedap	2	0.12																
23	Jangkang											1	0.70	1	1.03				
24	Kayu arang							1	1.03					3	0.82				
25	Kasai							17	0.82										
26	Kandis			1	0.68							1	0.77						
27	Kedondong			2	0.95	3	0.40			2	0.93	3	0.90	2	0.75	1	0.92	5	0.86
28	KerANJI					1	0.00					1	0.78			2	0.88	1	0.80
29	Minyak beruk			1	0.70	7	0.38					6	0.81	5	0.74				
30	Mata ulat			1	2.53											2	0.84		
31	Mahang							5	1.08	1	0.90	1	0.93			1	1.03		
32	Mempisang	2	0.10	3	0.67			1	1.20	3	0.93			1	0.75	3	0.97	1	1.00
33	Merbau									1	0.80								
34	Meribut																		
35	Miscellaneous																		
36	Penaga					1	0.00					2	0.83	1	0.80			2	0.85
37	Petai meranti																		
38	Putat																		
39	Rengas					1	0.20					2	0.74	3	1.04				
40	Jenjulong																		
41	Kekatong							1	0.65							1	0.80		
42	Keledang											1	1.13			3	0.80	5	0.95
43	Kerdas																		
44	Mengkulang											1	1.03						
45	Merpauh			3	0.63	3	0.17					3	0.77	3	0.88			6	0.87
46	Perah											12	0.78			3	0.68		
47	Sepetir									1	0.93	1	0.68			1	0.88		
48	Geronggang			3	1.05	1	0.48			3	1.00								
49	Ludai			1	1.05					1	0.88								
50	Tempinis			5	0.52	1	0.05												
51	Bitis			1	0.75	1	0.50							3	0.77				
52	Jelutung					1	0.57					1	0.90						
53	Pelong											1	0.65					1	1.15

54	Merbatu	1	0.05	5	0.74						1	0.75					3	1.53
55	Durian					1	0.00				1	0.65	1	0.80			1	1.00
56	Ramin																	
57	Terentang																	
58	Pulai																	
59	Meraga			1	0.83													
60	Kelumpang																	
61	Pauh kijang																	
62	Tampoi																	
63	Dedali																	
64	Bangkung			1	0.75													
65	Perupuk					1	0.15											
66	Gapis							3	0.64									
67	Kelempayan							2	1.19									
68	Kepayang							1	1.45									
69	Kubin							2	1.23									
70	Melembu							1	1.33									
71	Nipis kulit									2	0.93							
72	Damar minyak									1	0.95							
73	Ara bertih										1	0.80						
74	Terap															1	0.93	

Table 11:

Summary of Diameter p.a.i. of Dipterocarp Trees >30cm DBH for 18 PSPs.

NO.	DIPTEROCARP SPECIES	TOTAL	
		Sample Size	Dpai, cm/tree/yr
1	Resak	12	0.67
2	Meranti rambai daun	11	0.96
3	Meranti paang	8	1.36
4	Merawan	6	0.81
5	Balau	29	0.75
6	Damar hitam	27	0.82
7	Kapur	1	1.00
8	Keruing	16	0.91
9	Meranti lagong	12	0.81
10	Meranti melantai	25	0.84
11	Meranti sarang punai	34	0.87
12	Meranti kepong	12	0.76
13	Meranti sengkawang merah	8	0.76
14	Meranti nemesu	10	0.93
15	Meranti tembaga	17	1.05
16	Meranti seraya	7	0.90
17	Mersawa	2	1.28
18	Keladan	8	0.72
19	Chengal	1	0.70
20	TOTAL DIPEROCARPS (Incl. Other Dipterocarp Species not mentioned above)	292	0.82

Table 12:

Diameter Periodic annual increment for Non-Dipterocarp Species

No	Species	TOTAL Populatio n	dpai cm/tree/yr
1	Kelat	460	0.81
2	Simpoh	72	0.89
3	Medang	119	0.77
4	Membuluh	27	0.89
5	Rambutan	25	0.91
6	Sesenduk	28	1.03
7	Melunak	30	0.73
8	Nyatuh	63	0.82
9	Petai	8	0.79
10	Bintangor	28	0.72
11	Pelawan	2	0.96
12	Bekak	9	0.86
13	Kembang semangkok	16	0.83
14	Kempas	18	0.73
15	Kulim	7	0.92
16	Kungkur	3	0.71
17	Mempening	14	0.62
18	Penarahan	45	0.81
19	Tinjau belukar	2	0.75
20	Petaling	27	0.73
21	Berangan	29	0.70
22	Dedap	5	0.50
23	Jangkang	4	0.94
24	Kayu arang	12	0.74
25	Kasai	20	0.84
26	Kandis	7	0.79
27	Kedondong	42	0.84
28	KerANJI	9	0.67
29	Minyak beruk	29	0.64
30	Mata ulat	15	0.88
31	Mahang	23	0.91
32	Mempisang	22	0.83
33	Merbau	7	0.68
34	Meribut	1	1.10
35	Miscellaneous	1	1.05
36	Penaga	15	0.81
37	Petai meranti	1	0.97
38	Putat	5	0.81
39	Rengas	40	0.84
40	Jenjulong	1	0.88
41	Kekatong	3	0.83
42	Keledang	11	0.89
43	Kerdas	1	0.73
44	Mengkulang	7	0.87

45	Merpauh	36	0.82
46	Perah	19	0.74
47	Sepetir	4	0.87
48	Geronggang	10	0.84
49	Ludai	11	0.79
50	Tempinis	9	0.53
51	Bitis	16	0.83
52	Jelutung	4	1.23
53	Pelong	3	0.93
54	Merbatu	14	0.91
55	Durian	7	0.74
56	Ramin	1	1.03
57	Terentang	1	0.88
58	Pulai	1	0.90
59	Meraga	2	0.86
60	Kelumpang	1	1.03
61	Pauh kijang	1	0.75
62	Tampoi	1	0.82
63	Dedali	1	0.92
64	Bangkung	1	0.75
65	Perupok	1	0.15
66	Gapis	3	0.64
67	Kelempayan	2	1.19
68	Kepayang	1	1.45
69	Kubin	2	1.23
70	Melembu	1	1.33
71	Nipis kulit	2	0.93
72	Damar minyak	1	0.95
73	Ara bertih	1	0.80
74	Terap	1	0.93
75	TOTAL	1,471	0.81