



# TECHNICAL REPORT

The Quantification Of Dry And Wet  
Inland *Gonystylus* Spp. (Ramin),  
*Aquilaria* Spp. (Karas) And *Intsia* Spp. (Merbau)  
In Peninsular Malaysia

ITTO-CITES PROJECT  
MALAYSIA'S WORK PROGRAMME FOR 2008

Ensuring International Trade in CITES-listed Species is Consistent with  
their Sustainable Management and Conservation

PREPARED BY:  
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# GLOSSARY

BA	:	Basal Area
cm	:	Centimeter
dbh	:	Diameter Breast Height
EIA	:	Environment Investigations Agency
GPS	:	Global Positioning System
m	:	Meter
IUCN	:	International Union for Conservation of Nature
NFI	:	National Forest Inventory
NGO	:	Non-Governmental Organization
PSP	:	Permanent Sample Plot
PVC	:	Polyvinyl chloride
SU	:	Sampling Unit



*Intsia bijuga*

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# ABSTRACT



*Gonystylus confusus*

Assessment on the distribution of *Gonystylus* spp. (Ramin), *Aquilaria* spp. (Karas) and *Intsia* spp. (Merbau) are important due to widespread concerns about the existing rate in Peninsular Malaysia. Assessment on the distribution of these 3 species through Peninsular Malaysia was conducted using NFI-4 sampling unit and PSPs. The study shows (59 SU) only 2 species namely *A. hirta* and *A. malaccensis* were found. Total number of stem recorded is 3.955 stem per hectare where 2.800 and 1.156 stem per hectare for *A. hirta* and *A. malaccensis* respectively. Both species are concentrated in diameter classes 1.5m<10cm and 10 < 30cm, comprising 3.642 tree per hectare or 92.08% of the total stem number recorded. In term of *Intsia* spp., *I. bijuga* and *I. Palembangica* were recorded in the enumeration. Total number of stem per hectare for both species is 0.057, where *I. bijuga* made up recorded 0.01277 stem per hectare and *I. palembanica* recorded 0.0339 stem per hectare. Five *Gonystylus* spp. are recorded in the enumeration namely *G. bancanus*, *G. affinis*, *G. macrophyllus*, *G. brunnescens*, *G. confusus* and *G. maingayi*. Total number of stem per hectare for all species is 19.51 stem per hectare. *G. confusus* which is a dry inland *Gonystylus* spp. represents about 48.57% or 9.48 stem per hectare of the all the *Gonystylus* spp. recorded. As for *G. bancanus* or wet inland *Gonystylus* which mainly found in the peat swamp forest recorded 5.94 stem per hectare or 26.3% of all the *Gonystylus* spp. enumerated.

## 1.0 INTRODUCTION

- 1.1 *Gonystylus* (Ramin) is one of three genera of plants in the *Gonystyloidea* sub-family of *Thymelaeaceae* family. At present, the genus *Gonystylus* consisting of about 30 species of tall trees and some shrubs, is distributed throughout the Malesian area (Indonesia, Malaysia, the Philippines, Papua New Guinea, Singapore and Brunei Darussalam) (Soerianegara & Lemmens, 1994). The vast majority of species are found on Borneo (27 species), especially in Sarawak. Peninsular Malaysia and Sumatra come second with 7 species each, and the Philippines possess 2 species. There are seven (7) *Gonystylus* spp. (Ramin) species in Peninsular Malaysia, most of the species occur in the inland dipterocarp forests except *Gonystylus bancanus* that can be found in peat swamp forest (Whitmore, 1972).
  
- 1.2 Six species are currently known to be commercially valuable. These species are *G. affinis*, *G. bancanus*, *G. forbesii*, *G. macrophyllus*, *G. maingayi* and *G. velutinus*. *G. bancanus* is the most commonly traded of the six species. Of the six species, only *G. bancanus* is considered as wet inland *Gonystylus* spp. and the other species are dry inland *Gonystylus* spp. Reliable information on the growth dynamics of both 'dry' and 'wet' inland *Gonystylus* spp. is needed in Peninsular Malaysia for better management and conservation of these species. The silviculture characteristics and distribution of *Gonystylus* spp. is described in **Table 1**.
  
- 1.3 *Aquilaria* spp. is a genus of fifteen species of trees in the *Thymelaeaceae*, native to Southeast Asia. They occur particularly in the rain forests of Indonesia, Thailand, Cambodia, Laos, Vietnam, Malaysia, Northern India, the Philippines, Borneo and New Guinea. The trees grow to 6-20 m tall. *A. hirta*, *A. beccariana*, *A. rosrata*, *A. malaccensis* and *A. microcarpa* are found in Peninsular Malaysia. They produce resin-impregnated heartwood, called Agarwood, that has fragrant and highly valuable especially *A. malaccensis*. The wood is highly demanded for medicine, incense and perfume across Asia and Middle East. The 2002 IUCN Red List classified this species as Vulnerable.



**Table 1:** Silviculture Characteristics and Distribution of *Gonystylus* spp. in Peninsular Malaysia

Species	Silvicultural Characteristic (Average max. tree height and diameter size)	Distribution
<i>Gonystylus affinis</i>	Medium size tree up to 33m tall and bole up to 76cm diameter.	Dryland forest and undulating area.
<i>G. brunnescens</i>	Big size tree up to 36m tall and bole up to 95cm diameter.	Dryland forests and low lying area.
<i>G. confusus</i>	Medium to big size tree up to 30m tall and 70cm diameter.	Dryland forest and lowland area.
<i>G. maingayi</i>	Small to big size tree up to 40m tall and 76cm diameter.	Dryland forest and foothills of mountains up to 600m altitude.
<i>G. bancanus</i>	Medium size tree up to 27m tall and bole up to 67cm diameter. (Record shows that the tree bole up to 80cm diameter)	Found in Peat swamp forest
<i>G. velutinus</i>	Medium to large size tree up to 35m tall and bole up to 70cm diameter.	Sandy soil and clayey swampy soil, very low altitude.

**1.4** *Intsia* spp. is a genus of flowering plants in the pea family, *Fabaceae*. *Intsia* spp. is a widely distributed genus of about nine species (Verdcourt, 1979). In Malaysia, two species have been recorded – *I. bijuga* and *I. palembanica*. *Intsia* spp. has a number of common names but is most widely known as Merbau in Malaysia. *Intsia* spp. (Merbau) are small to large trees evergreen or deciduous, up to 42-50 m tall; bole sometimes of poor shape, branchless up to 20-25m; slight buttress 60-75 cm to huge buttress up to 2m; diameter at breast height up to 160(-250) cm, with spreading crown. There are concerns from NGOs such as Environmental Investigation Agency (EIA) that international trade in *Intsia* spp. exceeds sustainable levels, with evidence of population declines in some range States, and several species included in the IUCN Red List of Threatened Species and the World List of Threatened Trees.

- 1.5 *Gonystylus* spp. (Ramin), *Aquilaria* spp. (Karas) and *Intsia* spp. (Merbau) are important tree species that are currently being utilized in Malaysia. There are widespread concerns about the rate at which these species are being exploited. This is accelerated by the introduction of mechanization in harvesting, improved transport methods and land-use change from forest to agricultural land to support socio-economic development and the demand of an increasing population. Present concerns also include increasing demand for timber from industries, both local and international and to certain extent the threats from illegal logging. Given these concerns, the challenge is to manage the forest in a sustainable manner. Hence, there is a need to gather more information on the growth of both 'dry' and 'wet', *Gonystylus* spp. trees that occur in the inland forest areas. As such, more PSPs are needed to be established so as to be able to provide more reliable information on growth and population dynamics of these species in Peninsular Malaysia.

## 2.0 OBJECTIVES

The aim of the Activity is to contribute significantly in ensuring the stocking and sustainability of *Gonystylus* spp. (Ramin), *Aquilaria* spp. (Karas) and *Intsia* spp. (Merbau) are consistent with the sustainable forest management practices being implemented in Peninsular Malaysia. The specific objectives of this Activity are as follows:

- i. To collect information on the distribution, status and stocking of dry and wet inland *Gonystylus* spp. (Ramin), *Aquilaria* spp. (Karas) and *Intsia* spp. (Merbau) based on the Fourth National Forest Inventory (NFI-4) information in Peninsular Malaysia;
- ii. To establish ten (10) permanent sample plots (PSPs) to periodically monitor the growth, mortality and ingrowth of *Gonystylus* spp. (Ramin) in Peninsular Malaysia.

### 3.0 METHODOLOGY

#### 3.1 *Gonystylus* spp. (Ramin), *Aquilaria* spp. (Karas) and *Intsia* spp. (Merbau) distribution in Peninsular Malaysia based on the Fourth National Forest Inventory (NFI-4).

Study on the content and distribution of *Gonystylus* spp. was carried out based on the NFI-4 data conducted in 2002. Based on the 1644 sampling units (SU) set up for enumeration in NFI-4, a total of 60 SU units were selected that contained *Gonystylus* spp. as well as *Aquilaria* spp. and *Intsia* spp. The *Gonystylus* spp. was given priority in the selection of SU follows by *Aquilaria* spp. and *Intsia* spp. respectively. Of these 60 SU units, 59 still remain intact while one of the SU units have been seriously disturbed due to forest road construction. The 59 SU units chosen are distributed in the state of Selangor (12 SUs), Negeri Sembilan (6 SUs), Johor (11 SUs), Kedah (7 SUs), Terengganu (7 SUs), Kelantan (1 SUs), Perak (10 SUs), Pahang (4 SUs), and Pulau Pinang (1 SU). The distribution and location of the 59 SUs is shown in **Appendix 1**.

#### 3.2 Assessment on distribution and stocking of dry and wet inland *Gonystylus* spp. (Ramin), *Aquilaria* spp. (Karas) and *Intsia* spp. (Merbau)

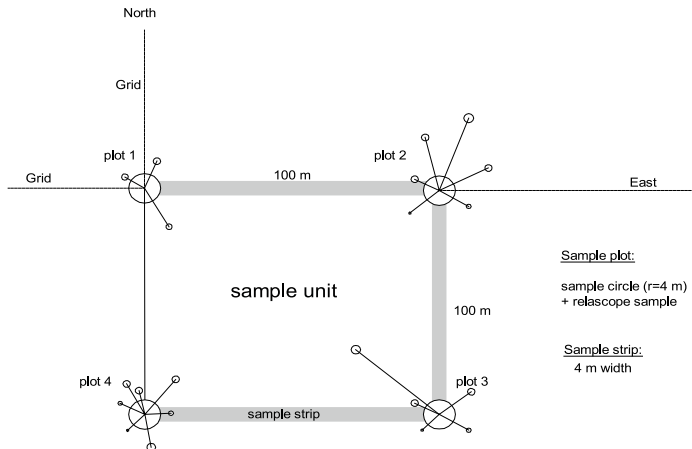
Evaluation on distribution and stocking of dry and wet inland *Gonystylus* spp., *Aquilaria* spp. and *Intsia* spp. was carried out on the 59 SU units selected among the 1644 SU units measured during NFI-4. The species that were enumerated under genus *Gonystylus* spp. are *G. bancanus*, *G. affinis*, *G. confusus*, *G. maingayi*, and *G. velutinus*. As for *Aquilaria* spp., the species are *A. hirta*, *A. beccariana*, *A. malaccensis*, and *A. microcarpa*. In addition, two species *I. palembanica* and *I. bijuga* of genus *Intsia* spp. (Merbau) were enumerated. The local name for all the species enumerated is shown in **Table 2**.

**Table 2:** *Gonystylus* spp. (Ramin), *Aquilaria* spp. (Karas) and *Intsia* spp. (Merbau) Enumerated in the study

Categories	Species	Local Name
<i>Gonystylus</i> spp.	<i>Gonystylus maingayi</i>	Ramin pipit
	<i>Gonystylus brunnescens</i>	Ramin daun tebal
	<i>Gonystylus confusus</i>	Ramin pinang muda
	<i>Gonystylus affinis</i>	Ramin dara elok
	<i>Gonystylus velutinus</i>	Ramin (name not available)
	<i>Gonystylus bancanus</i>	Ramin melawis
<i>Aquilaria</i> spp.	<i>Aquilaria hirta</i>	Karas baldu
	<i>Aquilaria malaccencis</i>	Karas candan
	<i>Aquilaria beccariana</i>	Karas batu
	<i>Aquilaria rosrata</i>	Karas minyak
	<i>Aquilaria microcarpa</i>	Karas buah
<i>Intsia</i> spp.	<i>Intsia bijuga</i>	Merbau ipil
	<i>Intsia palembanica</i>	Merbau

The enumeration of the 59 SU units were carried out by using similar sampling method as in NFI-4. The design of the sampling unit is shown in **Figure 1**. The sampling design consists of sample unit of circle shape with one sample plot each in each in every corner, altogether 4 plots. Each sample consists of a 4 meter radius circle plot for enumeration of small size trees (trees 1.5 m height and < 10cm dbh) and a point sample for big trees (trees  $\geq$  10cm dbh). The measurement of tree diameter at breast height (dbh) was carried out using caliper. Bitterlish Relascope with Basal Area Factor of 4 was used in point sampling method, measuring from the centre of the circle plot. As for the location of the sampling unit, GPS (Garmin 60 CSx) with accuracy of  $\pm 6$  m was used by the inventory team.

**Figure 1: Sampling Unit and Sampling Plots Design Used in the NFI-4**



### 3.3 Training and Implementation

Before enumeration was carried out, a course was conducted for five days to train the inventory teams on the following topics:-

- Navigation and identification of sample unit location of inventory design with the help of GPS, topographic map and field survey;
- Setting up the sampling unit, assessment and measurement procedure;
- Usage of measuring equipments used in the inventory, such as laser range finder, caliper, GPS and relascope; and
- Identification of the tree species.

Field measurement of the 59 SUs unit was carried out by a contractor inventory team, a inventory team consisting of seven men. On the average 8 to 10 SU units were enumerated per month. The field work was carried out from month June to October 2009.

Field check to control the quality of the field enumeration was carried out by an inventory team from the Forest Management Division, Forestry Department Peninsular Malaysia. Field checking was carried immediately every month to ensure that the enumeration procedure and identification of all the species was correctly conducted.

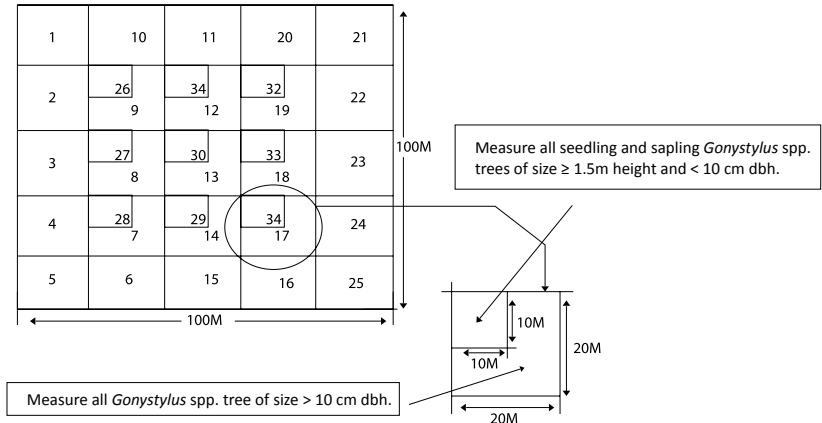
### **3.4 Establishment of ten (10) permanent sample plots (PSPs) for *Gonystylus* spp.**

3.4.1 Establishment of ten (10) permanent sample plots (PSPs) to periodically monitor the growth, mortality and ingrowth of *Gonystylus* spp. in Peninsular Malaysia was carried out in month July to August 2010. The ten (10) PSPs were selected based on the stand content of the 59 SU units that were carried out as described in paragraph 3.3. Selection of the 10 PSPs was based on the following criteria:-

- The number of stem of *Gonystylus* spp. recorded in each sampling unit. Sampling units with most number of stem are preferred to those with lesser number of stem.
- Out of the ten PSPs, five (5) PSPs were chosen based on the frequent occurrence of dry inland *Gonystylus* spp. and the other five PSPs of wet inland *Gonystylus* spp.
- All the strata have the representation of at least one PSP but this requirement must firstly satisfy both the criteria mentioned above.

3.4.2 The design of the PSP is shown in **Figure 2**. The size of each PSP plot is one (1) hectare with each sub-plot PSPs measured 25 sub-plots of 20m x 20m and 9 sub-plots of 10m x 10m. *Gonystylus* spp. trees of size  $\geq 10\text{cm}$  dbh are measured in the 20m x 20m sub-plots, while in the 10m x 10m sub-plots only trees of size  $< 10\text{cm}$  dbh as well as trees measuring  $\geq 1.5\text{m}$  height are measured.

**Figure 2 : Permanent Sample Plot Design**



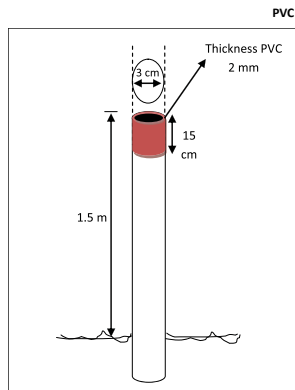
### 3.4.3 Marking PSP

#### i) Sub-Plot 20m x 20m

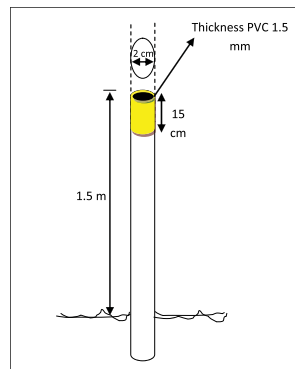
PVC picket with a diameter of three (3) centimetres, thickness of two (2) millimetres and a height of 1.5 meters are install at each corner of square (20m x 20m) and painted red on top (as in Figure 3).

#### ii) Sub-Plot 10m x 10m

PVC picket with diameter of two (2) cm, thickness 1.5 mm and a height of 1.5 meters are installed at each corner of the square and painted yellow at the top (as shown in Figure 4).



**Figure 3:** PVC Picket for Sub-Plot 20m x 20m



**Figure 4:** PVC Picket for Sub-Plot 10m x 10m

## 4.0 DATA COLLECTION AND ANALYSIS

- 4.1 A total of 59 SUs were chosen based on NFI-4, and enumeration was carried out on these 59 SUs to determine the potential areas or locations of establishing the 10 PSPs. This exercise was undertaken because during NFI-4 many of the species was identified as a “group of species” or to genus level. This is partly because some of the inventory work were contracted out to company that have limited number of experience workers who could not identify trees at the species level. In this regard, in the NFI-4, *Gonystylus* spp. was identified into two (2) main species namely, *G. bancanus* and *G. maingayi*, while for *Aquilaria* spp. and *Intsia* spp. they were identified as one species each. On top of that some of the NFI-4 SU established in 2002 are destroyed or damaged due to logging or road construction or forest conversion.
- 4.2 Data collection in the field was conducted as explained in The Field Manual Fourth National Forest Inventory (NFI-4). The distribution of the 59 SUs by state and strata is shown in **Table 3**. However two strata covering the stateland (Code 40 and 41) were left out during this exercise because the security of its tenure is uncertain in the future. Besides, most of the forest area on statelands is already earmark for land conversion and development projects.
- 4.3 Analysis of stem per hectare, basal area per hectare and volume per hectare for the 59 SUs was computed as follow.

- i. **Number of tree per hectare for each sampled tree for each point (TNP<sub>i</sub>).**

$$TNP_i = \frac{BAF}{BA_i}$$

- BAF – Basal area factor (4).  
BA<sub>i</sub> – Basal area of a sampling tree (m<sup>2</sup>).  
TNP<sub>i</sub> – Number of tree per hectare for each sampled tree for each point.



**ii. Number of tree per hectare for each defined species and diameter class for each point (TNP).**

$$TNP = \sum TNP_i$$

- TNP – Number of tree per hectare for each defined species and diameter class for each point.
- $TNP_i$  – Number of tree per hectare for each sampled tree for each point.

**iii. Number of tree per hectare for one sampling unit (TNS<sub>i</sub>).**

$$TNS_i = \frac{TNP_1 + TNP_2 + TNP_3 + TNP_4}{4}$$

- $TNS_i$  – Number of tree per hectare of a sampling unit for each defined species and diameter class.
- $TNP_i$  – Number of tree per hectare of Point 1 for each defined species and diameter.
- $TNP_2$  – Number of tree per hectare of Point 2 for each defined species and diameter.
- $TNP_3$  – Number of tree per hectare of Point 3 for each defined species and diameter.
- $TNP_4$  – Number of tree per hectare of Point 4 for each defined species and diameter.

**iv. Number of tree per hectare for 59 sampling units**

$$TNN_i = \frac{\sum TNS_i}{N_i}$$

- TNN<sub>i</sub> – Number of tree per hectare for each defined species and diameter class of the defined sampling units (no./ha).
- TNS<sub>i</sub> – Number of tree per hectare of a sampling unit for each defined species and diameter class (no./ha).
- N<sub>i</sub> – Number of sampling units (i = 59).

**v. Basal Area Formula**

$$V = (\pi * D^2 * F * L)/40000 \text{ or } V = BA \times L \times 0.65$$

where:

- V - Volume of individual tree (m<sup>3</sup>)      F - Form factor (0.65)  
 D - Diameter breast height (cm)      L - Bole length

Diameter Classes (cm)	Bole Length (m)
15 – 29.9	5
30 – 59.9	10
60 – 74.9	15
≥ 75	20

\* For trees of diameter class 10 -14.9 cm also use the bole length 5m

**Table 3: Forest Strata Used in NFI-4**

No.	Stratum	Code	Area (Ha)	No. of SU
1	Superior and Good Virgin Forest	11	236,292	5
2	Moderate and Poor Virgin Forest	12	505,825	12
3	Logged-over Forest (1-10 year)	20	520,193	6
4	Logged-over Forest (12-20 year)	21	733,791	3
5	Logged-over Forest (21-30 year)	22	534,549	10
6	Logged-over Forest (>30 year)	23	223,054	8
7	Virgin Peat Swamp Forest	31	84,510	2

No.	Stratum	Code	Area (Ha)	No. of SU
8	Logged-over Peat Swamp Forest	32	123,114	12
9	Stateland Inland Forest	40	390,929	-
10	Stateland Peat Swamp Forest	41	56,056	-
11	Protection Forest	50	2,321,701	2
Total			5,730,014	59

4.4 Criteria for selection of 10 PSPs is described in paragraph 3.4.1. Establishment of PSPs and data collection on *Gonystylus* spp. are based on the *Panduan Kerja Luar: Penubuhan "Growth Plots" bagi Daerah Hutan Di Semenanjung Malaysia* (Field Manual Establishing Growth Plots for Forest District in Peninsular Malaysia). The PSPs are located on same locations as the SU units of NFI-4. Reference point for SU unit (middle of the circular plot 1) was used as the reference point for PSP (the left corner of the PSP). The SU units chosen for the establishment of the 10 PSPs are shown in **Table 4**. Five PSPs are selected from Logged Peat Swamp Forest (Code 32), two plots from Moderate and Poor Virgin Forest (code 12), and one plot of PSP each for stratum Superior and Good Virgin Forest (code 11), Logged-over Forest (21-30 year) (code 22) and Logged-over Forest (>30 year) (code 23). The data collected from each PSP included tree species, diameter, number of stem and tree height for tree  $\geq 45$  cm dbh. Six (6) tree species of *Gonystylus* spp. enumerated are *G. affinis*, *G. bancanus*, *G. forbesii*, *G. macrophyllus*, *G. maingayi* and *G. velutinus*.

**Table 4:** Distribution of 10 *Gonystylus* spp. (Ramin) Permanent Sample Plots (PSP) in Peninsular Malaysia

No.	Refer- ence No.	Stratum NFI-4	RSO (Lati- tudes)	RSO (Longi- tudes)	PRF	Compt.	Topo Map
Perak (2 plots)							
1	A005	11	360000	616000	Gerik	49	3666
2	A111	22	349000	592000	Papulut	9	3565
Terengganu (3 plots)							
1	T146	23	594000	528000	Bukit Bauk	22	4363
2	T047	12	566000	541000	Jerangau	54	4264
3	T051	12	508000	608000	Gunung Tebu	105	4066
Johor (1 plot)							
1	J210	32	619000	272000	Gunung Arong	-	4455

No.	Refer- ence No.	Stratum NFI-4	RSO (Lati- tudes)	RSO (Longi- tudes)	PRF	Compt.	Topo Map
Selangor (4 plots)							
1	B123	32	369000	395000	Sungai Karang	217	3659
2	B124	32	370000	391000	Raja Muda Musa	7	3659
3	B125	32	371000	390000	Raja Muda Musa	22	3659
4	B141	32	382000	389000	Raja Muda Musa	82	3658
Negeri sembilan (1 plot)							
1	N015	11#	466000	280000	Tampin	17	3955
*PRF – Permanent Forest Reserve							

## 5.0 STAND CONTENT

### 5.1 Stand content of the 59 Sampling Units

This section presented the stand of content of 59 sampling units.

#### 5.1.1 Stems Per Hectare

##### i) *Aquilaria* spp.

Based on the analysis, only 2 species namely *A. hirta* and *A. malaccensis* are found. No *A. beccariana*, *A. rostrata* and *A. microcarpa* found in the 59 SUs. Total number of stem recorded is 3.955 stem per ha where 2.800 and 1.156 stem per ha for *A. hirta* and *A. malaccensis* respectively. Both species are concentrated in diameter classes 1.5m<10cm and 10 < 30cm, comprising 3.6423 tree per ha or 92.08% of the total stem number recorded. Detail on the number of stem per hectare for each species in each diameter class is shown in **Table 5**.

**Table 5:** Number of stem for 59 sampling units per hectare of *Aquilaria* spp. by diameter classes

Species	Diameter class (cm)					Stem/Ha
	1.5 m* < 10	10<30	30<45	45<60	>60	
<i>A. hirta</i>	0.8426	1.9571	-	-	-	2.7997
<i>A. malaccensis</i>	0.8426		0.2304	0.0826	-	1.1556
<i>A. beccarania</i>	-	-	-	-	-	0.0000
<i>A. rostrata</i>	-	-	-	-	-	0.0000
<i>A. microcarpa</i>	-	-	-	-	-	0.0000
<b>No. of Stems/Ha</b>	1.6852	1.9571	0.2304	0.0826	0.0000	3.9553

\* 1.5 m - ≥ 1.5 meter height

ii) *Intsia* spp.

Both species *I. bijuga* and *I. palembanica* were recorded in the enumeration. Total number of stem per hectare for both species is 0.057, where *I. bijuga* made up recorded 0.01277 stem per ha and *I. palembanica* recorded 0.0339 stem per ha. Both of the two species are only found in diameter class ≥ 60 cm dbh. Detail on the number of stem per hectare for each species in each diameter class is shown in Table 6.

**Table 6:** Number of stem for 59 sampling units per Hectare of *Intsia* spp. by diameter classes

Species	Diameter class (cm)					Stem/Ha
	1.5 m* < 10	10<30	30<45	45<60	>60	
<i>I. bijuga</i>	-	-	-	-	0.01277	0.01277
<i>I. palembanica</i>	-	-	-	-	0.03391	0.03391
<b>No. of Stems/Ha</b>	0.00000	0.00000	0.00000	0.00000	0.04668	0.04668

\* 1.5 m - ≥ 1.5 meter height

iii) *Gonystylus* spp.

Five *Gonystylus* spp. were recorded in the enumeration namely *G. bancanus*, *G. affinis*, *G. macrophyllus*, *G. brunnescens*, *G. confusus* and *G. maingayi*. Total number of stem per hectare for all species is 19.51 stems per ha. The stem is mainly in the diameter class of 1.5m <10cm, contributing to about 82.07% of the total stem number or 16.01 stem per hectare. *G. confusus* which is a dry inland *Gonystylus* spp. represents about 48.57 % or 9.48 stems per ha of the all the *Gonystylus* spp. recorded. As for *G. bancanus* or wet inland *Gonystylus* which is mainly found in the peat swamp forest recorded 5.94 stem per hectare or 26.3% of all the *Gonystylus* spp. enumerated. No *G. velutinus* is found in the 59 SUs units surveyed. Detail on the number of stem per hectare for each species in each diameter class is shown in **Table 7**.

**Table 7:** Number of stem for 59 sampling units per hectare of *Gonystylus* spp. by diameter classes

Species	Diameter class (cm)					Stem/Ha
	1.5 m* < 10	10 < 30	30 < 45	45 < 60	> 60	
<i>G. bancanus</i>	4.21322	0.83088	0.77133	0.09768	0.02705	5.94015
<i>G. affinis</i>	0.84264	0.51345	0.16196	-	-	1.51805
<i>G. macrophyllus</i>	-	-	-	-	-	0.00000
<i>G. brunnescens</i>	0.84264	-	-	0.10197	0.20500	1.14962
<i>G. confusus</i>	9.26908	-	0.11670	0.08987	-	9.47565
<i>G. maingayi</i>	0.84264	0.29599	0.28635	-	-	1.42498
<i>G. velutinus</i>	-	-	-	-	-	0.00000
<b>Total</b>	16.01024	1.64031	1.33634	0.28952	0.23205	19.50845

\* 1.5 m - ≥ 1.5 meter height

### 5.1.2 Basal Area Per Hectare

The basal area per hectare for *Aquilaria* spp., *Intsia* spp. and *Gonystylus* spp. is 0.051, 0.085 and 0.378 sq meter, respectively. Only tree of dbh size  $\geq 10$ cm are computed for basal area. Respectively, basal area for *Aquilaria* spp. , *Intsia* spp. and *Gonystylus* spp. is shown in **Table 8, 9** and **10**.

**Table 8:** Basal area for 59 sampling units per hectare ( $m^2/ha$ ) of *Aquilaria* spp. by diameter classes

Species	Diameter class (cm)				Stem/Ha
	10 < 30	30 < 45	45 < 60	> 60	
<i>A. hirta</i>	0.016949	-	-	-	0.016949
<i>A. malaccensis</i>		0.016949	0.016949	-	0.033898
<i>A. beccarania</i>	-	-	-	-	0.000000
<i>A. rostrata</i>	-	-	-	-	0.000000
<i>A. microcarpa</i>	-	-	-	-	0.000000
<b>Total</b>	0.016949	0.016949	0.016949	0.000000	0.050847

**Table 9:** Basal Area for 59 sampling units per Hectare ( $m^2/ha$ ) of *Intsia* spp. by diameter classes

Species	Diameter class (cm)				Stem/Ha
	10 < 30	30 < 45	45 < 60	> 60	
<i>I. bijuga</i>	-	-	-	0.016949	0.016949
<i>I. palembanica</i>	-	-	-	0.067797	0.067797
<b>Total</b>	0.00000	0.00000	0.00000	0.084746	0.084746

**Table 10:** Basal area for 59 sampling units per hectare ( $m^2/ha$ ) of *Gonystylus* spp. by diameter classes

Species	Diameter class (cm)				Stem/Ha
	10 < 30	30 < 45	45 < 60	> 60	
<i>G. bancanus</i>	0.033898	0.084746	0.016949	0.004954	0.140547
<i>G. affinis</i>	0.016949	0.016949	-	-	0.033898

Species	Diameter class (cm)				Stem/Ha
	10 < 30	30 < 45	45 < 60	> 60	
<i>G. macrophyllus</i>	-	-	-	-	0.000000
<i>G. brunnescens</i>	-	-	0.016949	0.101695	0.118644
<i>G. confusus</i>	-	0.016949	0.016949	-	0.033898
<i>G. maingayi</i>	0.016949	0.033898	-	-	0.050847
<i>G. velutinus</i>	-	-	-	-	0.000000
<b>Total</b>	0.067797	0.152542	0.050847	0.106649	0.377835

### 5.1.3 Volume Per Hectare

The volume per hectare calculated for all the species enumerated is shown in **Table 11**, **12** and **13**. The volume per hectare (m<sup>3</sup>/ha) for *Aquilaria* spp., *Intsia* spp. and *Gonystylus* spp. is 0.042, 2.068 and 1.021 respectively for the 59 SUs units. For *Intsia* spp. and *Gonystylus* spp. the volume is mainly contributed by trees of diameter class ≥ 60cm. However for *Aquilaria* spp. the volume is mainly in the diameter class of 45 < 60cm and none in the >60cm diameter class.

**Table 11:** Volume for 59 sampling units per hectare (m<sup>3</sup>/ha) of *Aquilaria* spp. by diameter classes

Species	Diameter class (cm)				Stem/Ha
	10 < 30	30 < 45	45 < 60	> 60	
<i>A. hirta</i>	0.00048	-	-	-	0.00048
<i>A. malaccensis</i>		0.00810	0.03390	-	0.04200
<i>A. beccarania</i>	-	-	-	-	0.00000
<i>A. rostrata</i>	-	-	-	-	0.00000
<i>A. microcarpa</i>	-	-	-	-	0.00000
<b>Total</b>	0.00048	0.00810	0.03390	0.00000	0.04248



**Table 12:** Volume for 59 sampling units per hectare (m<sup>3</sup>/ha) of *Intsia* spp. by diameter classes

Species	Diameter class (cm)				Stem/Ha
	10 < 30	30 < 45	45 < 60	> 60	
<i>I. bijuga</i>	-	-	-	0.29250	0.29250
<i>I. palembanica</i>	-	-	-	1.77576	1.77576
<b>Total</b>	0.00000	0.00000	0.00000	2.06826	2.06826

**Table 13:** Volume for 59 sampling units per Hectare (m<sup>3</sup>/ha) of *Gonystylus* spp. by diameter classes

Species	Diameter class (cm)				Stem/Ha
	10 < 30	30 < 45	45 < 60	> 60	
<i>G. bancanus</i>	0.004822	0.056980	0.019116	0.048301	0.129220
<i>G. affinis</i>	0.011529	0.001818	-	0.048301	0.013347
<i>G. macrophyllus</i>	-	-	-	-	0.000000
<i>G. brunnescens</i>	-	-	0.018311	0.793880	0.812192
<i>G. confusus</i>	-	0.016001	0.020778	-	0.036779
<i>G. maingayi</i>	0.003154	0.026586	-	-	0.029741
<i>G. velutinus</i>	-	-	-	-	0.000000
<b>Total</b>	0.019505	0.101386	0.058206	0.842182	1.021278

## 5.2 Stand Content of the 10 PSPs

This section presented the stand content of the 10 PSPs and its detail is in **Appendix 2**.

### 5.2.1 Stem Per Hectare

Only four out of the six *Gonystylus* species enumerated are found in the 10 PSPs. Three species are dry inland *Gonystylus* namely *G. maingayi*, *G. brunnescens* and *G. confusus* and one is wet inland *Gonystylus* spp. (*G. bancanus*).

The number of stem per hectare by diameter classes and species is shown in **Table 14**. *G. confusus* have the highest number of stem per ha; however, the stem is mainly confined in the lowest diameter class which is 1.5 m < 10 cm dbh. As for *G. bancanus*, which represents the wet inland *Gonystylus* spp. the number of stem per ha is 1.6 and the overall number of stem per ha for the dry inland *Gonystylus* spp. is 3.9 stem per ha. The stem content indicated that *G. confusus* is the most prevailing species and follows by *G. brunnescens* (1.5 stem per ha). **Table 14** shows more than 62% or 1.0 stem per ha of *G. bancanus* is in the diameter class  $\geq 30$ cm which represents the next potential tree crop. Overall content of *Gonystylus* species enumerated shows that the distribution of stem is very representative of various diameter classes and species for growth study.

**Table 14:** Number of stem for 10 PSPs per hectare of *Gonystylus* spp. by diameter classes and species

Species	Diameter class (cm)					Total
	1.5 m* < 10	10 < 30	30 < 45	45 < 60	> 60	
<i>G. maingayi</i>	-	0.1	-	-	-	0.1
<i>G. brunnescens</i>	1.1	-	-	0.1	0.3	1.5
<i>G. confusus</i>	2.2	0.1	-	-	-	2.3
<i>G. bancanus</i>	-	0.6	0.8	0.2	-	1.6
<b>Total</b>	<b>3.3</b>	<b>0.8</b>	<b>0.8</b>	<b>0.3</b>	<b>0.3</b>	<b>5.5</b>

\* 1.5 m -  $\geq$  1.5 meter height

### 5.2.2 Basal Area per Hectare

**Table 15:** Basal area for 10 PSPs per hectare of *Gonystylus* spp. by diameter classes and species

Species	Diameter class (cm)					Total
	1.5 m* < 10	10 < 30	30 < 45	45 < 60	> 60	
<i>G. maingayi</i>	-	0.0065	-	-	-	0.0065
<i>G. brunnescens</i>	0.005	-	-	0.0164	0.1689	0.1853
<i>G. confusus</i>	0.0006	0.0037	-	-	-	0.0042
<i>G. bancanus</i>	-	0.0269	0.0843	0.0398	-	0.1516
<b>Total</b>	<b>0.0011</b>	<b>0.0371</b>	<b>0.0843</b>	<b>0.0562</b>	<b>0.1689</b>	<b>0.3476</b>

### 5.2.3 Volume Per Hectare

The volume per hectare (m<sup>3</sup>/ha) by diameter classes and species is shown in **Table 16**. The volume/ha of stem of diameter >10 cm dbh varies from 0.0221 m<sup>3</sup>/ha to 2.2547 m<sup>3</sup>/ha. The total volume of *Gonystylus* spp. of the 10 PSPs is 3.8019 m<sup>3</sup>/ha. For trees with diameter class > 60 cm represent 59.3 % of the total volume or 2.2547 m<sup>3</sup>/ha.

**Table 16:** Volume for 10 PSPs per hectare of *Gonystylus* spp. by diameter classes and species

Species	Diameter class (cm)				Total
	10.1 < 29.9	30 < 44.9	45 < 59.9	>60	
<i>G. maingayi</i>	0.0631	-	-	-	0.0631
<i>G. brunnescens</i>	-	-	0.1386	2.2547	2.3933
<i>G. confusus</i>	0.0221	-	-	-	0.0221
<i>G. bancanus</i>	0.1573	0.738	0.4281	-	1.3234
<b>Total</b>	<b>0.2425</b>	<b>0.738</b>	<b>0.5667</b>	<b>2.2547</b>	<b>3.8019</b>

## 6.0 COSTING

The expenditure for this Activity amounted to RM315,611.00. The breakdown of the expenditure according to activity is shown in **Table 17**. The total budget allocated for this project was US\$ 131,800 and Government Contribution (direct and in-kind) US\$ 66,230.

**Table 17:** Activity Cost

ACTIVITIES	EXPENDITURE (RM)		TOTAL
	ITTO	GOM	
Acquisition of inventory equipment	-	34,326.00	34,326.00
Inventory work in the field	177,000.00	-	177,000.00
Data validation, processing and analysis	-	-	-

ACTIVITIES	EXPENDITURE (RM)		TOTAL
	ITTO	GOM	
Data validation, processing and analysis	-	-	-
Tree identification course to FDPM staff and contractor workers	13,800.00	-	13,800.00
Establishment and enumeration of 10 PSPs	43,335.00	-	43,335.00
Compilation of data, screening of data, and processing of data gathered from first enumeration of PSPs	-	-	-
Report and seminar	47,150.00	-	47,150.00
<b>TOTAL</b>	<b>281,285.00</b>	<b>34,326.00</b>	<b>315,611.00</b>

ITTO contribution - US\$ 131,800

GOM contribution (direct and in-kind) - US\$ 66,230

## 7.0 STEM CONTENT COMPARISON BETWEEN 59 SAMPLE UNITS AND NFI-4

Based on the National Forest Inventory Four (NFI 4) that was carried out by the Forestry Department Peninsular Malaysia (FDPM) between 2002 and 2004, for *Gonystylus* spp. tree of size  $\geq 10$ cm dbh in Peninsular Malaysia is 1.14 stem per hectare see **Table 18**. For 59 SUs the same diameter class  $>10$  cm dbh, it is recorded 3.5 stem/ha. **Table 19** shows the percentage distribution according to diameter classes where 16.21% of the total number of trees is in diameter class  $10 < 15$ cm, 50.38% in class  $15 < 30$ cm, 17.81% in class  $30 < 45$ cm, 13.87% in class  $45 < 60$ cm and 1.73% in diameter class  $\geq 60$ cm. Table 19 also shows the percentage distribution by diameter classes of the 59 SU units stem content.

**Table 18:** Number of stem per hectare of *Gonystylus* spp. in Peninsular Malaysia according to the Fourth National Forest Inventory (NFI4).

Species	Diameter class (cm)					Total
	10 < 15	15 < 30	30 < 45	45 < 60	> 60	
<i>G. spp.</i>	0.23289300	0.61550300	0.16873000	0.13094000	0.01636900	1.16443500
<i>G. bancanus</i>	0.00000000	0.10844000	0.08087000	0.06836086	0.00854588	0.26621674
<i>G. maingayi</i>	0.00000000	0.00000000	0.00639716	0.00000000	0.00000000	0.00639716
<b>Total</b>	<b>0.23289300</b>	<b>0.72394300</b>	<b>0.25599716</b>	<b>0.19930086</b>	<b>0.02491488</b>	<b>1.43704890</b>

**Table 19:** Comparison on Percentage Distribution of Stem content of *Gonystylus* by Diameter Classes

Enumerations Methods	Diameter class (cm)					Total
	10 < 15	15 < 30	30 < 45	45 < 60	> 60	
NFI-4	16.21%	50.38%	17.81%	13.87%	1.73%	100%
59 SU	46.9%		38.2%	8.28%	6.63%	100%

For *Aquilaria* spp. the stem content of NFI-4 for trees of size  $\geq 10$ cm dbh is 0.62 stem/ha and for the 59 SUs while it is 2.27 stem/ha see **Table 20** and **Table 5**). **Table 21** shows the NFI-4 stem content distribution by percentage where 47.57% of the total number of trees is in diameter class 10<15cm, 31.98% in class 15<30cm, 16.27% in class 30<45cm, 2.91% in class 45<60cm and 1.27% in diameter class  $\geq 60$ cm. **Table 21** also shows the percentage distribution by diameters classes of the 59 SU units stem content.

**Table 20 :** Number of stem per hectare (Stem/Ha) of *Aquilaria* spp. in Peninsular Malaysia According to Fourth National Forest Inventory (NFI4).

Species	Diameter class (cm)					Total
	10.1-14.9	15.0-29.9	30.0-44.9	45.0-59.9	> 60	
<i>Aquilaria</i> spp.	0.29475	0.19812	0.1008	0.01803	0.00787	0.61957
<b>Total</b>	0.29475	0.19812	0.1008	0.01803	0.00787	0.61957

**Table 21 :** Comparison on Percentage Distribution of Stem content of *Aquilaria* spp. by Diameter Classes

Enumera- tions Methods	Diameter class (cm)					Total Stem/Ha
	10.1-14.9	15.0-29.9	30.0-44.9	45.0-59.9	>60	
NFI-4	47.57	31.98	16.27	2.91	1.27	100%
59 SU	86.21		10.15	3.64	-	100%

NFI-4 inventory shows the stem content for *Intsia* spp. is 0.813 trees/ha (**Table 22**). Based on the same diameter class ( $>10$  cm dbh) the stem content for the 59 SU units is 0.047 stem/ha and it is only confined in diameter class  $>60$ cm (shown in **Table 6**). The distribution percentage of the stem content of NFI-4

for the *Intsia* spp. is shown in **Table 22**. The table shows that 2.15% of the total number of trees is in diameter class 10<15cm, 52.63% in class 15<30cm, 26.16% in class 30<45cm, 11.06% in class 45<60cm and 8% in diameter class >60cm. For the stem content of the 59 SU units it is found only confined to diameter class >60cm.

**Table 22** : Number of Stem (Stem/Ha) of *Intsia* spp. in Peninsular Malaysia According to Fourth National Forest Inventory (NFI4).

Species	Diameter class (cm)					Stem/Ha
	10.1-14.9	15.0-29.9	30.0-44.9	45.0-59.9	>60	
<i>Intsia</i> spp.	0.01750119	0.42783986	0.21271499	0.08994245	0.06502710	0.81302559
<b>Total</b>	<b>0.01750119</b>	<b>0.42783986</b>	<b>0.21271499</b>	<b>0.08994245</b>	<b>0.06502710</b>	<b>0.81302559</b>

**Table 23** : Comparison on Percentage Distribution of Stem Content of *Intsia* spp. According to Diameter Classes

Enumerations Methods	Diameter class (cm)					TOTAL Stem/ha
	10.1-14.9	15.0-29.9	30.0-44.9	45.0-59.9	>60	
<i>NFI-4</i>	47.57	31.98	16.27	2.91	1.27	100%
<i>59 SU</i>	86.21		10.15	3.64	-	100%

The above deliberation shows that the 59 SU units selected in this study are sufficient to be used to set growth plots for *Gonystylus* spp. and *Aquilaria* spp. since it closely reflected stem distribution by diameter classes of the NFI-4 stand content. For *Intsia* spp. further selection of the NFI-4 sampling units for setting growth plot as what has been successfully achieved for *Gonystylus* spp.. The deliberation has also indicated that the reliability of NFI-4 SU units data for locating species occurrence.



## 8.0 CONCLUSION

The results reported in this study must not be used for quantifying the distribution of *Gonystylus* spp. (Ramin), *Aquilaria* spp. (Agarwood) and *Intsia* spp. (Merbau) species in Peninsular Malaysia because the 59 sampling units and 10 permanent sampling plots (PSPs) are not adequate in term of number of sample and not representing all strata or forest types in Peninsular Malaysia. This report should be treated as providing information for later analysis on successive periodical measurement and for later analysis on the 10 PSPs regarding growth. Sufficient information on growth and population dynamics is essential for better management and species conservation.

## 9.0 REFERENCE

- Anon,(2002) Field Manual, Fourth National Forest Inventory (NFI-4). Forestry Department Peninsular Malaysia. Jalan Sultan Salahuddin, K.L
- Anon,(2007) Laporan Inventori Hutan Nasional Ke Empat Semenanjung Malaysia, Jabatan Perhutanan Semenanjung Malaysia. Jalan Sultan Salahuddin, K.L
- Soerianegara & R.H.M.J. Lemmens (eds), 1994. Timber tree: major commercial timbers. In Plant Resources of South-East Asia (PROSEA) No. 5(1).
- Whitmore, T.C., (1972). Tree Flora of Malaya. Longman Group, London.
- Whitmore, T. C., ed. (1973). Tree Flora of Malaysia. Longman Group, London
- Yunus (2000). Modelling the Growth of the Logged over Inland Production Forests of Peninsular Malaysia with Forest Management Consideration. PhD Thesis. De Monfort University, UK. pg 22



# APPENDIX 1

No.	State	District	*PRF	Compt.	Stratum	Forest Type	UP. No
1	Johor	Johor Timur	Lenggor	53	12	Moderate & Poor Virgin Forest	J 024
2	Johor	Johor Timur	Lenggor	15	12	Moderate & Poor Virgin Forest	J 042
3	Johor	Johor Timur	Lenggor	140	20	Logged-over Forest (1-10 year)	J 057
4	Johor	Johor Selatan	Ma'okil	245	22	Logged-over Forest (21-30 year)	J 099
5	Johor	Johor Selatan	FRS Labis	-	22	Logged-over Forest (21-30 year)	J 111
6	Johor	Johor Selatan	Panti	58	23	Logged-over Forest (>30 year)	J 146
7	Johor	Johor Selatan	North Ayer Hitam	20	31	Virgin Peat Swamp Forest	J 174
8	Johor	Johor Selatan	North Ayer Hitam	11	31	Logged-over Peat Swamp Forest	J 205
9	Johor	Johor Timur	Gunung Arong Tambahan	30	32	Logged-over Peat Swamp Forest	J 205
10	Johor	Johor Timur	Gunung Arong	-	32	Logged-over Peat Swamp Forest	J 210
11	Johor	Johor Selatan	Ulu Sedili	7	32	Logged-over Peat Swamp Forest	J217
12	Kedah	Kedah Utara	Koh Mai	15	12	Moderate & Poor Virgin Forest	K 021
13	Kedah	Kedah Utara	Chebar	19	12	Moderate & Poor Virgin Forest	K 023
14	Kedah	Kedah Utara	Rimba Telui	60	21	Logged-over Forest (12-20 year)	K 092
15	Kedah	Kedah Tengah	FRS Ulu Muda		22	Logged-over Forest (21-30 year)	K 108
16	Kedah	Kedah Utara	Rimba Telui	81	22	Logged-over Forest (21-30 year)	K 115
17	Kedah	Kedah Selatan	Padang Terap	45	23	Logged-over Forest (>30 year)	K 129
18	Kedah	Kedah Utara	Chebar	3	23	Logged-over Forest (>30 year)	K137
19	Kelantan	Kelantan Barat	Jentiang	12	23	Logged-over Forest (>30 year)	D 142

No.	State	District	*PRF	Compt.	Stratum	Forest Type	UP. No
20	N. Sembilan	N. Sembilan Timur	Tampin	17	11	Superior and Good Virgin Forest	N 015
21	N. Sembilan	N. Sembilan Timur	Tebong	14	20	Logged-over Forest (1-10 year)	N 063
22	N.Sembilan	N. Sembilan Barat	Kenaboi	40	21	Logged-over Forest (12-20 year)	N 084
23	N.Sembilan	N. Sembilan Barat	Gapau	21	21	Logged-over Forest (12-20 year)	N 091
24	N.Sembilan	N. Sembilan Barat	Triang	20	23	Logged-over Forest (>30 year)	N 138
25	N.Sembilan	N. Sembilan Barat	Pelangai	1	50	Protection Forest	N 174
26	P. Pinang	P. Pinang	Bukit Panchor	2	50	Protection Forest	P 1407
27	Pahang	Jerantut	Tekam	112	11	Superior and Good Virgin Forest	C 011
28	Pahang	Rompin	Lesung	226	22	Logged-over Forest (21-30 year)	C 102
29	Pahang	Gambang	Bekelah	396	22	Logged-over Forest (21-30 year)	C 107
30	Pahang	Bentong	Lentang	81	23	Logged-over Forest (>30 year)	C 137
31	Perak	Hulu Perak	Gerik	49	11	Superior and Good Virgin Forest	A 005
32	Perak	Hulu Perak	Temenggor	22	12	Moderate & Poor Virgin Forest	A 028
33	Perak	Hulu Perak	Temenggor	79	12	Moderate & Poor Virgin Forest	A 029
34	Perak	Hulu Perak	Belum	350	12	Moderate & Poor Virgin Forest	A 031
35	Perak	Hulu Perak	Temenggor	78	12	Moderate & Poor Virgin Forest	A 033
36	Perak	Hulu Perak	Bujang Melaka	14	12	Moderate & Poor Virgin Forest	A 049
37	Perak	Hulu Perak	Temenggor	238	20	Logged-over Forest (1-10 year)	A 065
38	Perak	Kuala Kangsar	Bintang Hijau	128	22	Logged-over Forest (21-30 year)	A 100

No.	State	District	*PRF	Compt.	Stratum	Forest Type	UP. No
39	Perak	Hulu Perak	Papulut	9	22	Logged-over Forest (21-30 year)	A 111
40	Perak	Hulu Perak	Gerik		23	Logged-over Forest (>30 year)	A 135
41	Selangor	Hulu Selangor	Bukit Kutu	27	20	Logged-over Forest (1-10 year)	B 033
42	Selangor	Hulu Selangor	Batang Kali	23	20	Logged-over Forest (1-10 year)	B 034
43	Selangor	Hulu Selangor	Bukit Belata	10	22	Logged-over Forest (21-30 year)	B 072
44	Selangor	Hulu Selangor	Sungai Karang	126	32	Logged-over Peat Swamp Forest	B 119
45	Selangor	Hulu Selangor	Sungai Karang	217	32	Logged-over Peat Swamp Forest	B123
46	Selangor	Pantai Kelang	Raja Musa	7	32	Logged-over Peat Swamp Forest	B 124
47	Selangor	Pantai Kelang	Raja Musa	22	32	Logged-over Peat Swamp Forest	B 125
48	Selangor	Hulu Selangor	Sungai Karang	23	32	Logged-over Peat Swamp Forest	B 133
49	Selangor	Pantai Kelang	Raja Musa	11	32	Logged-over Peat Swamp Forest	B 139
50	Selangor	Pantai Kelang	Raja Musa	82	32	Logged-over Peat Swamp Forest	B 141
51	Selangor	Pantai Kelang	Raja Musa	97	32	Logged-over Peat Swamp Forest	B 142
52	Selangor	Hulu Selangor	Sungai Karang	225	32	Logged-over Peat Swamp Forest	B 145
53	Terengganu	Terengganu Barat	Hulu Terengganu	30	11	Superior and Good Virgin Forest	T 001
54	Terengganu	Terengganu Barat	Jerangau	42	12	Moderate & Poor Virgin Forest	T 046
55	Terengganu	Terengganu Barat	Jerangau	54	12	Moderate & Poor Virgin Forest	T 047
56	Terengganu	Terengganu Utara	Gunung Tebu	105	12	Moderate & Poor Virgin Forest	T051

No.	State	District	*PRF	Compt.	Stratum	Forest Type	UP. No
57	Terengganu	Terengganu Selatan	Jengai	104	20	Logged-over Forest (1-10 year)	T 075
58	Terengganu	Terengganu Selatan	Gunung Tebu	23	22	Logged-over Forest (21-30 year)	T 112
59	Terengganu	Terengganu Selatan	Bukit Bauk	22	23	Logged-over Forest (>30 year)	T 146

*\*PRF - Permanent Reserve Forest*

*UP. No - Code for each Sampling Unit*

# APPENDIX 2

Stand Content of 10 PSPs by Strata and DBH classes

Strata	Plot No.	Forest Reserve	Species	1.5m < 10cm			10.1 < 29.9 cm			30 < 44.9 cm			45 < 59.9 cm			> 60cm			*TOTAL		
				No of stem	Basal Area	Vol-ume	No.of stem	Basal Area	Vol-ume	No.of stem	Basal Area	Vol-ume	No.of stem	Basal Area	Vol-ume	No.of stem	Basal Area	Vol-ume	No.of stem	Basal Area	Vol-ume
11	N015	Tampin	<i>G. mangayi</i>		0.065	0.631	1												1	0.065	0.631
12	T047	Jerangau	<i>G. brunnescens</i>																1	0.614	7.581
	T051	Jerangau																	0	0.000	0.000
22	A111	Papulut	<i>G. confusus</i>		0.037	0.221	1												1	0.037	0.221
23	T146	Bukit Bauk	<i>G. brunnescens</i>																2	1.075	14.966
32	B123	Sg. Karang	<i>G. bancanus</i>		0.048	0.251	1		0.165	1.292									3	0.213	1.543
	B124	Raja Musa	<i>G. bancanus</i>		0.068	0.485	1		0.245	2.329	2	0.398	4.281						5	0.711	7.095
	B125	Raja Musa	<i>G. bancanus</i>					1	0.110	1.292									1	0.110	1.292
	B141	Raja Musa	<i>G. bancanus</i>	11.1	0.006	0.837	4	0.153	0.323	2.467									7	0.482	3.304
J210		Gunung	<i>G. brunnescens</i>								1	0.164	1.386						1	0.164	1.386
		Arong	<i>G. confusus</i>	22.2	0.005														0	0.005	0.000
<b>TOTAL FOR 10 plots</b>				33.3	0.011	2.426	8	0.371	0.843	7.38	3	0.562	5.667	3	1.689	22.547	22	3.476	38.019		

# Total \* n/ha is excluded no. of stem 1.5m height and < 10cm DBH