POPULATION AND NATURAL REGENERATION OF RAMIN

TECHNICAL REPORT NO. 02

ITTO PPD 87/03 REV. 2 (F)

IDENTIFICATION OF *Gonystylus* spp. (RAMIN) POTENCY, DISTRIBUTION, CONSERVATION AND PLANTATION BARRIER

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IDENTIFICATION OF GONYSTYLUS SPP (RAMIN) POTENCY, DISTRIBUTION, CONSERVATION AND PLANTATION BARRIER

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PREFACE

Data and information presented in this technical report are complementary to the data and information collected earlier (Technical Report No. 1) and result of brief survey carried out in two separate locations: Berbak National Park, in the province of Jambi, Sumatra which represents a primary (virgin) forests and Sebangau National Park, in the province of Central Kalimantan, Kalimantan which represents logged over area (Secondary Forest). Additional data on ramin population and natural regeneration of ramin presented in this technical report are still insufficient to be a representative of existing condition in Indonesia. It requires further field survey and or inventory to the representative habitats of ramin.

The Project thanks to Dr. Tukirin Partomiharjo, senior scientist of National Institute of Science (LIPI), Dr. Machfud, Dr. Erdy Santoso and Dr. Taulana Sukandi, senior scientist of Forestry Research and Development Agency (FORDA) for their critical comment to improve the content of this technical report. Great appreciation is also extended to Mr. Suryamin, Technician of FORDA for his assistance during field survey and species identification. To those who have given their assistance during field survey in Berbak National Park and Sebangau National Park but their name are not mentioned in this technical report are also greatly appreciated.

Finally, the project thanks to Mr. Drasospolino, Field Manager of WWF Indonesia, Kalimantan Project and his staffs for their assistance during field survey in Sebangau National Park and other who have given contribution to this activity.

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Contribution from other whose name are not mentioned is also appreciated.

Authors

ABSTRACT

Ramin Population and Natural Regeneration. The exploitation of ramin forests in Indonesia was started since 1970, almost in the same time as that of other Indonesian Tropical Forests. Based on collected data and information, it is indicated that the natural regeneration of ramin is poor, silvicultural system applied to ramin forest is not fully implemented and efforts to rehabilitate or restore ramin forest is still insignificant. These all have contributed to the great degradation of ramin forests throughout Sumatra and Kalimantan as primary ramin habitats in Indonesia.

Data and information on ramin populations and growing stock have been previously compiled by various agencies, such as government, state-owned and private companies and even Non-Government Organization, such as WWF and Telapak. However, recent data on the population and growing stocks are now limited to those areas with relatively higher accessibility, such as active forest concessions. Whereas from other areas, such as forest concessions which have been closed down since last several years ago and forest concessions which are not allowed to harvest ramin, recent data and information are almost impossible to obtain.

Data and information presented in this Technical Reports are complementary to the data and information obtained in Activity 1.1.1 of the Pre-Project (PPD87/03 Rev.2 (F)). Data and information in this technical report are obtained from a brief field survey carried out in two separate locations: Berbak National Park, in the province of Jambi, Sumatra which represents a primary (virgin) forests and Sebangau National Park, in the province of Central Kalimantan, Kalimantan which represents logged over area (Secondary Forest). Additional data on ramin population and natural regeneration were also collected from other sources. Data and information presented in this report are expected to represent an overall situation in population and natural regeneration of ramin in Indonesia.

Based on the above collected data, it is indicated that ramin population and regeneration vary depending on the site and condition of forests. Results of this survey are described as follow: ramin in Berbak National Park, which represent primary and mature forest was dominant and the population was dominated by large and mature ramin trees. Ramin was in the first rank out of 36 forest tree species based on its value of the important value index calculated from overall species recorded. On the contrary, ramin was relatively rare in Sebangau National Park which represent a secondary (logged over area). In this forest, ramin was in the tenth rank out of 31 recorded forest tree species based on its value of the important value index and ramin trees were relatively small.

Natural regeneration indicated by the presence of seedlings and saplings was extremely poor in both site (Berbak National Park and Sebangau National park). The number of seedlings and saplings recorded from all plots was less than two. This poor natural regeneration is one of the primary threats to extinction of ramin species, even though earlier studies in other forests indicated rich of ramin natural regeneration. Other threats, especially to the remaining population are illegal logging, habitat degradation or conversion to other uses and frequent forest fires.

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I. INTRODUCTION

1.1. Background

Ramin (*Gonystylus bancanus*) is one of the most highly valued tropical woods. This whithish wood belongs to the category of fancy woods (Soerianegara and Lemmens 1994). In Indonesia, the sources of ramin timber is limited to natural forests, mainly in peat-swamp forest of Sumatra and Kalimantan. In Sumatra, ramin naturally distributes in the provinces of Riau, Jambi and South Sumatra. In Kalimantan, ramin forests mainly distribute in the provinces of West and Central Kalimantan, and small part of South Kalimantan. In both Sumatra and Kalimantan, ramin populations are found in production forest (mainly managed by forest concessionaires) and Conservation areas, such as National Park and Nature Reserves.

Ramin, especially *G.bancanus* has been extracted from their natural forests for decades. After that such exploitation, ramin forest has been severely degraded. The degradation is caused by over exploitation, illegal logging and in appropriate implementation of silvicultural practices as well as natural disaster , especially forest fires. These conditions have led to a temporary banning of logging of this species through a moratorium policy issued by the Ministry of Forestry in 2001. At the same year, Ramin (*Gonystylus spp.*) was listed in Appendix III of Convention on International Trade for Endangered species of flora and fauna (CITES) (Samedi, 2005).

The purposes of logging moratorium and trade regulation (also the inclusion to CITES Appendix) are to prevent further loss of ramin population due to unwise exploitation, to provide time and space for the remaining ramin population to recover and regenerate and in the long run to alleviate ramin scarcity. However, in the field, ramin extraction is still ongoing illegally causing severe lost of ramin populations, severe degradation of their habitat and scarcity of ramin woods .

The further loss of ramin population causes one segment of wood industries (primarily furniture and molding industries) faces a serious shortage of raw material. The raw material shortage causes the close down of the ramin wood industry and or at the same time create a conducive condition for black market or trade of illegal ramin timber. The close down of ramin industry will contribute to the increase of unemployment rate and criminals, and decrease in National income from forestry sector.

Several efforts have been pronounced to solve ramin problems, consisting of (1) conservation effort of remaining ramin forests and population, (2) law enforcement to combat illegal logging, especially in ramin habitat, (3). Re-inventory of ramin standing stock and potential volume, (4) Rehabilitation of ramin habitats, especially through National Movement of forest/land rehabilitation.

Ramin habitat rehabilitation should be part of the movement. However, as occur to many other species, the insufficient supply of planting materials may hamper the target of plantation for ramin species. Furthermore, the slow growth and more specific site requirement may also inhibit the establishment of artificial ramin plantation. Lessons learned from previous trials show that the survival rate of ramin seedlings after transplanting is poor, especially at the transition stage between shade tolerant and shade intolerant.

This field survey, however, will be part of the program to re-identify the existing potential of ramin remaining population and regeneration. Earlier data collected by Bismark *et al* (2005) indicate a great reduction on ramin standing stock or harvestable woods from production forests managed by forest concessionaires in Sumatra dan Kalimantan. The data are mainly based on cruising results recorded before moratorium policy issued by the MoF. In addition, Bismark *et al* (2005) predicted current volume of the standing stock is approximately 6.8% out of the total volume predicted in 1983 by

Directorate Bina Produksi Kehutanan. Natural regeneration of this species is characterized by the presence of flowering and fruiting interval, limited seed production, specific site requirement for seed germination and seedling growth (Istomo, 2005; Mujijat dan Hermansyah, 2005).

Table 1. The approximate area of peat swamp forest in Indonesia from time to time

No.	Provinces	Total area at different time period		
		1980* (x 1000 ha)	1983** (x1000 ha)	2002*** (x1000 ha)
1	Aceh (Nangroe Aceh Darussalam)	152	N/a	N/a
2	North Sumatra	460	N/a	N/a
3	West Sumatra	52	N/a	N/a
4	Riau (+ ramin)	4,750	2,222	1,667
5	Jambi (+ ramin)	595	397	524
6	South Sumatra (+ ramin)	2,036	684	335
7	Lampung	130	N/a	N/a
		8,175	3,304	2,517
8.	West Kalimantan	1,179	3,371	2,052
9	Central Kalimantan	2,115	5.941	4,225
10	South Kalimantan	43	154	N/a
		3,599	9,376	
11	South Sulawesi	22	N/a	N/a
12	Irian Jaya	n/a	N/a	N/a
		11,796		

** Risalah Hutan Indonesia, Departemen Pertanian, Ditjen Kehutanan 1980 (Supriyanto and Hamzah, 1983)*
*** Directorate of Forestry Planning, 1983*
**** Directorate of Forestry Planning, 2002*
N/a : data not available

1.2. Objectives

The objectives are

(1). To obtain primary data on ramin population and regeneration from sampled areas in two separate locations of ramin habitats: Berbak National Park, Jambi, Sumatra and Sebangau National Park, Central Kalimantan, Kalimantan.

(2). to collect secondary and relevant data and information on ramin population, regeneration and other related problems that influence the future of ramin in Indonesia.

1.3. Methodology

Data and information collection on ramin population, regeneration and other related problems were collected through (1) field survey of two different locations in Sumatra and Kalimantan and (2) Other data collection from other relevant institutions, such as Center for International Management of Tropical Peat of Central Kalimantan (CIMTROP), World Wildlife Fund (WWF)-Indonesia Program, Provincial Forest Services, Center for Natural Resources Conservation of Central Kalimantan and Berbak National Parks, Jambi.

Field Survey

This activity is treated as additional to the activity 1.1.1 Collecting baseline data and information on potency, distribution and conservation of ramin in Indonesia through literature search or secondary data. This activity focused on the ground check of selected sites in Sumatra and Kalimantan. The ground checks are expected to enrich some existing data and information collected earlier. Extensive survey was not possible in most sites of peat swamp forests. The accessibility in peat swamp forests are mostly extremely poor, especially in ex-logging areas.

The field survey was conducted in two different sites in Sumatra and Kalimantan. In Sumatra the site surveyed was Berbak National Park (BNP), which is located in the province of Jambi, Sumatra (Figure 1). In Kalimantan, the field survey was conducted in Sebangau National Park (SNP), which is located in the province of Central Kalimantan, Kalimantan (Figure 2). Site in Berbak National Park represents ramin population in virgin forest, whereas site in Sebangau National Park represents ramin population in secondary forest, logged over area of ex-several forest concessionaires operating in Central Kalimantan.

1.3.1. Description of each Location

Berbak National Park

Berbak National Park is located in eastern part of the Province of Jambi with the total area of approximately 162,700 ha. The topography of this area is flat with elevation of only 15 meter above sea level. The majority of the area is covered with alluvial, peat swamp forest and tidal land. Most parts of the Park are peat swamp forests. According to the strategic plan (Rencana Pengelolaan Taman Nasional) of Berbak National Park, 2000), there are many valuable timber species reside in this National Park, including ramin (*Gonystylus spp*). The Park management is divided into three different zones based on the land uses: protected zone, Buffer zone and utilization zone. Most forests in this Park, except in the protected zone have been illegally logged and used for other purposes. Forest in the protected zone is relatively intact and in good condition. The other zones have been severely degraded. The field survey was conducted in the outer area of protected zone (frequently called as core zone), where outer primary forest was located and able to be surveyed.

Sebangau National Park

Sebangau National Park is located in the southern part of the province of Central Kalimantan. This park consists of secondary forest and virgin forests. The secondary forests are located in ex-forest concessionaires, such as PT Sanitra Sebangau Indah SSI) and some other ex-forest concessionaires. The total area of park is approximately 500,000 ha (WWF-I, 2004). The vegetation survey was located 1 to 10 kilometers from the periphery of Sebangau river, which is the outside Eastern border of the park. The accessibility to this site was moderate. The primary access is through the artificial canal established earlier either by forest concessionaire or illegal loggers for logs transportation. The access to this site has also been improved through the presence of activities of World Wildlife Fund for Nature Indonesia Project (WWF-I). WWF-I is primarily work for the rehabilitation and conservation of Orang Utan.

1.3.2. Plot Establishment

Berbak National Park

Plot establishment was as follow:

(1). Field orientation and establishment of 5 plots in separate area within the accessible sites. The distance between plot was at least 1000 meter to any directions.

(2). Five plots of 50 x 50 square meter was set in the area for tree stage

(3). Established a 25x25 square meter in side the 50x50 m plot for pole stage

(4). Established a 10x10 square meter in side the 25x25 m plot for sapling stage

(5). Established a 2x2 square meter in 10x10 m plot for seedling stage

Sebangau National Park

Plot establishment was similar to that of in Berbak National Park except in plot setting, distance between plots. In Sebangau National Park, plot of 50 x 50 square meter was place in parallel to the existing artificial canal, which lay from Sebangau River toward the deep of the SNP. The distance between canal and established line strip was approximately 1000 meter and the distance between plots was 1000-2000 meter. These plots represent extremely small percentage of the total area of the Park, which is almost similar to that of Berbak National Park.

1.3.3. Vegetation data collection

All forest tree species, which have reached sapling, pole and mature stages. found in the 50x50 square meter plot were recorded. For the pole and tree stages, height, diameter at breast height, clear bole, the name of the species and local name. Ramin at seedling stage were recorded in 2x2 square meter. However, since extremely limited seedling and sapling were found in early survey, the number of plot wa expanded to other area within the 50x50 m plot. Familiar species were recorded directly their name (local and scientific) and the family name. Herbarium specimens for unfamiliar species or species with some doubt on its identity were collected and further identified in BOany Lab of the Center for Forest and Nature Conservation R&D.

1.3.4. Data analyses

Data collected from the field survey were further processed to obtain the frequency, dominancy and important value index for each species using a formula described by Whittaker (1975) Brower and Zar (1977) as cited and described earlier by Solihin (1997).

Other Data Collection

1.3.5. Collecting other Relevant Information

Sumatra

The main sources of data on vegetation survey in Sumatra are PT. Diamond Raya Timber (DRT) and PT Yos Raya Timber (YRT). PT DRT, which is located in the province of Riau, is the only certified forest concession in Indonesia that passed the assessment on sustainable forest management from an independent assessor for sustainable forest management, Lembaga Ecolabel Indonesia (Indonesian Ecolabelling Institute). By this certification, DRT is legally allowed to harvest ramin in its area using sustainable way of harvesting as exception from the moratorium policy on ramin issued by the Ministry of Forestry (Ministrial Decree, 2001). CITES Scientific Authority of Indonesia, Indonesian Institute of Science is a responsible agency to carry out routine field checking for potency and regeneration. Logged over areas (secondary forest area) of PT DRT are highly accessible to be surveyed and therefore recent data on this area are relatively easier to be collected.

Sufficient data on vegetation study have also been available from PT. Yos Raya Timber, another forest concessionaire in Riau. Vegetation data of 1997 have extensively collected and studied by Solihin (1997) as part of his research study on ramin natural regeneration. No other more recent data available, except from PT DRT collected by an integrated team formed for CITES monitoring puspose.

Kalimantan

Additional information regarding the ramin population was collected from literature search and communication with relevant institutions. The sources of information are primarily from Provincial and district forest services, Center for Natural Resources Conservation (BKSDA), Office of National Park, Forest company and WWF-Indonesia, Kalimantan Program.

CENTER FOR NATURE RESOURCES CONSERVATION (BKSDA) OF CENTRAL KALIMANTAN

Valuable data and information were obtained from BKSDA of Central Kalimantan, Palangkaraya. The data obtained are related the problem with peat swamp forest in Central Kalimantan, especially on the illegal logging and frequent forest fires during the dry season.

CENTER FOR INTERNATIONAL MANAGEMENT FOR TROPICAL PEAT (CIMTROP)

This research institution, part of research center within the Palangka Raya University, Central Kalimantan has carried out several studies and surveys on peat swamp forests. However, only limited information obtained for vegetation study including potency on ramin.

WORLD WILDLIFE FUND (WWF)-Indonesia, Kalimantan Program

WWF-Indonesia, Kalimantan Program has carried out several surveys and monitoring site for peat swamp forest in central kalimantan. WWF-I is the main source of recent data and information on current status of ramin population in Kalimantan, major threat to ramin conservation. This NGO has carried out field surveys and monitoring on the habitat condition and illegal logging activities until deep of the primary forests. Several data on illegal logging are also recorded and cited.

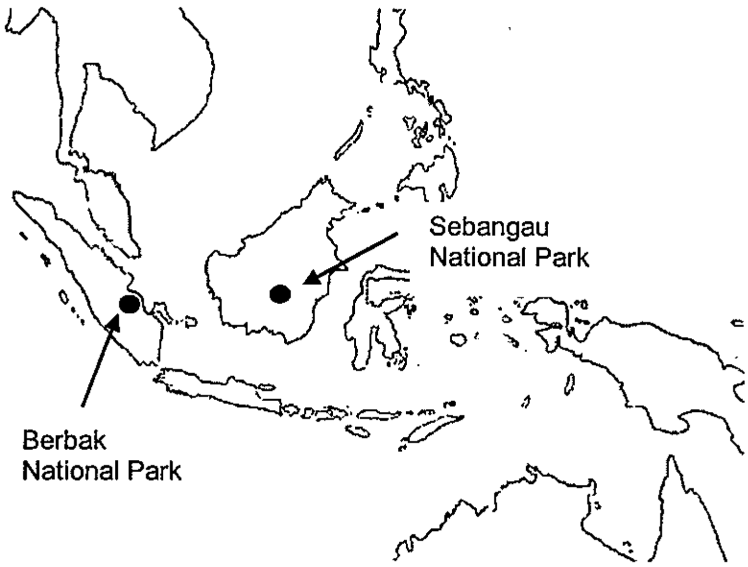

Figure 1. Site locations for brief field survey (Berbak National Park of Sumatra and Sebangau National Park of Central Kalimantan, 2005)

II. RESULTS

2.1. Ramin Population

2.1.1. Berbak National Park

Result of field survey on the population in BNP are as follows: From four different growing stages (seedling, sapling, poles and mature stem), the results indicated that no seedling and sapling stage of ramin was found in all observation plots. The number of pole and tree stage of ramin was found and recorded as appear in Appendix 1 as summarized in Table 1. Diameter at breast height, clear bole and total height of poles and trees of all species were recorded and measured and presented in the same table. The number of trees (density) per ha for each species, the species recorded for each plots which represent the frequency and the number of individual species in each plot which represent the density of each species were recorded and calculated.

Over 36 tree species of pole and tree stages are found and recorded in Berbak National Park. Ten major tree species out of the 36 tree species are listed in Table 2 and 5. From that table it is showed that Ramin (*Gonystylus bancanus)* is highly important species and compose the whole vegetation in this Park. Data recorded indicated that this species is a dominant with relative dominance (RD) of 24.2% and total basal area of 2,239 m2/ha and also widely distributed in the area with relative frequency (RF) of 6.3. Other important tree species in the vegetation structure, after *G. bancanus,* are *Parastemon urophylum, Urandra scorpioides, Syzygium sp., Melicope sp, Tetramerista glabra Miq, Palaquium ridleyi, Diospyros baloen, Mangifera parviflora and Aglaea argentea.* From these ten major species, some are commercial species, such as Punak (*Tetramerista glabra Miq*), kayu malas (*Parastemon urophylum*) and kayu hitam (*Diospyros baloen).* Other commercial species are also recorded but not dominant in that plot site and therefore were not included in the ten major species based on their relative dominance and frequency of distribution.

Table 2. The first ten major tree species recorded in Berbak National Park* (The rank is based on value of the important value index calculated for all species)

No.	Scientific name	Family	Local name	RF	RDe	RDo	IVI
1	***Gonystylus bancanus***	***Thymeliaceae***	***Ramin***	***6.3***	***7.11***	***24.2***	***37,64***
2	*Urandra scorpioides*	Icacinaceae	Setebal	6.3	19.11	8.83	34,07
3	*Syzygium sp*	Myrtaceae	Kelat	6.3	12.89	9.03	2825
4	*Parastemon urophylum*	Chyrobalanaceae	Kayu malas	6	6.67	12.35	25,34
5	*Melicope sp*	Rutaceae	Simpur	5.0	8.0	2.6	15.69
6	*Tetramerista glabra Miq*	Theaceae	Punak	5.0	3.11	5.27	13.44
7	*Palaquium ridleyi*	Sapotaceae	Balam tikus	3.8	3.55	5.61	12,95
8	*Diospyros baloen*	Ebenaceae	Kayu hitan	5.1	5.33	1.9	12,38
9	*Mangifera parviflora*	Anacardiaceae	Selenye	3.8	4.0	1.64	9,44
10	*Aglaea argentea*	Meliaceae	Parak hutan	3.8	1.78	3.5	9,06

Note:
** The rank is based on value of the important value index calculated for all species*
Abbreviation: RF=Relative Frequency, RDe=Relative Density, RDo=Relative Dominance, IVI= the important Value Index

2.1.2. Sebangau National Park (SNP)

Nearly similar regeneration condition is found in Sebangau National Park. In this area, no ramin seedlings and saplings was found. The number of tree species recorded is slightly lower than those in Berbak National Park. In SNP, only 31 tree species found and recorded (Appendix 2 and the first ten major tree species based on value of the important value index are summarized in Table 3). Ramin is not a dominant species in this logged over area (basal area of 0.461 m2/ha), but widely distributed to all observation plots. According to the important value index (IVI), ramin is in the tenth rank out of the first ten major species recorded. The dominant and very important species in this secondary forest are kayu Tumi (*C. rotundatus)*, followed by Bintangur (*C. dasyfolium)*, Meranti semut (*S.pauciflora)*, Terentang (*C. coriaceum)*, Jambu burung (*Syzygium sp.), Nyato babi (Palaquium cochlearia), Combretocarpus sp, Pisang-pisang (A. teysmanii)* and belawan merah (*T. whiteana)* (Table 3 and 5).

Table 3. The first 10 major tree species recorded in SNP*

No.	Scientific name	Family	Local name	RF	RDe	RDo	IVI
1	*Combretocarpus rotundatus*	Rhyzophoraceae	Tumi/ kayu tumi	3.9	3.65	20.30	27,95
2	*Callophylum dasyfolium*	Guttiferae	Bintangur	4.9	12.0	10.00	26,96
3	*Shorea pauciflora*	Dipterocarpaceae	Meranti semut	4.9	9.92	7.64	22.72
4	*Campnosperma coriaceum*	Anacardiaceae	Terentang	4.9	7.31	7.34	19.60
5	*Syzygium sp*	Myrtaceae	Jambu burung	4.9	7.83	5.78	18.58
6	*Palaquium cochlearia*	Sapotaceae	Nyato babi	4.9	7.57	4.75	17.28
7	*Cambretocarpus sp*	Rhyzophoraceae	?	3.9	6.52	6.28	16.77
8	*Alponsea teysmanii*	Annonaceae	Pisang-pisang	4.9	6.53	4.4	15.88
9	*Tristaniopsis whiteana*	Myrtaceae	Belawan merah	4.9	5.48	2.97	13.40
10	***Gonystylus bancanus Kurz***	***Thymeliacea***	***ramin***	***4.9***	***2.87***	***5.0***	***12.87***

Note:
** The rank is based on value of the important value index for all species*
Abbreviations: R F=Relative Frequency, RDe=Relative Density, R Do=Relative Dominance, IVI= Important Value Index

From the ten major species, some are commercially valued timber, such as tumi (*C. rotundatus*), which has straight stem and long clear bole. This species is also relatively fire resistant and produce many copies after fire. Other commercial species are bintangur (*C. dasyfolium*), Meranti (*S. pauciflora*), terentang (*C. coreacium*) and belawan merah (*T. whiteana*).

Table 4. Density and basal area of the first 10 major tree species recorded in BNP

No.	Scientific name	Family	Local name	Density (N/ha)	Basal Area (m2)
1	***Gonystylus bancanus***	***Thymeliaceae***	***Ramin***	***32***	***4.239***
2	*Parastemon urophylum*	Rosaceae	Kayu malas	30	2.163
3	*Syzygium sp*	Myrtaceae	Kelat	58	1.582
4	*Urandra scorpioides*	Icacinaceae	Setebal	86	1.512
5	*Palaquium ridleyi*	Sapotaceae	Balam tikus	16	0.983
6	*Tetramerista glabra Miq*	Theaceae	Punak	14	0.923
7	*Shorea ovalis*	Dipterocarpaceae	Meranti batu	4	0.727
8	*Aglaia argentea*	Meliaceae	Parak hutan	8	0.611
9	*Melicope sp*	Rutaceae	Simpur	36	0.460
10	*Parartocarpus triandus*	Moraceae	Tangayun	2	0.466

Table 5. Density and basal area of 10 major tree species recorded in SNP

No.	Scientific name	Family	Local name	Density (N/ha)	Basal Area (m2)
1	*Combretocarpus rotundatus*	Rhizophoraceae	Tumi	28	1.858
2	*Callophylum dasyfolium*	Gutteferae	Bintangur	92	0.913
3	*Shorea pauciflora*	Dipterocarpaceae	Meranti semut	76	0.716
4	*Combretocarpus sp*	Rhizophoraceae	Madang	50	0.573
5	*Syzygium sp*	Myrtaceae	Jambu burung	60	0.528
6	*Dyera lowii*	Apocinaceae	Pantung	28	0.481
7	***Gonystylus bancanus***	***Thymeliaceae***	***Ramin***	***22***	***0.461***
8	*Palaquium cochlearia*	Sapotaceae	Nyatoh babi	58	0.434
9	*Alponsea teysmanii*	Annonaceae	Pisang-pisang	50	0.402
10	*Tristaniopsis whiteana*	Myrtaceae	Belawan merah	42	0.271

2.1.3. Tree Density and Basal Area

As presented in Table 4 and 5, in Berbak National Park, setebal (*U. scorpioodes*) is one of major species in this area with total density of 86 trees per ha. The other major species are Kelat (*Syzygium sp*), Simpur (*Melicope sp*) and Ramin (*G. bancanus*). Ramin (*G.bancanus*) and kayu malas (*P. urophyllum*) are the most potential species to produce valuable timber. The basal area is approximate 4,239m2 for ramin and 2.163m2 for kayu malas.

In Sebangau National Park, kayu tumi (*C.rotundatus) and bintangur (C. dasyfolium*) and meranti semut (*S. pauciflora*) are the major species in this area based on value of the important value index. Kayu tumi is a major species in this area with basal area of 1.858 m2 per hectare even though the number of trees per hectare only 28. Ramin (*G.bancanus*), in Sebangau National Park is the least populated species with the density is 22 trees per ha and total basal area of 0.461 m2 per hectare.

2. 2. Other Related Problem on Ramin Forest

Based on the field survey and discussion with local stakeholders, there are several problems associated with current ramin population. Those problems are related to (1) Inappropriate silvicultural system, (2). Illegal Logging, (3) Method of log transportation and (4) Frequent Forest fires.

2.2.1. Inappropriate Silvicultural System

Silvicultural system introduced in forest management in Indonesia has initiated early 1970. During that time, the vast investment inflowed into Indonesia, especially after the issuance of several investments incentives. The investments incentives had significantly promoted the exploitation of Indonesian tropical forests. Method of exploitation referred to the only one silvicultural system, *Indonesian Selective Cutting* (TPI).

Indonesian selective cutting is a modification of existing silvicultural system from *Minimum Diameter Limit* of Indonesia and *Philippinne Selective Cutting* of the Philippine. This system was implemented in Indonesian forest until late 1980 to early 1990. After this time, Indonesian Selective Cutting has received modification and become Indonesian Selective Cutting and Enrichment Planting (TPTI).

The substantial difference between the two system are the presence of obligatory activity in TPTI system to carry out an enrichment planting in newly logged forest area when the number of the required seedlings for stand recovery is insufficient and unevenly distributed in that area or site. Other silvilcutural systems are Clear Cutting with Artificial Regeneration (THPB), and Selective Cutting with Strip Replanting. Clear Cutting with natural regeneration as silvicultural system has never been applied in Indonesian forests.

Both TPI and TPTI have been applied in all types of forests and vegetation in Indonesia, including in peat swamp forests, the ramin habitats. The application of TPI and TPTI using general rules and guidance to all forest types and vegetations was later identified as inappropriate and has resulted to the damage and degradation of most natural forest in Indonesia, including peat swamp forests.

Other than the system is itself inappropriate, several stages following the rules and guidance of TPI (9 steps) and TPTI (11 steps) have not been imposed consistently. This inconsistent is caused by several other factors, such as poor law enforcement, poor official controlling and supervising and lack of applicable guidelines, manual and procedures.

It has been realized, the TPI and TPTI has not been appropriate to be applied in peat swamp forest, especially ramin. The system was not appropriate due to ramin natural growing behaviour. The inappropriateness are due to the following reasons:

(1). Ramin is a slow growing species, with the diameter growth rate far less than 1 cm per year. TPI and TPTI are applied based on the assumption that the growth rate of any species growing in natural forest is 1 cm per year. Ramin cutting cycles need to be re-identified based on the diameter growth rate.

(2). The fact that ramin is growing in clamp, not homogenously distributed along the landscape. This is related to the minimum number of required trees per ha to be cut in the next cutting cycles and the preliminary inventory of population needs to be adjusted.

(3). The enrichment planting of ramin, as in other species growing in peat swamp forests, is extremely difficult to be carried out. Most accessibility in peat swamp forest is poor and the planting materials are not always available.

(4). The flowering/fruiting season and seed characteristics of ramin are frequently unable to provide seeds and seedlings for regeneration. Therefore enrichment planting with ramin species is frequently impossible. In natural stands, this causes regeneration gap in *G. bancanus*.

2.2.2. Illegal Logging

Illegal logging is the main threat to the sustainability of tropical forest in Indonesia. This threat will be more serious for ramin for which this species is slow growing, lack of continued regeneration materials and high mortality rate in the naturally regenerated stands.

The illegal logging has caused severe degradation of ramin habitat and forest, both in production forests and conservation areas in Sumatra and Kalimantan. In Sumatra, ramin forest in Riau, Jambi and South Sumatra have been severely degraded caused primarily by illegal logging. The location includes national parks and nature reserve. In Kalimantan, Tanjung Putting National Park, where the most dominant ramin species are located has also been severely degraded due to illegal logging. Several ex-forest concessionaires in central Kalimantan have also been illegally logged. In relation to this, WWF Kalimantan office has successfully advocated some areas to be protected from any types of logging. Some of those areas, later become parts of Sebangau National Park.

According to local authorities, such as Center for Natural Resources Conservation of Central Kalimantan in Palangka Raya, the change of status of secondary forest areas to the Sebangau National Park has contributed to the reduction of illegal logging activities in some parts of the parks. A great reduction of illegal logging activities has been significant when the national movement to combat illegal logging is pronounced.

2.2.3. The Impact of Canalization

The cheapest method of log transportation in peat swamp forests is using artificial canal. The canal is established from the periphery of the main river toward the deep of primary forests, The length and the wide of canal is depending on the potential volume to be extracted ftom the forest area. Other method, but quite expensive is through railway established during logging operations. Some concessionaires establish railway *lorri* for logs transportation, while other community including illegal loggers used canal for log transportation.

In Sebangau National Park, a number of canals with various sizes (length and width) are spread throughout the park. Some were established during logging operation by Concessionaire and by illegal loggers. It could be seen from the upper part of the river toward the sea, to where the illegal logs are transported to.

The canalisation of peat swamp forests has been proved to be worst for the forest ecological functions. The water surface around the canal decline toward the level of water inside the canal and causing the severe drought of the peat swamp forest, especially during the dry season. Where it occurs, this easily ignites fire in peat swamp forests.

In peat forest in the block of ex-PT. Sanitra Sebangau Indah, the canals were established with sufficient distance and width. The dry season in year 2004, this block has been wiped out by forest fire. Similar cases have also wiped out other places of peat swamp forest lands in other part of Kalimantan, such as Tumbang Nusa research site (Central Kalimantan) and Mega Rice Project (with nearly one million hectares of peat swamp forest converted to agricultural land) have also been devastated by forest fires.

Peat swamp forest in Sumatra has also been devastated by forest fire in last several decades. The primary causes of forest fire are the establishment of canal for log transportation and land clearing for planting other crops.

2. 2.4. Frequent Forest Fires

Fire has occurred in most peat swamp forests in Indonesia, especially during dry season. The fire occurred underground forest and mostly produces substantial amount of smoke. The fire is frequently scattered and difficult to be extinguished. Some parts of Sebangau National Park have also been attacked by fire at least since last two years. The other sides of the Park including Mega Rice Project sites have also been frequently attacked by underground fire causing severe degradation of peat swamp forest in Central Kalimantan. Sebangau NaPart of the field survey site in Sebangau National Park has also been attacked by forest fire for some parts and it occurs repeatedly.

Severe peat swamp forest fires have destructed vegetation in peat swamp forest including the lost of seedlings of various species and burn out the forest stands. The damaged main stems due to the fire will eventually fall down causing canopy opening and damage to regeneration potentials that is valuable for subsequent regenerations. The canopy opening will suppress the shade tolerant species and in some cases cause high mortality rate.

III. DISCUSSION

3.1. Natural Population

Ramin

Observation in both locations, Berbak National Park and Sebangau National Park, seedlings and saplings are not found in all observation plots. Only poles to tree stage are abundant in both National Parks. In virgin or primary forests in the protected zone of Berbak National Park, where their population were measured, the majority of ramin trees are at mature stage. Ramin is a dominant and widely distributed in this area with basal area of 4,329 m2 and important value index of 37.64. In Sebangau National Park, which is a secondary forest or logged over area of over 10-15 years after logging operation, the number of ramin trees is least abundant, only 22 trees per hectare with the important value index of 12,67. In Sebangau National Park, ramin is in tenth rank out of 31 observed tree species. Kayu 'Tumi' (*C. rotundatus*] is a major tree species in Sebangau National Park. From these patterns, there are some facts as follow:

1. The number of seedlings (Regeneration) in a newly logged over area are abundant compared to the old or relatively old growth ramin trees.
2. The number of ramin seedlings in primary or virgin forests and old secondary forests tends to decrease.

There is no straightforward explanation for the difference in the number of seedling in both areas, since earlier data on the ramin population in both sites area not available. There are several studies have been conducted on the regeneration of ramin in various sites (Kusumahnegara *et al* 1976; Solihin 1997; Istomo,1993, 2005). According to the earlier reports, there are abundant of ramin seedlings under the forest floor prior to logging operation. Similar results are also found in a newly logged over forests in many studies conducted earlier (Box 1).

The high number of ramin seedlings in a newly logged over area is speculated to be related to the characteristic of the vegetation and canopy closure. The opening of the forest canopy resulted in the entry of sunlight through forest floor. The biological response to the light could cause the promotion of seed germination and rapid growth of seedlings that have been previously suppressed by light and space competition in the area. In old logged over area and virgin forest where extremely limited sunlight reaching forest floor could causes severe suppression to some species. This causes the slow growth at early stage of the species.

Other Species

Kayu Tumi (*C. rotundatus*) is one of the high value timber in Sebangau National Park with long clear bole and relatively dominant in this area. This species is also widely distributed through the area. Observation in ex-fire of peat swamp forest area in the site of ex-Sanitra Sebangau Indah, stems of this species remain intact approximately one year after forest fire occurred in this area. In this ex-forest fire area, tall trees stems and long clear bole still appear. However, the size of stem for most species is relatively small, ranged between 20-40 cm. The stem of tumi produces many sprouts.

Box 1. Regeneration Pattern of Ramin

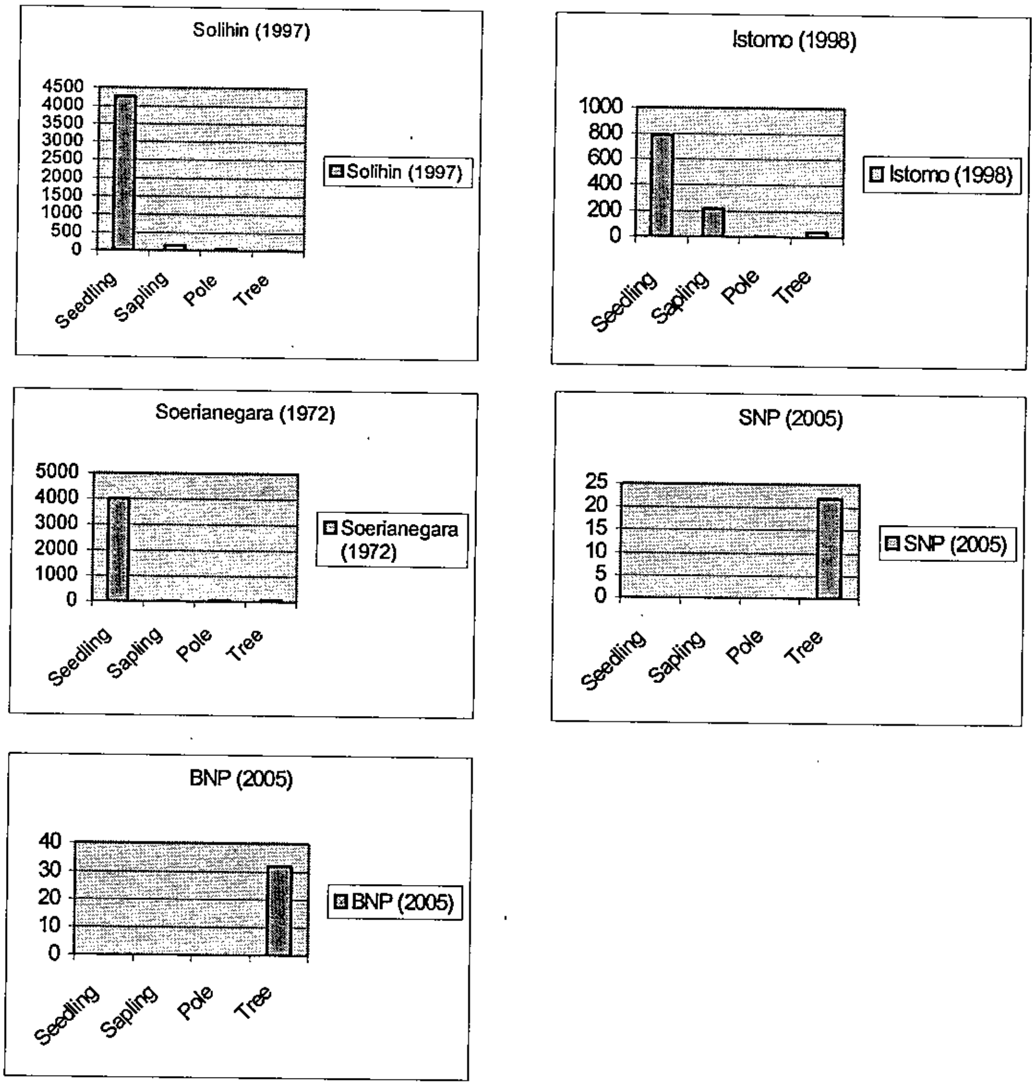

Figure 2. Population and Natural Regeneration pattern of ramin recorded in different locations and time period (Y-axis indicates the number of individual)

Regeneration pattern of ramin is varied between habitat and ecological conditions (Figure 2). In logged over area of five months and three years after logging operation showed significant variation. Observation by Kusumahnegara et al (1976) in Sukalanting, West Kalimantan indicated the regeneration at seedling stages was abundant (nearly 3000 seedlings per ha) and the number of seedlings is low in the logged over area of three years after logging operation (only around 800 seedlings per ha). Observation by Istomo (1993,1998) in Sampit, also West Kalimantan indicated the variation in the number of seedlings between habitat conditions, especially due to the peat thickness. In this area the number of seedlings stage are nearly 2000 seedlings per ha. Observation in virgin forests by Al-Rasyid and Soerianegara (1971) in West Kalimantan also indicated abundant seedlings stage, which

Was nearly 4000 seedlings per ha. Observation by Solihin (1997) in ex-logging operation in PT. Yos Raya Timber, Riau Sumatra also indicated the number of seedlings of over 4000 per ha. Regeneration pattern presented by both Istomo (1993,1998) and Solihin (1997) are nearly similar to that presented earlier by Soerianegara (1972). However, these are in contrast with result of field survey in primary/virgin forests in Berbak National Park (BNP, 2005) and Secondary/logged over area in Sebangau National Park (SNP, 2005). Observation in secondary forest (LOA) of 10-15 years after logging operation in Sebangau National Park, Central Kalimantan showed extremely limited number of seedlings. In this area, ramin was found only at pole and mature tree stages.

Nearly similar results are also found in Berbak National Park. In this virgin forest, ramin is dominant with mostly at mature stage, large diameter. Observation by an Integrated team for CITES scientific authority in PT. Diamond Raya Timber, Riau Sumatra indicate similar trend, which is the number of mature trees are relatively abundant than that of sapling and seedlings stages. According to Partomiharjo (2005), this regeneration trend indicates a limited regeneration potential of the species. For ramin, the limited regeneration potentials are due to the presence of interval in flowering and fruiting, short live seeds (recalcitrant), high requirement of site to grow, inefficient mechanism of seed dispersal and very slow growing.

Figure 3. The main and large ramin stem in Berbak National Park (left hand side) and ex-burnt peat swamp forest in Sebangau National Park (right hand side)

3.2. The Application of Silvicultural Practice in Ramin Harvest

Existing methods of ramin harvest refer to the existing Silvicultural system imposed by the government and its application has been evaluated. Earlier, 1970s to 1989, an Indonesian Selective Cutting (TPI) was applied. Since 1989 an Indonesian Selective Cutting and Replanting (TPTI) was imposed to replace earlier system (TPI). In this silvicultural system, the main critical change is the maintenance of residual stands of ex-post logging operation and enrichment planting in the site where the number of required seedlings is insufficient and the distribution is uneven. These treatments are to ensure the sustainable productivity for future harvest and to improve stand quality. However, there are some facts that pre-requisite and required stages and step as described in the guideline of TPI and TPTI were not consistently followed. The supervision and evaluation of all steps required prior to timber harvesting and evaluation after logging operation by the designated institution were also not conducted consistently. These have resulted in severe degradation of most logged over area. The future standing stock does not meet expected quantity (volume) as described in the system. The management of LOA, therefore, is no longer attractive for the investors, except conversion to other commodity or other uses.

The TPI and later TPTI has been claimed as the most suitable silvicultural system to used in the Indonesian tropical rain forests. Indonesian tropical forests consist of many types of forests, such as hill to lowland tropical forest, mangrove and peat swamp. Physical condition of forests requires comprehensive study and assessment to evaluate whether one system is appropriate to be applied, especially in respect to ecology and biological condition. Current silvicultural system for ramin follows TPI (TPTI) system. Based on recent evaluation (Al-Rasyd, 2005), it is recommended that some modifications are required to ensure sustainability of ramin, especially in ex-post harvesting maintenance.

As described in the Guideline, the system (TPTI) consists of several steps. The following conditions are incorporated into the steps to improve methods for ramin harvest, such as

1. The field cruising carried out prior to logging operation. This is to ensure the sustainability of timber production, good condition of existing hydro-orologis, soil and water conservation and landscape condition including forest composition and structure.
2. The management of existing species composition to ensure the provision of valuable future standing stock with high quality and quantity.
3. The management of population structure and diversity to ensure the achievement of required condition, especially space to enable the existing population to grow and adapted to the new environments.

The case for ramin, several technical barriers in the application of the system as required by Guidelines are those related to:

1. Marking mother trees for the sources of seeds or regeneration material and core trees as sources for timber in subsequent cutting cycles. Our observation indicated that there are some potential difficulties in marking mother and core trees in peat swamp forest, especially during the wet season.
2. Maintenance of residual stands. This is probably the most difficult part in the system. Maintenance of residual stands requires extra effort, since the accessibility to the logged over area after logging is extremely poor.
3. Forest compositions, stand structure and the nature of growth of particular species.
4. Knowledge on the characteristics of each species and its spatial distributions
5. Knowledge on the reproductive biology/capacity of each species.

The distribution pattern of ramin follows clamping pattern. Each clamp is scattered along the landscape. This type of distribution requires special silvicultural modification to ensure sufficient growing stock and good care of residual stands. The growing patterns of ramin will exactly influence the residual stand and population density of logged over area for subsequent cutting cycles.

In relation to the guidelines, one of the requirements of TPTI (TPI) is the sufficiency of seedlings for future population (growing stocks). If the number of seedlings is insufficient and the distribution is uneven, the enrichment planting is mandatory. The physical barrier is due to the fact that the accessibility in peat swamp forest is poor at ex-post logging operation. The other is due to the lack of planting materials for which most seeds of ramin are not always available at the time of planting. Reports indicated that the flowering and fruiting of ramin is every interval 4-5 years (Istomo, 1993, Mujijat and Hermansyah 2005). During loggings operation, logging tract used is mostly made of poles of variable sizes. This track are mostly deteriorated or removed several months after logging operation.

3.3. Ramin Logs Transportation

Another unique aspect of timber harvesting in peat swamp forests is log transportation. In most peat swamp forests, logs are transported using railway *lorri* and or through water canal. Lorri is a small railway tract formed by using various sizes of poles. Water canal is channel established by digging peat swamp soil forming stream flow toward the closest river. *Lorri* and water canal are established prior to logging operation (Box 2). The establishment of water canal has caused several problems related to the drought and the decrease in peat water level. Therefore this method of log transportation has not been recommended. Illegal logs are mostly carried out through water canal.

The impact of canalization has been proved to be worst ecologically, especially for the growth of residual stands. More canals per unit area, the impact to the vegetation is more severe. The establishment of the canal causes to the decrease in ground water surface and therefore causes extreme drought to the peat materials. During the dry season, it will easily ignite fire.

In Sebangau National Park, the establishment of water canal has been in such intense, spread to all over the places. The canals lie from Sebangau river toward the core or virgin forest of the Park. Logged Over Area of ex-PT. Sanitra Sebangau Indah has been frequently attacked by fire, especially during the dry season. In 2003, nearly 100 ha of this area has been wiped out by fire, followed by other forest fires in 2004 and July-August 2005. In 2005, it was reported that other peat swamp area, near Tumbang Nusa, west of SNP has also been attacked by fire. Wetland International and WWF-I, Kalimantan Program has carried out effort to rehabilitate the peat swamp forests and to prevent further loss by similar forest fire (Box 3).

Box 3. Log Transportation in Peat Swamp Forests

Timber harvesting in peat swamp forests is marked by the uniqueness in log transportation. Slightly different from log transportation in mangrove forest, at which logs and other mangrove products could be carried out through water transportation using various types of floating material. In peat swamp forest, the logs could be skidded though the peat soil surfaces and the logs are carried out using railway or lorri or through floating material/equipment in water canal. Special apparatus might be required to walk through the peat swamp forest especially during the wet season, where most forest floors are covered with water (Figure 4).

Figure 4. Canal used for log transportation in Sebangau National Park (left hand side) and railway lorry established in Berbak nearby forest area (Right hand side)

3.4. Ramin Illegal Logging

Sumatra

According to the Strategic Plan of Berbak National Park Management (2000), there are many major commercial species growing in the Park including ramin. The major threat to these major commercial species in the Park is illegal logging. Ramin is one of the species that is frequently becoming the target for illegal logging. Outer zones of the Park, utilization and buffer zone have been severely degraded due to illegal logging operated in that area.

Forest encroachment is also another threat for Berbak National Park. The long term plan for the Park include to prevent further degradation of forests. Several measures to be taken include the promotion of utilization zone, such as cultivation of high valuable agricultural species.

Central Kalimantan

Under current condition, Sebangau National Park and Central Kalimantan as a whole, are still under risk for the sustainability of existing peat swamp forest (Yohannes, 2005, Director of BKSDA, Palangkaraya, personal communication during the field visit). This is because, the park has many potential woods other than ramin such as balangeran (*Shorea balangeran*), Nyatoh and Tumi. But the illegal logging in this park is still on going, even though the central government has issued Minstrial Decree to put these ex-concessionaires as conservation area with the category as National Park. By this issuance, the status of the area should be more secure and protected from any disastrous activity, including illegal logging. The fact that thousands of cubic meters of ramin logs are still extracted from the Park and buried under the peat swamp along the earlier established artificial canal. The illegal loggers remain inside the park waiting further conducive situation to bring the logs out of the park. Felling activity decreases following the various rumors on the integrated operation involving police and military to combat illegal logging. The cukong, which is the influential player on illegal logging, has reduced their activities temporarily. Once the integrated operation to combat illegal logging reduce or decline, it is predicted the illegal loggers will resume their illegal activity.

Canalization

The Impacts of the canalization has also become a threat for ramin population especially young trees (seedling and sapling). The canalization caused rapid flow of water toward the nearby river. This flow has caused extreme dry in the peat swamp forest, especially during the dry season. This could affect at least to the following aspects:

1. The risk of fire increases due to the droughts of soils, peat and other biological materials
2. The extreme drought could cause the death of seedling, especially for non-drought resistant species.
3. The siltation of the peat swamp forests
4. The movement of soil nutrient toward the canals and then to the river.
5. The change of vegetation from non-drought resistant species to drought resistant species.
6. The changes of vegetation from non-fire resistant to fire resistant species.

Various effort has been introduced for the recovery of peat swamp forest due to canalization. De-canalization has been introduced in ex-Mega Rice Project by Wetland International by blocking the canal with artificial damp (Indonesia: tabat). WWF-I has established such tabat in one of the canals in Sebangau National Park. This will be a necessary step toward the recovery of peat swamp forest land in this area. However, this de-canalization requires high cost, especially to purchase concrete materials for dam establishment. WWF-I has introduced the utilization of durable wood materials available in that area. The durability of the materials should cover the period of recovery of the peat land condition.

CITES Implementation

Barrier to CITES implementation in Indonesia (Sumatra and Kalimantan) ranges from lack of coordination between responsible institutions, lack of qualified human resources in the check points and lack of appropriate documentation for logs (Box 4).

Box 4. CITES Implementation on Ramin

Ramin (*Gonystylus spp.*) is one of the most valuable timber species in Indonesia and has been excessively extracted from their natural habitat. Ramin habitat and the remaining population have faced problems due to the forest land conversion to other uses and repeated forest fires in the peat swamp forests. Human activities and natural disaster have caused ramin to extinction. In relation to these various threat, the government of Indonesia (Ministry of Forestry) has issued moratorium policy on ramin in 2001 which is aimed to down size ramin exploitation and more control on ramin International trade.

Almost at the same time, ramin was also listed in Appendix III Annotation #1of Convention of International Trade of Endangered Species of Fauna and Flora (CITES). By this listing, all wood specimen of ramin (log, sawn timber and finished products) are controlled under CITES permits to be exported to other countries and each ramin product must be accompanied by permit and certificate issued by CITES Management Authority. Some of the permit and certificates required under the Appendix III are CITES certificate of origin, CITES export permit, CITES re-export certificate, Non-Party Country of Origin certificate and Non-Party Re-export Certificate (Samedi 2005). In late, 2004 ramin was up-listed into Appendix II of CITES. Under this Appendix, more requirements to export ramin products could be followed.

The implementation of CITES on ramin in Indonesia still bears several limitations, some of them are as follows:

1. The weakness in the documentation of ramin products by authority.
2. The limited capacity of human resources, especially in the identification of ramin wood and ramin wood product in the forest product check points and shipping port.
3. Awareness of responsible institutions is still limited
4. Lack of coordination between authorities and related institutions.

Figure 5. Illegal logs cut from Sebangau National Park (left hand side) and illegal logs at Berbak National Park (Right hand side)

IV. CONCLUSION AND RECOMMENDATION

4.1. Conclusion

1. Ramin population and natural regeneration show a great variation in density, regeneration status and species composition depending on each forest condition (site). In virgin or primary forests of Berbak National Park, ramin was dominant and ramin population was dominated by large and mature trees.
2. Ramin was relative rare in secondary forests (logged over area) of Sebangau National Park. In this Park, ramin trees were relatively small.
3. Natural regeneration in both Parks was extremely poor. Ramin natural regeneration in other locations, as recorded from other sources of data, was relatively rich.
4. Threats to ramin population and natural regeneration include poor implementation of silvicultural system, the excessive impact of canalization, extreme drought and peat swamp forest fires and conversion to other uses.
5. The extreme drought caused by canalization has resulted in potential peat forest fire and high mortality of vegetation in the area. The mortality of certain species could cause change in biological diversity and species composition.
6. Illegal logging operated in secondary and primary peat swamp forests has become a major threat for ramin growing stock and sustainability.

4.2. Recommendation

1. It is recommended that a detail ecological studies on ramin population and regeneration be carried out.
2. A silvicultural prescription for ramin needs to be further improved and adjusted based on the biological characteristics of ramin and physical barrier.
3. It is recommended that the land use planning for ramin habitat, forest and conservation be identified and legally documented.
4. Rehabilitation of ramin habitat and de-canalization using 'tabat' (water blocking) be recommended to be further established.
5. Ramin slow growing causes poor investments interest to forest companies. Therefore, it is also recommended that an incentive scheme for rehabilitation and plantation of ramin be developed.

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Appendix 1. Result of vegetation analyses in the forest of Berbak National Park, Jambi

No.	Species	Family	No. of Plot	No. of Stem	Basal Area (m2)	F	D/Ha	Basal area/Ha	RF (%)	RD (%)	RDo (%)	IVI (%)
1	*Aglaia argentea*	Meliac.	3	4	0.611	60	8	1.222	3.797	1.778	3.488	9.064
2	*Alseodaphne* sp.	Laur.	2	5	0.254	40	10	0.508	2.532	2.222	1.450	6.204
3	*Amoora rubiqinosa* Hiern.	Meliac.	1	2	0.123	20	4	0.246	1.266	0.889	0.702	2.857
4	*Anisoptera laevis* Ridl.	Dipt	1	1	0.213	20	2	0.426	1.266	0.444	1.216	2.926
5	*Blumeodendron subrotundifolium* Merr.	Euph.	1	2	0.085	20	4	0.17	1.266	0.889	0.485	2.640
6	*Calophyllum grandiflorum* J.J.S.	Gutt.	1	2	0.049	20	4	0.098	1.266	0.889	0.280	2.434
7	*Cyathocalyx* sp.	Annon.	1	1	0.021	20	2	0.042	1.266	0.444	0.120	1.830
8	*Diospyros baloen-idjuk* Bakh.	Eben.	4	12	0.348	80	24	0.696	5.063	5.333	1.987	12.383
9	*Diospyros maingayi* Bakh.	Eben.	2	3	0.284	40	6	0.568	2.532	1.333	1.621	5.486
10	*Diospyros siamang* Bakh.	Eben.	1	1	0.063	20	2	0.126	1.266	0.444	0.360	2.070
11	*Dyera lowi* Hook.f.	Apoc.	2	2	0.146	40	4	0.292	2.532	0.889	0.834	4.254
12	*Ganua motleyana* Pierre	Sapot.	2	4	0.14	40	8	0.28	2.532	1.778	0.799	5.109
13	*Garcimia* sp.	Gutt.	1	1	0.139	20	2	0.278	1.266	0.444	0.794	2.504
14	*Gonystylus bancanus* Kurz	Thym.	5	16	4.239	100	32	8.478	6.329	7.111	24.202	37.642
15	*Ilex cymosa* Bl.	Aquif.	1	6	0.104	20	12	0.208	1.266	2.667	0.594	4.526
16	*Knema mandarahan* Warb.	Myrist.	1	1	0.015	20	2	0.03	1.266	0.444	0.086	1.796
17	*Koompassia malaccensis* Maing.	Caes.	1	1	0.165	20	2	0.33	1.266	0.444	0.942	2.652
18	*Lindera subumbelliflora* Kosterm.	Laur.	1	1	0.015	20	2	0.03	1.266	0.444	0.086	1.796
19	*Mangifera parviflora* Boerl.	Anac.	3	9	0.288	60	18	0.576	3.797	4.000	1.644	9.442
20	*Melicope* sp.	Rut.	4	18	0.46	80	36	0.92	5.063	8.000	2.626	15.690
21	*Mezzettia parviflora* Becc	Annon.	1	1	0.026	20	2	0.052	1.266	0.444	0.148	1.859
22	*Myristica* sp.	Myrist.	3	3	0.22	60	6	0.44	3.797	1.333	1.256	6.387
23	*Neoscortechinia kingii* Pax. et Hoffm.	Euph.	3	8	0.166	60	16	0.332	3.797	3.556	0.948	8.301
24	*Palaquium ridleyi* K. et G.	Sapot.	3	8	0.983	60	16	1.966	3.797	3.556	5.612	12.965
25	*Parartocarpus triandrus* J.J.S.	Morac.	1	1	0.466	20	2	0.932	1.266	0.444	2.661	4.371
26	*Parastemon urophyllum* A.DC.	Ros.	5	15	2.163	100	30	4.326	6.329	6.667	12.349	25.345
27	*Payena leerii* Kurz	Sapot.	2	3	0.077	40	6	0.154	2.532	1.333	0.440	4.305

28	*Polyalthia hypoleuca* Hook.f. et Th.	Annon.	1	1	0.052	20	2	0.104	1.266	0.444	0.297	2.007
29	*Shorea ovalis* Blume	Dipt.	1	2	0.727	20	4	1.454	1.266	0.889	4.151	6.305
30	*Shorea teysmanniana* Dyer	Dipt.	3	4	0.48	60	8	0.96	3.797	1.778	2.741	8.316
31	*Shorea teysmanniana* Dyer ex Brandis	Dipt.	2	2	0.098	40	4	0.196	2.532	0.889	0.560	3.980
32	*Syzygium* sp.	Myrt.	1	2	0.053	20	4	0.106	1.266	0.889	0.303	2.457
33	*Syzygium* sp. 1	Myrt.	1	4	0.225	20	8	0.45	1.266	1.778	1.285	4.328
34	*Syzygium* sp. 2	Myrt.	5	29	1.582	100	58	3.164	6.329	12.889	9.032	28.250
35	*Tetramerista glabra* Miq.	Theac.	4	7	0.923	80	14	1.846	5.063	3.111	5.270	13.444
36	*Urandra scorpioides* Oktz.	Icac.	5	43	1.512	100	86	3.024	6.329	19.111	8.633	34.073
	Total		79	225	17.515	1580	450	35.03	100	100	100	300

Note:

D = *Density*
F = *Frequent*
RF = *Relative Frequency*
RD = *Relative Density*
RDo = *Relative Dominancy*
IVI = *Important Value Index*

Appendix 2. Result of vegetation analyses in the forest of Sebangau National Park, Central Kalimantan

No.	Species	Familiy	No. of Plot	No. of Stem	Basal Area (m2)	Frequency	D/Ha (Btg)	Basal Area/Ha (m2)	RF (%)	RD (%)	RDo (%)	IVI (%)
1.	*Alponsea teysmanii* Boerl.	Annon	5	25	0.402	100	50	0.804	4.950	6.527	4.404	15.882
2.	*Alseodaphne* sp.	Larur	1	1	0.02	20	2	0.040	0.990	0.261	0.219	1.470
3.	*Amoora rubiginosa* (Hiern.) Panel	Meliac	1	1	0.014	20	2	0.028	0.990	0.261	0.153	1.405
4.	*Calophyllum dasyfolium* Miq.	Gutt	5	46	0.913	100	92	1.826	4.950	12.010	10.002	26.963
5.	*Calophyllum* sp.	Gutt	2	2	0.073	40	4	0.146	1.980	0.522	0.800	3.302
6.	*Camnosperma coriaceum* (Jack) Steer	Anac	5	28	0.67	100	56	1.340	4.950	7.311	7.340	19.601
7.	*Combretocarpus rotundatus* Dans.	Rhyz	4	14	1.856	80	28	3.712	3.960	3.655	20.333	27.949
8.	*Combretocarpus* sp.	Rhyz	4	25	0.573	80	50	1.146	3.960	6.527	6.277	16.765
9.	*Cratoxylum glaucum* Korth.	Hyper	3	4	0.079	60	8	0.158	2.970	1.044	0.865	4.880
10.	*Cryptocarya* sp.	Larur	1	1	0.022	20	2	0.044	0.990	0.261	0.241	1.492
11.	*Dactylocladus stenostachys* Oliv.	Cryp	3	12	0.28	60	24	0.560	2.970	3.133	3.067	9.171
12.	*Diospyros evena* Bakh.	Eben	1	1	0.013	20	2	0.026	0.990	0.261	0.142	1.394
13.	*Diospyros malam* Bakh.	Eben	2	7	0.17	40	14	0.340	1.980	1.828	1.862	5.670
14.	*Dyera lowii* Hook.f	Apoc	5	14	0.481	100	28	0.962	4.950	3.655	5.270	13.875
15.	*Garcinia* sp.	Gutt	3	3	0.037	60	6	0.074	2.970	0.783	0.405	4.159
16.	*Gonystylus bancanus* Kurz.	Thym	5	11	0.461	100	22	0.922	4.950	2.872	5.050	12.873
17.	*Knema conferta* Warb.	Myrist	3	5	0.078	60	10	0.156	2.970	1.305	0.855	5.130
18.	*Lithocarpus dasystachys* (Miq) Rehd.	Fag	1	1	0.009	20	2	0.018	0.990	0.261	0.099	1.350
19.	*Lithocarpus* sp.	Fag	2	2	0.036	40	4	0.072	1.980	0.522	0.394	2.897
20.	*Palaquium cochlearia* Engl.	Sapot	5	29	0.434	100	58	0.868	4.950	7.572	4.755	17.277
21.	*Palaquium* sp.	Sapot	1	1	0.012	20	2	0.024	0.990	0.261	0.131	1.383
22.	*Parastemon urophyllum* A.DC.	Ros	2	3	0.04	40	6	0.080	1.980	0.783	0.438	3.202
23.	*Ptychopyxis* sp.	Euph	1	1	0.011	20	2	0.022	0.990	0.261	0.121	1.372
24.	*Sageraea* sp.	Annon	3	7	0.106	60	14	0.212	2.970	1.828	1.161	5.959
25.	*Shorea pauciflora* King.	Dipt	5	38	0.716	100	76	1.432	4.950	9.922	7.844	22.716
26.	*Syzygium* sp 1.	Myrt	5	16	0.234	100	32	0.468	4.950	4.178	2.564	11.692
27.	*Syzygium* sp 2.	Myrt	5	30	0.528	100	60	1.056	4.950	7.833	5.784	18.568

28	*Tristaniopsis stellata* Ridl.	Myrt	4	7	0.106	80	14	0.212	3.960	1.828	1.161	6.949
29.	*Tristaniopsis whiteana* Griff.	Myrt	5	21	0.271	100	42	0.542	4.950	5.483	2.969	13.402
30.	*Urandra scundiflora* Oktz.	Icac	5	19	0.262	100	38	0.524	4.950	4.961	2.870	12.782
31.	*Xylopia malayana* Hook.f.	Annon	4	8	0.221	80	16	0.442	3.960	2.089	2.421	8.470
Total			101	383	9.128	2020	766	18.256	100	100	100	300

Note:
D = *Density*
RF = *Relative Frequency*
RD = *Relative Density*
RDo = *Relative Dominancy*
IVI = *Important Value Index*