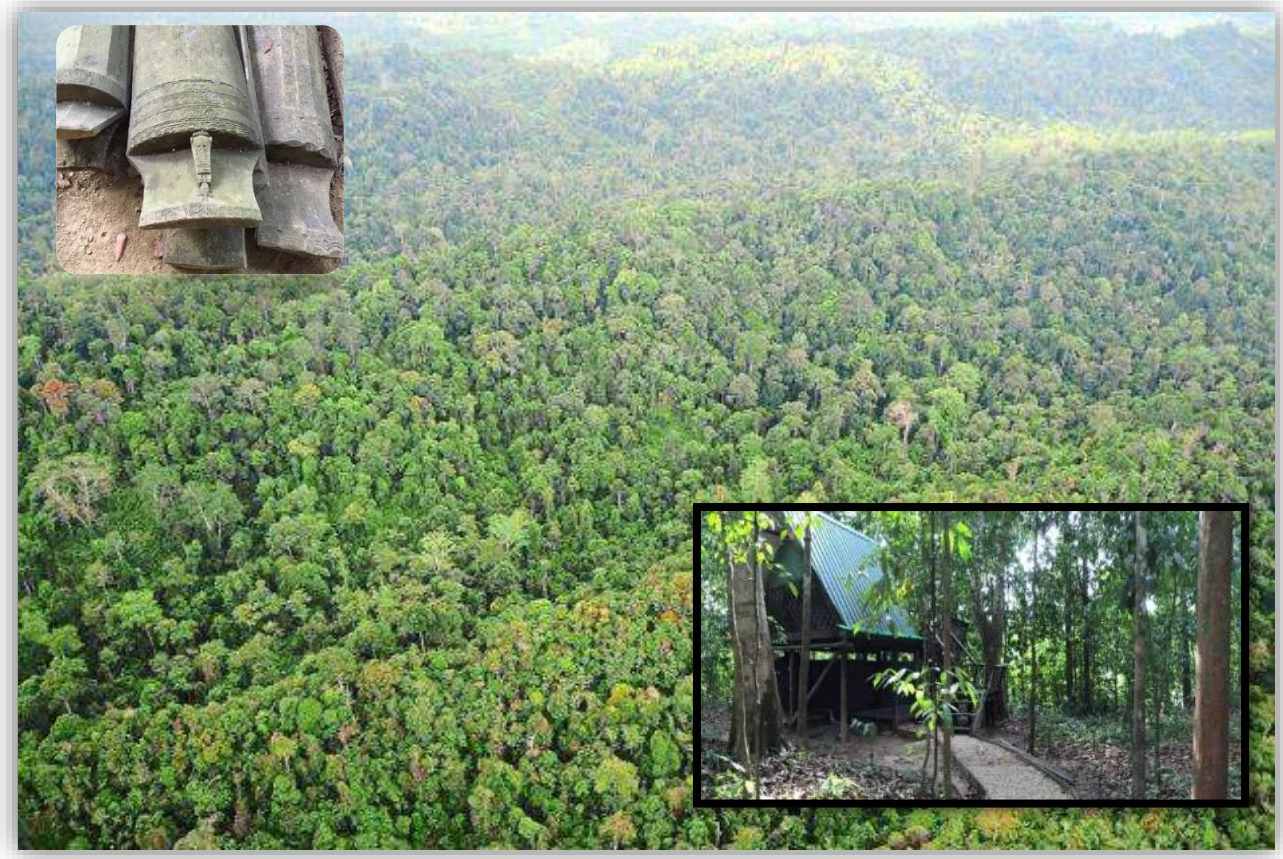
2nd FOREST MANAGEMENT PLAN (2018 – 2027)

Pin-Supu Forest Reserve, Kinabatangan



SABAH FORESTRY DEPARTMENT

2nd FOREST MANAGEMENT PLAN

(2018 – 2027)

For

Pin-Supu Forest Reserve – Class VI (VJR)

Approved by:

(DATUK MASHOR MOHD JAINI)

Chief Conservator of Forests

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BOD	-	Biological Oxygen Demand
CITES	-	Convention on International Trade in Endangered Species
DFO	-	District Forestry Officer
DO	-	Dissolve Oxygen
EMP	-	Environmental Monitoring Program
FMU	-	Forest Management Unit
FMP	-	Forest Management Plan
FSC	-	Forest Stewardship Council
HCV	-	High Conservation Value
HCVF	-	High Conservation Value of Forest
IUCN	-	International Union for Conservation of Nature
KOPEL	-	Koperasi Perlancongan Mukim Batu Puteh Kinabatangan Bhd.
MESCOT	-	Model Ecologically Sustainable Community Conservation and Tourism
MOU	-	Memorandum of Understanding
MDF	-	Mix Dipterocarp Forest
PSFR	-	Pin-Supu Forest Reserve
PSSFM	-	Pin-Supu Sustainable Forest Management
R & D	-	Research and Development
SAC	-	Supu Adventure Camp
SFD	-	Sabah Forestry Department
SIA	-	Social Impact Assessment
TREC	-	Tourist Eco Camp
WCE	-	Wildlife Conservation Enactment

PART I

INTRODUCTION

1.1 BACKGROUND AND PURPOSE OF THE FOREST MANAGEMENT PLAN

Pin-Supu Forest Reserve (PSFR) consists of three blocks which are located in the eastern part of the state, within the Kinabatangan District. The area covers a land of 4,696 ha. Within the area, it contains various types of lowland forest formations, 7 oxbow lakes, a limestone karst system with more than 20 large caves and an abundance of flora and fauna. From a landscape perspective, the reserve forms an important and critical forested area that connects the larger Lower Kinabatangan floodplain ecosystems.

The area used to be a production forest in the past. Its timber resource was exploited up to the early 1980s before it became a protected area in 1984. Unfortunately, a number of forest fire events and illegal logging in the early 1990s have greatly reduced the quality of the forest due to very little management attention. Nevertheless, gradually the forests of PSFR have regenerated into some of the most intact floodplain forest in the entire Lower Kinabatangan.

The reserve surrounds the community of Batu Puteh, which consists of 3 villages and is bisected by the Sandakan–Lahad Datu Highway. The reserve is relatively unique in part due to the community forestry program between the Sabah Forestry Department and the local community of Mukim Batu Puteh via the MESCOT Initiative and the local community cooperative, Koperasi Perlancongan Mukim Batu Puteh Kinabatangan Bhd. (KOPEL Bhd).

This initiative has been active for more than 20 years and has evolved into a unique scenario whereby the community cooperative focuses on forest conservation and restoration which generates local employment via recreation and eco-tourism activities. Both efforts on forest conservation and restoration are largely funded by the government. This initiative supports sustainable forest management from a number of angles whilst creating jobs locally and raising a sense of appreciation of this special forest reserve.

1.1.1 Planning Team

A core team from the Sabah Forestry Department and Community Ecotourism Cooperative (KOPEL) has prepared the 2nd revision of the Forest Management Plan (FMP) for Pin Supu Forest Reserve (Appendix I).

1.1.2 Policy Framework and Period of Operation

The two larger blocks (Block A and B) of the reserve were first gazetted as a forest reserve on the 2nd of December 1935 and the smallest block (Block C) was gazetted on 1st of August 1959, before re-gazzeted as Class VI Virgin Jungle Reserve (F.D. No: 4/1984) on 14th March 1984 (Figure 1). The main function of PSFR is the conservation of forest for forestry research purposes and biodiversity conservation.

This second Forest Management Plan (FMP) for Pin-Supu Forest Reserve commenced on January 2018 and will end on December 2027. The FMP will highlight the

management prescriptions for 10 years and also to ensure that forest ecosystems, resources and functions are managed on a sustainable basis. Furthermore, additional information on the identification of High Conservation Value attributes in the reserves and initial environmental impact assessment on the management of the reserve are provided in this document.

Optimizing these resources for economic, social and environmental benefits to the people and state of Sabah is inherent with the approach of sustainable forest management. The implementation of this plan will be continually monitored throughout the management plan period. The Kinabatangan District Forestry Officer will administer the implementation of this FMP. In this document, the project area is referred as Pin-Supu Sustainable Forest Management (PSSFM) area or Pin-Supu Forest Reserve (PSFR). The sustainable forest management of the project area is recently certified under the Forest Stewardship Council Scheme in 20 March 2015 as a well manages reserve (Figure 2).

The Sabah Forestry Department's forestry policy statements are:

- The Sabah Forestry Department is committed to managing the Pin-Supu Forest Reserve in accordance with the principles of sustainable and responsible management as prescribed by the Forest Stewardship Council (FSC) and in conformity with all existing State forest policies, environmental policies, legislation and regulations.

- The Sabah Forestry Department will ensure to protect the Pin-Supu Forest Reserve from fire, illegal felling and encroachment as well as to safeguard the resource security under responsible management.

- The Sabah Forestry Department (SFD) is committed to support the effort to combat global warming in Pin-Supu Forest Reserve through restoration activities and the establishment of intensively managed planted areas that will sequester carbon and produce carbon credits in accordance to CCB standards.

- The SFD shall maintain and enhance areas identified as 'high conservation value forests' (HCVF) for the protection of biodiversity, wilderness, soil, and water resources;

- The SFD shall consult with local stakeholders in its efforts to manage the Forest Reserve.

- The SFD shall optimize economic returns to the State on a long-term basis by optimizing the utilization and efficient use of the resources while maintaining conservation and environmental values as well as providing social benefits. Social benefits will include job opportunities and socio-economic development activities, particularly for the local communities who formed the Community Ecotourism Cooperative (KOPEL) to reduce poverty, foster local participation in forest protection, and alleviate long-term unsustainable utilization of this forest reserve.

- The SFD shall identify and protect sites of special cultural or religious significance in the project area and such sites are to be documented.

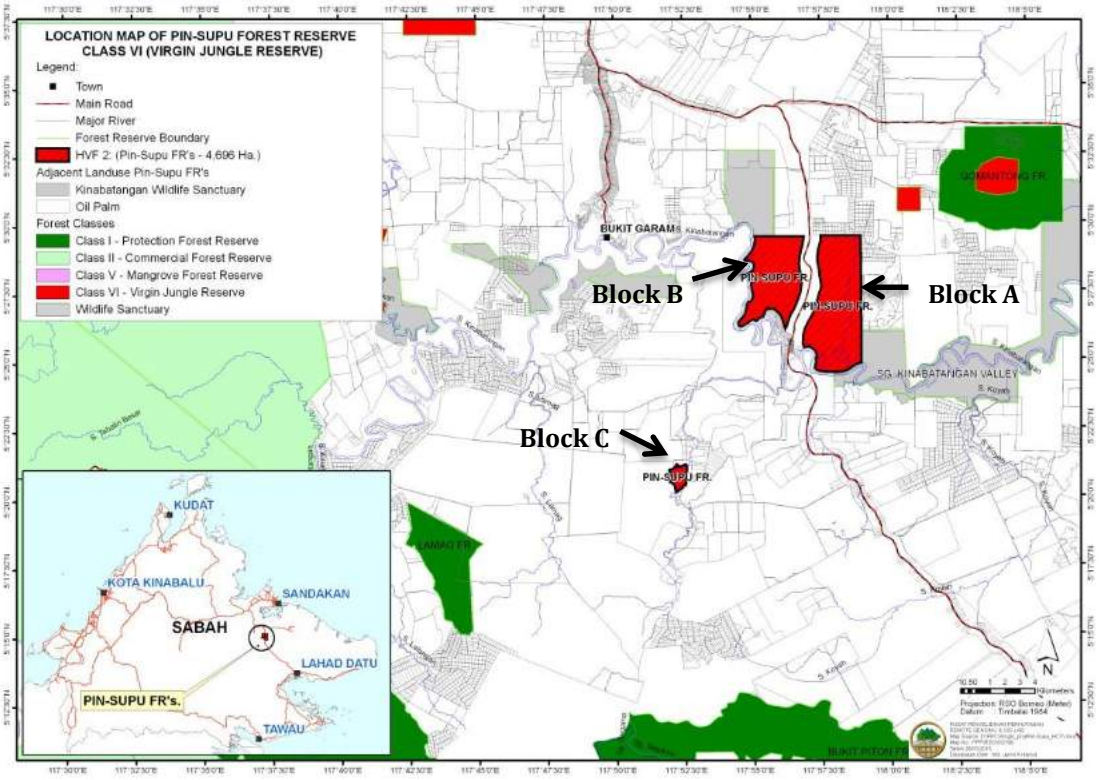


Figure 1: Pin-Supu Forest Reserve consists of three blocks, i.e. Block A, Block B and Block C.

1.1.3 Management Objectives

i. To protect the Pin-Supu Forest Reserve from encroachment, poaching and forest fire.
ii. To support forest resource conservation activities through monitoring forest ecosystems and biodiversity together with forest restoration in degraded sites within the reserve.
iii. To proactively support and enhance the community forestry initiatives that incorporate local community involvement in the employment and service contract, management and community-based ecotourism in the reserve.
iv. To enhance and showcase the community forestry initiatives.
v. To enhance the capacity of the District Forestry Office.

1.1.4 Long Term Objective

To establish Pin-Supu Forest Reserve as a model of sustainable forest management and community partnership.

1.1.5 Short Term Objectives

i. To support other forest resource conservation activities within the reserve.

ii. To support forest restoration in degraded sites within the reserve.

iii. To proactively support and enhance the local community involvement in the management and protection of the reserve through KOPEL Bhd.

iv. To enhance and showcase the community forestry initiatives.

v. To enhance and maximize the benefits from community-based ecotourism activities in Pin Supu Forest Reserve.

Figure 2: A copy of international certification scheme certificate under the Forest Stewardship Council to certify Pin-Supu Sustainable Forest Management project area as a well manages reserve.

1.1.6 Legal Framework and Management Guidelines

The implementation of Sustainable Forest Management (SFM) in Sabah is based on a number of fundamental laws and regulations enacted by the State Government. This legal framework is designed to safeguard the protection of all of Sabah's natural resources and maximize their benefits to the state and its people. As a foundation, these laws give rise to the application of forestry policy which is further guided by recommendations and guidelines outlined by the Sabah Forestry Department and other related agencies. The management of all activities within and surrounding Pin-Supu Forest Reserve shall be guided by the following laws and regulatory guidelines:

1. Sabah Forest Policy, 2018
2. Forest Enactment, 1968
3. Forest Rules, 1969
4. Sabah Land Ordinance, 1930
5. Sabah Labour Ordinance, 1967
6. Sabah Parks Enactment, 1984
7. Environmental Quality Act, 1985
8. Cultural Heritage (Conservation) Enactment, 1997
9. Wildlife Conservation Enactment, 1997
10. Water Resources Enactment, 1998
11. Biodiversity Enactment, 2000
12. Environmental Protection Enactment, 2002
13. Environmental Protection Enactment (Prescribed Activities), 2005
14. Sabah Conservation Strategy, 1992
15. FSC Principles
16. Responsible Tourism (Ecotourism/RT) Principles
17. Health & Safety Regulations

PART II

GENERAL INFORMATION ON FOREST RESERVE, BIODIVERSITY CONSERVATION, SOCIO-ECONOMIC, RECREATION & THREATS

2.1 THE NATURAL PHYSICAL OVERVIEW

2.1.1 Geographic Location

The Pin-Supu Forest Reserve (PSFR) or known to be Pin-Supu Sustainable Forest Management area is geographically located in the mid-reaches of the Lower Kinabatangan Valley between latitude 05° 20’ 09.5” – 05° 29’ 27.5” N and longitude 117° 51’ 54.2” – 117° 59’ 15.5” E of Sabah (Figure 3). It comprises of a cluster of three units of forested areas. The reserve is approximately 42 km southwest from Sandakan following the bearing of 200° and 146 km by river from the Sulu Sea (Figure 3). By road, the northern end of the reserve is 20 km from the Kota Kinabatangan District Forestry Office and 90 km by road from Sandakan. The Kinabatangan River Bridge (which marks the southern end of Blocks A and B of the reserve) is 98 km from Sandakan and 75 km from Lahad Datu. Block C is located approximately 60 km southwest of Sandakan.

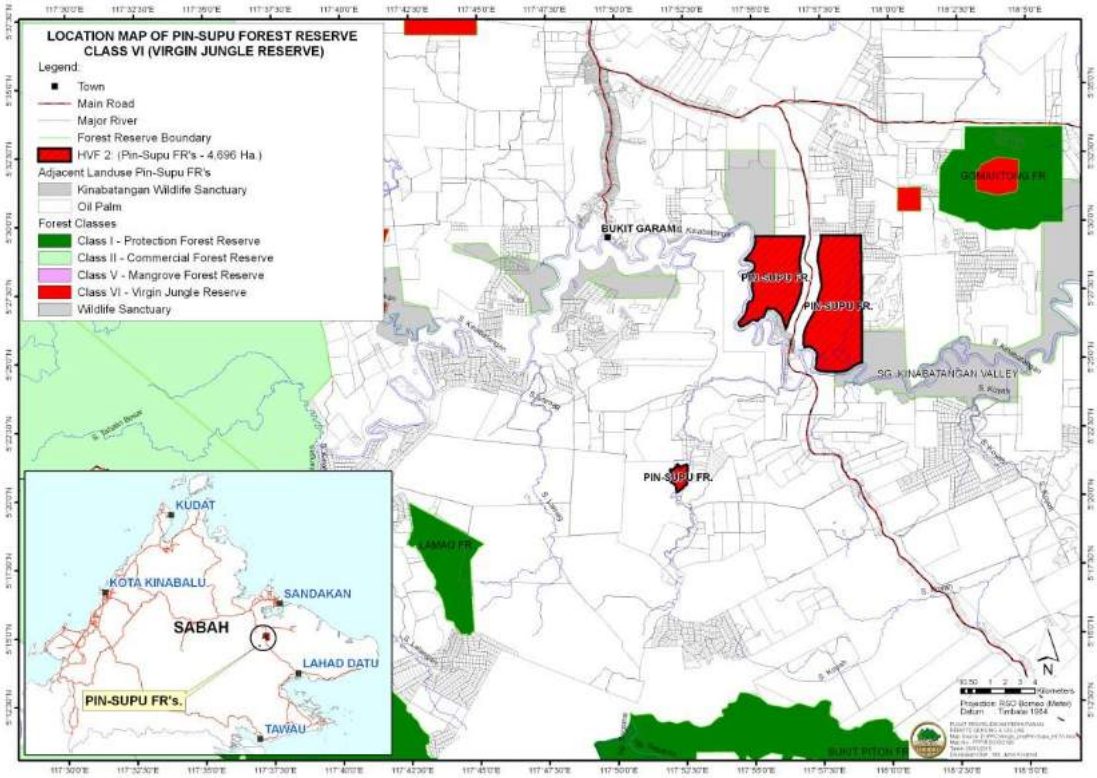


Figure 3: Location of Pin-Supu Forest Reserve.

2.1.2 Site Boundaries and Size

The reserve is **4,696 ha** in size and is almost square in shape extending for approximately 8 km (north – south) by 6 km (east – west), on the northern side of the Kinabatangan River. The Kinabatangan River forms the southern boundary of the reserve, which follows the meandering shape of the Kinabatangan River. The reserve is divided into three separate areas. The two main areas of the reserve are located north of the Kinabatangan River, divided by the Sandakan – Lahad Datu Highway, in the vicinity of the Batu Puteh Village (Mukim Batu Puteh). This main arterial road runs southward through the center of

the reserve. The largest part of the unit which is located on the right-hand side is known as Block A, whilst the left unit is known as Block B. However, the smallest unit of the reserve, which in known as Block C is about 151 ha in size, is located south of the Kinabatangan River adjacent to the Pin River. This area is accessed from the Tung Hup Road or Borneo Samudera Road Junctions just south of the Kinabatangan River Bridge.

2.1.3 Climate

To date, there has been no long-term rainfall data collected for the Pin-Supu Forest Reserve. The nearest climate stations are located at Sekong River (21 km to the north), Bilit (27 km to the east) and Bukit Garam (previously Lamag station, 13 km to the west) of the reserve (source: Drainage & Irrigation Department). Averaging the annual rainfall between these stations gives an approximate average rainfall for the Pin-Supu Forest Reserve area of 2,754 mm per year. Minimum monthly rainfall is between March and April with an average a 39% decrease in average monthly rainfall in this period. Maximum monthly rainfall is between December and January with an average a 54% increase in average monthly rainfall in this period.

2.1.4 Topography

Physically, Block A is relatively flat, low-lying and consists of peat swamps and freshwater swamps. There are three (3) ox-bow lakes near the Kinabatangan River, namely Danau Biandong, Danau Tungog and Danau Kaboi. There are patches of hills above 30 m in the northeast, east and the south. Block B has hills over 90 m asl and slopes often greater than 25° along the eastern boundary. Hill crests are often very narrow. The hills are formed of interbedded sandstone and mudstone. Towards the north are low hills (between 30 and 60 m) and valley floors, with amplitudes less than 15 – 30 m and with a regular pattern of dissection. Slopes range from 0 - 25° but are commonly in the 10^{o} - 15° range. A steep and high limestone outcrop is found in the northwest corner of Block B. The peak is called Bukit Supu Besar (about 180 m asl). The central portion is very low-lying, enclosed by hills. In addition, external drainage is impeded by broad levee zones on the Kinabatangan River in the south. Block C is generally very hilly and the terrain is similar to the hills of Block B.

2.1.5 Geology

Generally, the geophysical properties of the PSSFM area composes of three distinct geological ages that had major influences on the soils, topography and drainage properties of the area (Table 2.1.1). The dominant hilly features of the western block B of PSFR marks an area of sandstone which is believed to have been laid down as a seabed in the Eocene period (more than 34-53 million years ago) (Fitch, 1958). Known as the Kulapis Formation, these sandstones are mixed. It is predominantly made up of soft red, purple and grey sandstone, interbedded with layers of grey and grey-green mudstone and shale. These sandstones form very steep low-lying hills caused by the folding and buckling of this relatively soft sedimentary rock (probably during the Miocene, or 5 – 24 million years ago - Fitch, 1958).

This folding has formed a series of steep parallel ridges (up to 450 ft. a.s.l.) throughout the PSFR following a north-northeasterly direction. These hills are known as the Laab Hills.

Less distinctive and more recent geological formations are found throughout the reserve known as the Labang Formation mudstone bedrock. This formation indicates a much later geological history, which formed when the area was still inundated by sea during the Miocene period (or approximately 5 – 24 million years ago). Bedrock of this formation consists of steeply dipping soft grey mudstone, mixed with shale and sandstone. Within this formation, thick beds of foraminiferal limestone and conglomerate rocks (mostly white quartzite pebbles) are found. There are also a number of striking hills of crystalline foraminiferal coral Limestone associated with the similar geological period of formation (Fitch, 1958). The largest of these limestone hills is in the north-western part of the reserve adjacent to the Kinabatangan River, and is called Supu Hill (after which the forest reserve gets its name). Just south of this hill is the Sapat-Taring Hill and Lingkongan Hill. The Batu Puteh and Batu Tulug outcrops are just outside the reserve on the southern boundary. The limestone hills and outcrops within PSFR form massive scarps and white cliffs which are the most distinctive landmarks throughout the reserve.

A small area in the east of the reserve (Block A), comprises a bedrock of sandstone, mudstone and mixed miscellaneous rock. This formation is known as the Kuamut Formation and is composed of a mix of rocks in a mostly greyish, green or purple sandstone matrix. Miscellaneous rocks include those of volcanic origin, such as spilite, chert, tuffite, gabbro and dolerite, with ultramafic rocks, such as serpentinite, along with limestone and stony colluvium of sandstone. These rocks occur in regolith as hill caps or distinct knolls.

The greater part of Pin-Supu Forest Reserve is made up of recent alluvium derived from the weathering and decay of sedimentary rocks from throughout the Kinabatangan catchment. Geologically these areas are the most recent forming within the Quaternary Period (probably from Upper Pleistocene 1.8 million years ago) until present. Closest to the Kinabatangan River, these alluvial deposits form high terraces and levees (mounded embankments); however, moving away from the river, the floodplain is successively lower lying. (Figure 4).

Figure 4: Geological Cross Section through Pin-Supu Forest Reserve

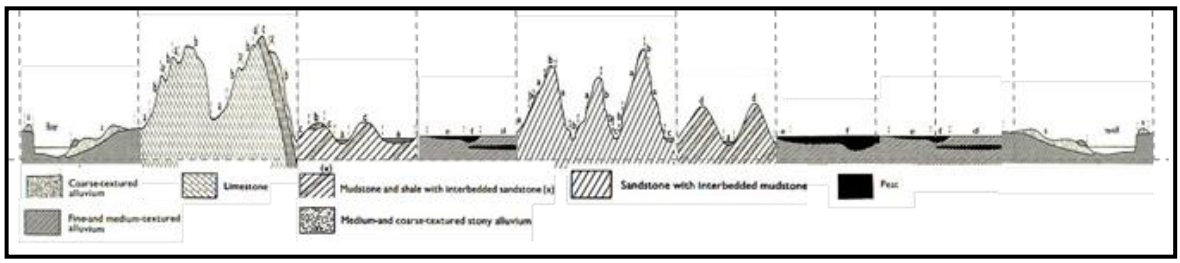


Table 2.1.1. The geological information and soil associations of Pin-Supu Sustainable Forest Management (PSSFM) Area.

Parent Material	Age (year)	Epoch	Soil Association	Area (ha)	Percentage of total PSSFM (%)
Alluvial-Floodplain	≤10,000	Late Pliocene-Holocene	Tuaran	806	17.2
			Kinabatangan	606	12.9
			Sapi	716	15.3
			Klias (peat)	1,231	26.2
Sandstone & Mudstone	5–24 mil	Miocene	Kretam	144	3.1
Mudstone & minor mudstone	5–24 mil	Miocene	Kalabakan	81	1.7
		Miocene	Silabukan	450	9.6
Limestone	5–24 mil	Miocene	Gomantong	172	3.7
Sandstone & Mudstone	40–55 mil	Eocene	Lokan	490	10.4
Total Area				**4,696**	**100**

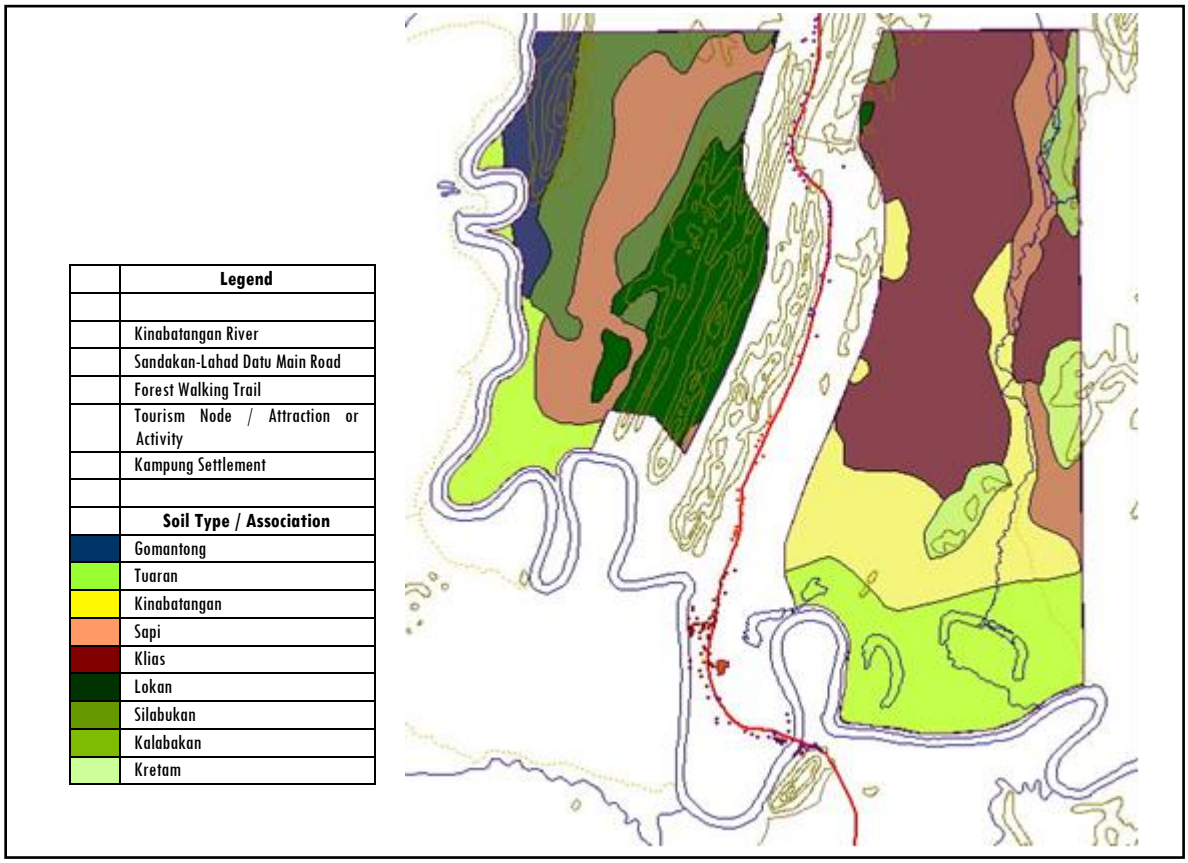
2.1.5 Soil

There are nine major soil associations underlying the PSSFM area that derived from sedimentary rocks and recent alluvium (Table 2.1.1 and Figure 5). About 72% of the project area that are categorised as Tuaran, Kinabatangan, Sapi and Klias soil associations is occasional or seasonally inundated. The other soil associations, i.e. Kretam, Kalabakan, Silabukan, Gomantong and Lokan are considered as well as drained lands (Acres *et al.*, 1975). Of the four alluvial associations (Tuaran, Kinabatangan, Sapi & Klias Associations), the main problem for agricultural development is drainage and severe flood impacts with a large proportion of these soils seasonally or permanently waterlogged. A small hilly area bordering the eastern part of Block A is associated with sandstone and mixed volcanic rocks. The Kretam Association as it is known is complex in both origin and potential for development. Although the soils are on small hills it is often stony and because of this it is classed marginal.

A large part of the central western part of the reserve (approximately 10%) is dominated by shallow soils on sandstone inter-bedded with mudstone (Lokan Association). The agricultural development of this sandstone association is limited due to the steep 30 – 40% slopes, erosion and drought effects. There are many sheer cliffs (scarps) found in this area. The final types of soil found in the reserve are associated with the limestone of Supu and Sapat Taring Hills. The soils on limestone are particularly poor with high porosity due to the limestone bedrock (Gomantong Association). These areas are not considered suitable for agricultural development because of the steep slopes (and sheer cliffs) and dry conditions associated with the high porosity.

Of all nine soils association, only two of these are recommended for agriculture development in Acres & Folland (1975) that is the Silabukan and Kalabakan associations. This represents a mere 10% of the reserve and is found adjacent to the Supu Hill in the north-western part of the reserve.

Figure 5: Soil Associations Map of Pin-Supu Forest Reserve



2.1.6 Hydrology & Drainage

Hydrology is the second main factor alongside soil type in determining the habitat for tree species found in the floodplain and the characteristic forest type. The hydrology of PSFR can be divided into 3 main types (a) seasonally flooded, which corresponds to the floodplain area, (b) well drained which corresponds to the hills, and (c) porous which corresponds to the limestone outcrops.

The seasonally flooded areas are the area of most concern for the development and long-term management of forests in the area. This is of particular concern for forest management because much of the highly degraded forest is found in the seasonally flooded areas. The flood patterns and length of flood determines the chemical structure of the soil and in addition creates a harsh environment for plant life. Only specially adapted trees can survive for long periods in the anaerobic environment which gives rise to the various forms of alluvial floodplain forest (see section 2.2).

The riparian zone (namely river banks) is characterized in PSFR by elevated alluvial terrace and river levees. Although not uniform in elevation this riparian zone is generally inundated by floodwater only every 3-5 years - or in other words a flood of 10m and above. Moving away from the river, the area immediately behind the alluvial terrace is characterized by a marked drop in elevation. This basin effect of the floodplain means that, if the main channel of the Kinabatangan River rises more than 3–5 m (a relatively small flood), much of this area will be completely inundated with water. These smaller floods in effect take place between 4-8 times per year depending on annual fluctuation in rainfall. The most severe floods in the PSFR take place between December and February. When the water from the main channel rises the floodwaters spew out into the floodplain through the small streams, which normally drain the floodplain catchment. This process will take many days as the massive volume of water slows down as it spreads out into the floodplain. Similarly, the drainage of this massive volume of water from the flooded areas can take many days to drain completely. The height and length of period of inundation will depend very much on the severity and duration of rainfall in the upper parts of the Kinabatangan catchment (i.e. Maliau, Kuamut, Inarat, Labau, Melikop, Melian, and Lokan Rivers). The tidal influence at the mouth of the Kinabatangan can also severely affect the duration of the floodwaters in the floodplain. The floods of February 2000 saw vast areas of the floodplain within PSFR being inundated more than 9 consecutive weeks. In February 2004, these areas were underwater for more than 3 months.

The lowest lying areas, such as most of the peat lands and parts of the alluvial plain, remain permanently inundated or waterlogged. This includes abandoned river channels, oxbow lakes, and smaller tributaries or drains through the floodplain. These lands have swamp forest characteristics or open marshland associated with them and are the most severely affected by the annual rise and fall of the main channel.

The Kinabatangan River itself flows for more than 26 km adjacent to the southern boundary of the Pin-Supu Forest Reserve and is considered the most significant feature alongside the reserve. From within the reserve however, there are only minor tributaries with the largest being Girang Nunuk - Kaboi River. The Girang Nunuk – Kaboi River flows for approximately 10.7 km in a southerly direction through the centre of Block A in the east of the reserve. Periodic flooding that occurs in the area (up to 8 times a year), means that the Girang Nunuk Tributary is navigable by small engine powered boats through the length of the Block A of the Reserve. This river provides access to picturesque areas of flooded forest during these flooded periods. The western Block B has two main streams that draining the area namely the Sapat Taring River (5.6 km) and the Laab River (4.3 km). All these tributaries flow through the low- lying floodplain and when the main river is in flood, these rivers disappear with their surrounding forest being completely inundated. Both these rivers are accessible by small boat during flood season.

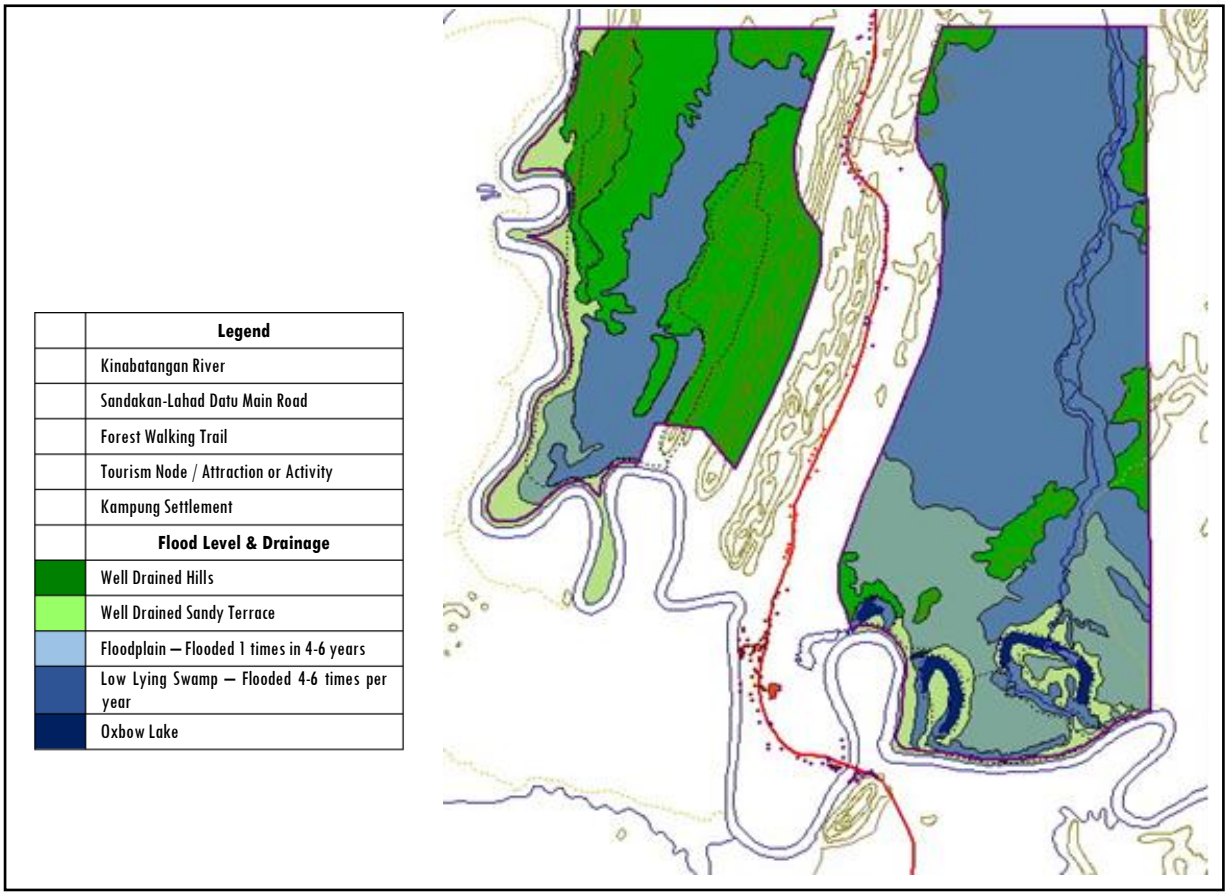
Apart from the small rivers throughout the reserve, there are 7 oxbow lakes within PSFR. The most beautiful and significant lake within PSFR is the Tungog Lake. With an 18.3 ha size, it is the largest oxbow lakes in the PSFR and almost completely disconnected from the main channel of the Kinabatangan. This means that there is very little river sediment

being dumped into the lake, and for this reason Tungog Lake has clear water reaching depths of up to 5m. This lake is also reported to contain large quantities of high value fish such as Ikan Kalui (*Osphronemus goramy*) and Ikan Ubi (*Oxyeleotris marmorata*). The lake is also home to three otter species (*Lutra sumatrana*, *Lutra perspicillata*, and *Aonyx cinerea*) and numerous rare water birds such as the Oriental Darter (*Anhinga melanogaster*) and the Storms stork (*Ciconia stormii*). The second largest of the oxbow lakes within PSFR is the Kaboi Lake.

The Kaboi Lake is found in the center of Block A approximately 1.6 km inland from the Kinabatangan River. The Kaboi Lake is well connected to the Kinabatangan River via the Kaboi River. The Kaboi Lake is accessible by boat following the Kaboi River, although this river becomes unnavigable during the dry months of the year. This lake is 17.6 ha in size, previously being a contiguous 2.1 km in length. Due to rapid sedimentation, the lake is now divided into 3 separate lakes (known as Kaboi I, II & III respectively), connected by a single narrow channel. The sediment infilling causes both Kaboi Lakes I and II to dry up during the dry months of the year.

The only other lake within the reserve is the Biandong Lake, which is located less than 1 km east of the Tungog Lake at the boundary of PSFR with Kampung Batu Puteh. This lake is very shallow, drying up during the dry months of the year within the month of March to June. The flood level and hydrology map of the reserve was shown in Figure 6.

Figure 6: Flood Levels & Hydrology Map of Pin-Supu Forest Reserve



2.1.7 Adjacent Land – Use

The major land-use adjacent to the Pin-Supu Forest Reserve is agriculture activities, such as the cultivation of oil palm (Figure 7). This is so extensive, that 55% or 32 km of the entire 52 km boundary have oil palm cultivation up to the boundary of the forest reserve. Land-use adjacent to the reserve falls in to five distinctly different categories:

(a) Local village small-holders, characterized by local indigenous population. These small-holdings or small-scale farms are mostly between 3 – 6 ha in size. These farms today are dominated by oil palm (80%), but often have a mixed cultivation of oil palm with fruit trees or short-term crops such as corn or watermelon.

(b) Large scale oil palm plantation companies. These large holdings are many hundreds of hectares in size and dominate the land-use adjacent to Pin-Supu Forest Reserve along the northern and eastern boundaries (approximately 24%). One of these plantations Global Agriculture Plantations Sdn Bhd has constructed a road along the north-eastern boundary of the forest reserve (within the forest reserve).

(c) A localized, but significant, land-user adjacent to the Pin-Supu Forest Reserve, in the north-eastern part of the reserve which is the Global Palm Oil Processing Mill. The mill is located immediately adjacent (just outside the forest reserve boundary).

(d) Lot 7 of the Lower Kinabatangan Wildlife Sanctuary is adjacent to the south-eastern boundary of Block A and Lot 8 to the north-western boundary of Block B of the PSFR. These forested areas are protected and classified under wildlife sanctuary. These sanctuaries are not being utilised for any immediate economic purpose.

(e) The southern and western boundaries of the reserve are marked by the Kinabatangan River. Although this river and its waterways do not constitute a specific “land use”, the river is still a major conduit for the transport of timber (from upper parts of the Kinabatangan) and is utilised for its fisheries resources. Although the dependence of local people on the river as a source of livelihood has decreased markedly in recent years, due partly to the marked drop in fishery stocks, there is still a minority group within the local community that still depends on the Kinabatangan River and the waterways adjacent to, and within, PSFR for their livelihood.

(f) The lands adjacent and connecting the reserve to the west and southwest is private land owned by the State Government Linked Company Sawit Kinabalu. In this area more than 2,500ha have been zoned by this company as conservation zone and is currently totally protected by this company with an MOU signed with the Sabah Forestry Department to support the sustainable management of this area. Although this area was severely degraded by logging activities in 1999 it provides critical forest connectivity at the landscape level along the Kinabatangan corridor.

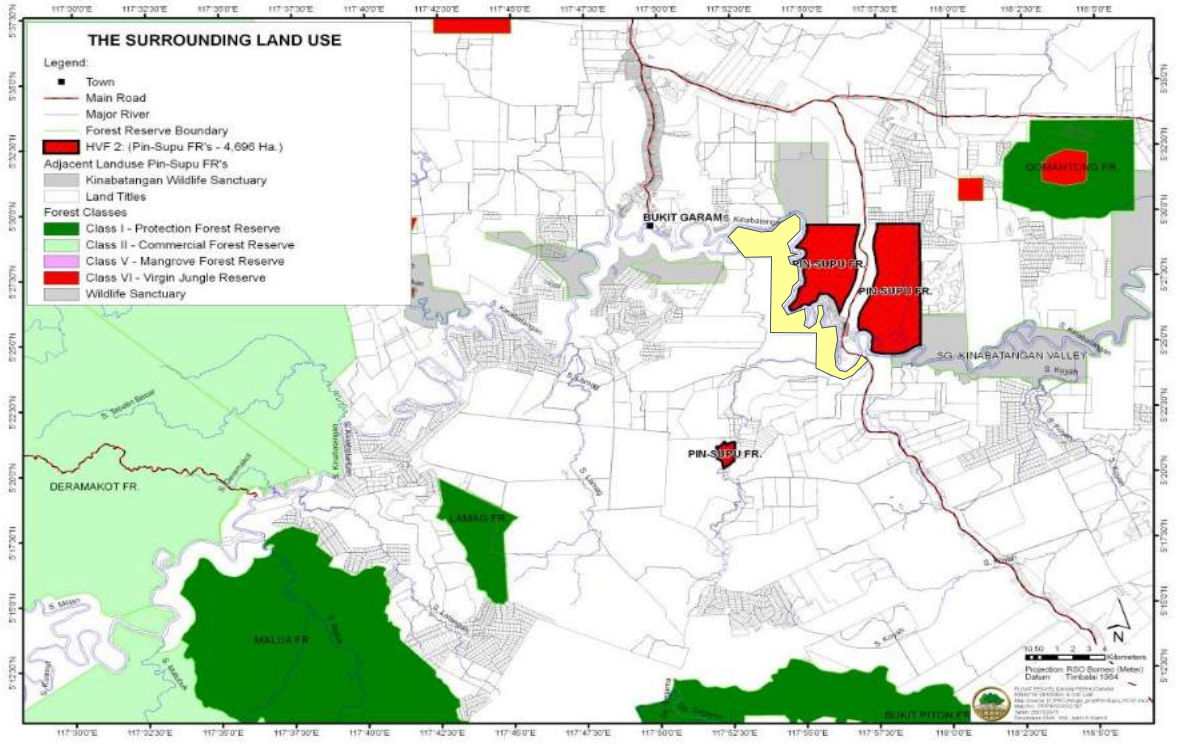


Figure 7: The surrounding land-use of Pin-Supu Forest Reserve.

2.2 BIOLOGICAL OVERVIEW

2.2.1 Forest Ecosystems

The classification of forest ecosystems in PSSFM area is based broadly on several environmental factors, such as edaphic conditions, topography and elevation (Figure 8). The zoning of floristic communities is based on an array of major or dominant groupings that are mono-dominated or co-dominated by various tree species. Most of the PSSFM area is a sub-set of well-known lower Kinabatangan floodplains that basically occur less than 300 m a.s.l. and were formerly classified as comprising of poor structured dipterocarp stand within the matrix of the swamp forest (Acres & Folland, 1975). Therefore, there are two distinct drainage systems, namely, well-drained soils (dryland) and poorly drained soils (wetland). Based on the soil surveys conducted by Acres & Folland (1975), Silabukan, Lokan, Kretam, Kalabakan and Gomantong associations are categorized as drylands; whereas, Tuaran, Kinabatangan, Sapi and Klias are categorized as wetlands (Figure 8).

Previously, the slightly well-drained soils were covered with lowland mixed dipterocarp forest that was established on riparian terrace, alluvial, sandstone and limestone substrates. These lowland forests established about 36% of the total area of the reserve. The other fractions (64%) of the reserve were covered with forest that adapted to inundation condition, such as freshwater swamp forest (mostly permanent or seasonally inundated) and peat swamp forest.

Although the natural vegetation could be differentiated and described by the above classification system, the current vegetation cover in PSSFM area has been highly disturbed by past activities such as log extraction and forest fire. During the drought event in 1997, almost the entire peat swamp forest and part of freshwater swamp forest in Block A areas were burnt. Currently, the forested areas are comprised mostly with secondary forests at various successional stages and sporadic occurrence of regenerating old growth forest or sparsely distributed relics of climax tree species. These degraded or disturbed areas eventually develop into secondary forest whereby more than 70% of the forest structure (tree density and basal area) is dominated by secondary species. Furthermore, these areas naturally lack or are devoid of regeneration capacity of the main climax species, although occasionally some individuals are to be found occurring naturally amongst the under-story trees. These disturbed areas are therefore exposed to a process of vegetative succession, and comprises a series of seral communities, which may have developed initially from grassland or barren-land (or marshes in previously peat swamp or freshwater swamp forests), into a lower structure of scrub vegetation and eventually into a high structure mid-late series secondary forest (Figure 8). About 1800 ha of the reserve is degraded and covered with marsh, grass, shrub and vines vegetation. Due to water table condition, only 27 % of this degraded area may be feasible for restoration activities.

A total of 627 trees above 10 cm dbh were enumerated in 10 permanent sample plots that were established in Pin-Supu FR during the HCV assessment in 2016 (Nilus *et al* 2016; Appendix II). Of these total, 151 number of taxa and 105 number of genera derived from 47 known families were recorded. The Dipterocarpaceae is the most species-rich families and followed by the Malvaceae & Euphorbiaceae (Figure 9).

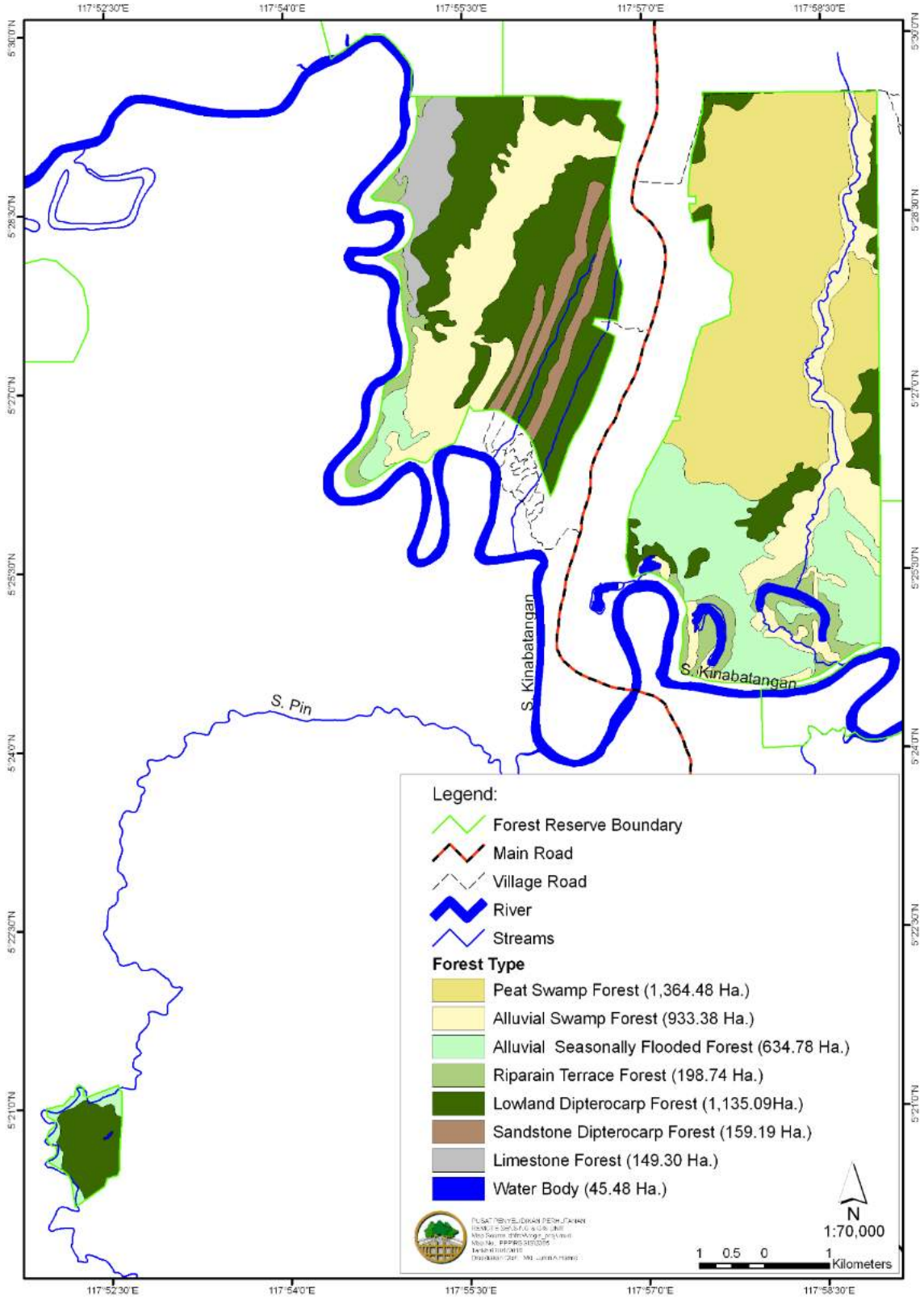


Figure 8: The original natural forest type of Pin-Supu Forest Reserve SFM area, Sabah.

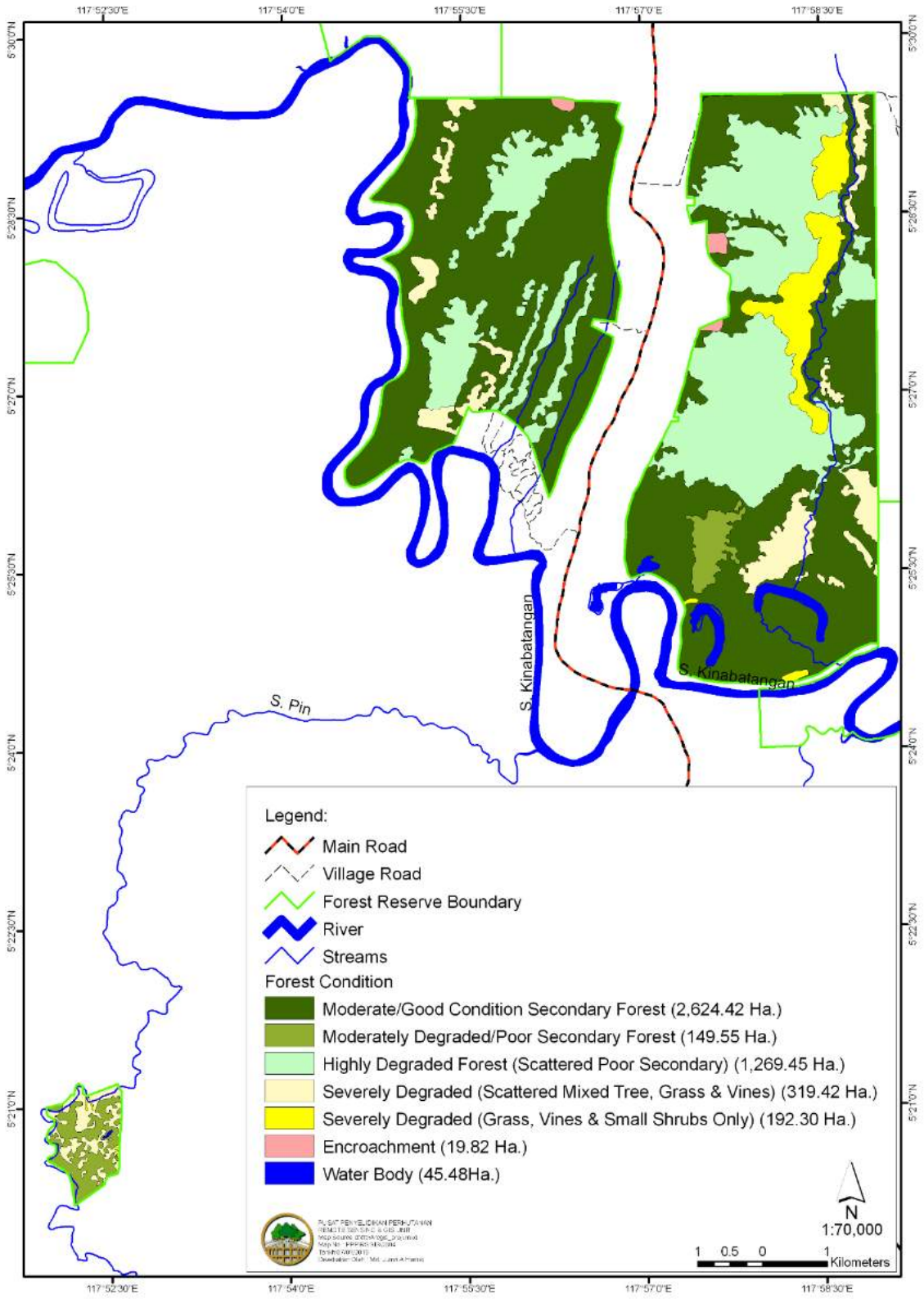


Figure 9: Map of forest condition in Pin-Supu Forest Reserve.

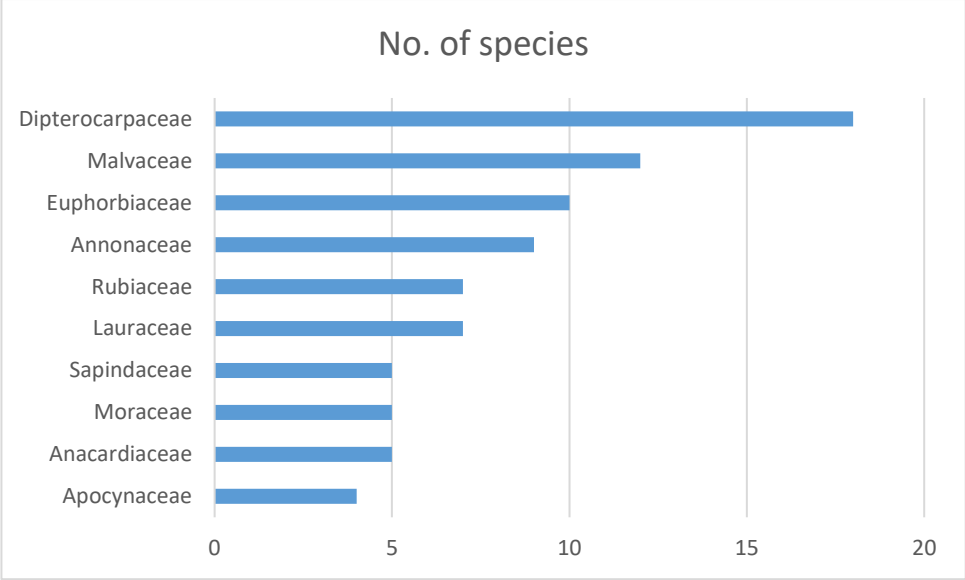


Figure 10: The 10 most species-rich families derived from pooled data of all the 12 transects for trees ≥ 10 cm dbh in Pin-Supu Forest Reserve SFM area.

Shorea acuminatissima, *Shorea multiflora*, *Shorea domatosia*, *Anisoptera grossivenia*, *Dipterocarpus acutangulus*, *Dipterocarpus kerrii*, *Shorea argentifolia*, *Shorea macroptera* and *Shorea pauciflora*

2.2.1.1 Forest Structure and Composition

i. Mixed Dipterocarp Forest

The original extends of mixed dipterocarp forest (MDF) were estimated about 1,642ha or 35% of the total PSFR (Table 3.5). Of this figure, currently the lowland MDF covers about 1,294ha (28% of the total FMU); with riparian terraces covering about 199ha (4%); and mixture of MDF-limestone vegetation covers about 149ha (3%) respectively. Large tract of this forest ecosystem has been reduced to secondary forest due to past activities. Five of the PSPs were established on remaining patches of MDF that are categorized as advance growth condition.

The Dipterocarp tree family dominated the forest with at least 16% and 39% of the total tree density and basal area, respectively. The dipterocarps are also well represented in main and middle storey canopy layers. The main canopy of lowland MDF consists of mature trees with diameter of >50 cm and they can attain height to about 50–60 m. The common trees found in main canopy are *Shorea acuminatissima*, *Shorea multiflora*, *Shorea domatosia*, *Anisoptera grossivenia*, *Dipterocarpus acutangulus*, *Dipterocarpus kerrii*, *Shorea argentifolia*, *Shorea macroptera* and *Shorea pauciflora* from the tree family Dipterocarpaceae; and *Scaphium longipetiolatum* and *Durio* sp. from the tree family Malvaceae. The middle storey canopy of lowland MDF consists of medium size of main canopy trees and other

species with diameter between 20–50 cm and they can attain height to about 30 m. The common trees found in mid-storey canopy are *Hopea* sp., *Dipterocarpus confertus*, *Dipterocarpus khortalsii*, *Shorea* cf. *domatosia* and *Vatica oblongifolia* from the tree family Dipterocarpaceae; and *Glochidion rubrum*, *Macaranga gigantea*, *Macaranga conifera*, *Macaranga hypoleuca*, *Spathiostemon javensis* and *Sumbaviopsis albicans* from the tree family Euphorbiaceae. The under storey canopy of lowland MDF consists of pole-sized trees of main canopy trees and other treelet species with diameter between 10–20 cm and they can attain height to about 15 m. The common trees found in under storey canopy are *Pentace borneensis, Heritiera elata, Microcos sp.* and *Pentace laxiflora* from the tree family Malvaceae.

In severely disturbed previously MDF area, the late secondary forest is largely represented by pioneer tree species from the families Euphorbiaceae, Rubiaceae and Tetramelaceae. Large portion of the basal area is represented by medium- and large-sized pioneer mainly contributed by *Neolamarckia cadamba* and *Neonauclea artocarpioides* (Rubiaceae); *Macaranga pearsonii*, *Macaranga gigantea* and *Macaranga hypoleuca* (Euphorbiaceae); *Octomeles sumatrana* (Tetramelaceae); *Pterospermum elongatum* (Sterculiaceae); and *Duabanga mollucana* (Sonneratiaceae). Relics of representatives of main canopy climax trees of the Dipterocarpaceae, Burseraceae and Fabaceae were found regenerating in clumps. The under storey and middle storey specialists can still persist but in low abundance. The density of pioneer woody climber and climbing bamboo in this forest is high.

Low-stature secondary growth vegetation also occurred on recently disturbed by encroachment or forest fire. In open areas, vines or woody climbers such as, *Croton cordata* (Euphorbiaceae), *Merremia* sp. (Convolvulaceae), *Smilax borneensis* (Smilacaceae), and *Uncaria* sp. (Rubiaceae), scramble on the ground or smother many other secondary plants. The regenerating trees are mostly pole- and medium-sized pioneer trees that are usually established in clumps. A number of secondary treelets, namely *Fagraea cuspidata* (Gentianaceae), *Ficus septica* (Moraceae), *Leea indica* (Leeaceae), *Melicope luna-ankenda* (Rutaceae), *Dillenia orientalis* (Dilleniaceae), *Callicarpa longifolia* (Verbenaceae), *Pternandra* sp. (Melastomataceae), *Homalanthus populneus* and *Glochidion* sp. from the family Euphorbiaceae, are also found to establish in the matrix of secondary vegetation.

ii. Freshwater Swamp Forest

This forest ecosystem once covered about 933ha or 20% of the total PSFR area and was largely disturbed by logging and affected by forest fire in the past. The secondary forest developed within disturbed areas of previously freshwater swamp forest has a broken canopy structure. The Euphorbiaceae tree species, namely *Mallotus muticus* dominates most of forest structures and some patches this species formed mono-dominant stand.

iii. Seasonal Freshwater Swamp Forest

This forest ecosystem once covered about 635ha or 14% of the total PSFR area and largely disturbed in the past. The main canopy of this forest consists of mature trees with diameter of >40 cm and they can attain height to about 30 m. The common trees found in main canopy are *Vitex pinnata* and *Vitex sp.* from the tree family Lamiaceae; *Pterospermum elongatum*, *Pterospermum sp.*, *Colona serrata* and *Kleinhovia hospita* from the tree family Malvaceae; and *Terminalia copelandii* (Combretaceae). The middle storey canopy consists of medium size of main canopy trees and other species with diameter between 20–40 cm and they can attain height to about 20 m. The common trees found in midle storey canopy are *Beilschmiedia sp.* and *Dehaasia sp.* from the tree family Lauraceae; and *Antidesma thwaitesianum* (Phyllanthaceae). The under storey canopy consists of pole-sized trees of main canopy trees and other treelet species with diameter between 10–20 cm and they can attain height to about 10 m. The common trees found in under storey canopy are *Diospyros sp.*, *Diospyros elliptifolia* and *Diospyros wallichii* from the tree family Ebenaceae; *Alseodaphne* sp. and *Litsea* sp. from the tree family Lauraceae; *Baccaurea tetrandra* (Phyllanthaceae); and *Dillenia excelsa* (Dilleniaceae).

iv. Peatswamp Forest

Peatswamp forest once covered about 1,365ha or 30% of total PSFR area. Forest fire incidence in 1997 had decimated all natural vegetation of peatswamp forest that establishes on the Klias soil association.

2.2.2 Plant Diversity

2.2.2.1 Enumeration of Plants

Based on secondary data derived from studies by Nilus *et al*. (2007) forest inventory; MESCOT survey, Conservation Assessment & Information Management System, and data retrieved from plant database (BRAHMS) in Sandakan Herbarium, Sabah Forestry Department, a total of 335 taxa (identified to specific and infraspecific level) from 77 family and 207 genera were recorded from the reserve. Of these taxa, 4 fern families, 2 gymnosperms, 8 angiosperms (Monocotyledon) and 63 angiosperms (Dicotyledon) were recorded (Table 2.2.1).

Table 2.2.1: Number of plant taxa according to plant groups from Pin-Supu Forest Reserve, Sabah, Malaysia.

Plant Group	No. of Families	No. of Taxa
Ferns	4	4
Gymnosperm	2	2
Angiosperm:		
Monocotyledon	8	28
Dicotyledon	63	301
Total	**77**	**335**

The ten most speciose families are Dipterocarpaceae with 27 taxa, Euphorbiaceae - 22, Rubiaceae - 18, Fabaceae - 17, Malvaceae - 17, Lauraceae - 15, Arecaceae - 14, Sapindaceae - 12, Moraceae - 11 and Anacardiaceae - 8 (Figure 11).

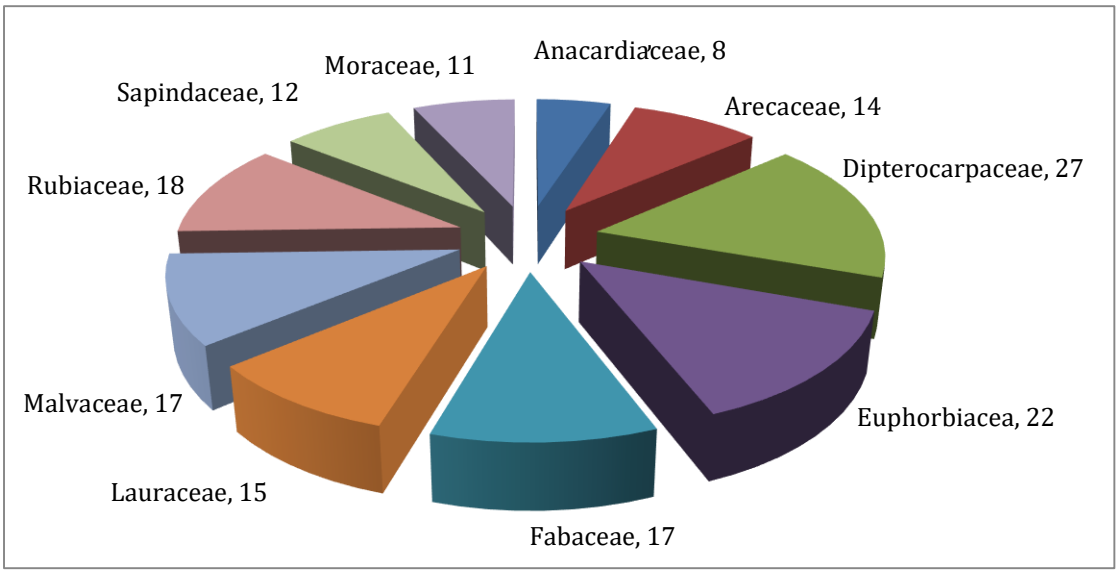


Figure 11: Ten most speciose plant families in Pin-Supu Forest Reserve SFM Area.

2.2.2.2 Plant Conservation Status

There are 3 plant species that listed in the IUCN red list as Near Threatened, 4 Vulnerable (VU), 4 Endangered (EN) and 7 Critically Endangered (CR) are known from this area (Appendix II). All of these threatened species are from the family Dipterocarpaceae, the most dominant group of trees in the lowland area and important source of timber for the state in the past. However, 85% of the flora recorded from PSSFM area are yet to be evaluated under IUCN categories and the assessment and updating process by the relevant research agencies will take a considerable period of time.

Under Sabah Forest Rules 1969, the Chief Conservator of Forests may for reasons of silviculture or for any other reason prohibit or restrict the cutting or removal of plant species in the forest reserve. There were 14 plant taxa in PSSFM area that fall under the prohibited

species by the Chief Conservator of Forests. Furthermore, two taxa namely, *Eria javanica* (Orchidaceae) and *Aquilaria malaccensis* (Thymelaeaceae) are listed under CITES list. Based on the secondary data compiled from previous studies and Sandakan Herbarium database, there is a total of 60 species that are recognized as endemics to Borneo, representing about 18 % of tree species known from PSSFM area, and only four (4) species are endemic to Sabah, namely *Calamus acuminatus*, *Claoxylon praetermissum*, *Diospyros squamefolia* and *Gluta sabahana.*

A total of 4 endemic tree species are currently protected under Schedule 1 of the Forest Rules 1969, which are *Shorea macrophylla* and *S. mecistopteryx* of the Dipterocarpaceae family and *Dimocarpus dentatus* and *Paranephelium joannis* of the Sapindaceae family. A single shrub was identified as a Bornean endemic (*Pandanus pachyphyllus*) and is not formally protected under any national or state laws. A total of 13 species of climbers were listed as Bornean endemics, and 1 Sabah endemic (e.g. *Calamus acuminatus*). None of the endemic climbers are formally protected under any national or state laws.

2.2.3 Animal Diversity

Although there have been a number of descriptive studies of the wildlife within Pin-Supu Forest Reserve, there has been no formal population census of wildlife within the Reserve. Present studies show that there are more than 75 mammal species (not including bats – which is normally one of the most diverse groups of mammals), as well as more than 208 bird species, and over 100 species of reptiles, amphibians and fish (Chai, 1994; Vaz, 1998). In addition, a survey on birds and large mammals was conducted by Cede Prudente in 2009. On-going research on wildlife is also being conducted by researchers from collaborating KOPEL Program's such as Danau Girang Field Centre and the Nahiya-Borneo Project in collaboration with Sabah Wildlife Department.

2.2.3.1 Mammals

Of particular significance in PSFR is the high concentration of primates. All ten species of the primates of Borneo can be found within PSFR. Of these the Orang-utan (*Pongo pygmaeus*), the endemic Proboscis Monkey (*Nasalis larvatus*), the Maroon Langur (*Presbytes rubicunda*), and Hose's Langur (*Presbytes hosei*) are the rarest and most significant. In addition to this, the Bornean Gibbon (*Hylobates muelleri*), Silver Langur (*Presbytis cristata*), Tarsier (*Tarsius bancanus*), Slow Loris (*Nycticebus coucang*), Short-tailed & Long-tailed Macaque are also present within the reserve.

Of the large mammals, the Bornean Pygmy Elephant (*Elephas maximus*) is the most prominent. The Bornean Pygmy Elephant is not a resident of PSFR, however these large mammals frequent the reserve during repeated seasonal migrations throughout the year. Recent sightings of the Bornean endemic Clouded Leopard (*Neofelis diardi borneensis*) are a rare and exciting find in PSFR. There are also four ungulate species (*Tragulus javanicus, Tragulus napu, Muntiacus atherodes*, and *Cervus unicolor*). Other mammals include,

Sunbear (*Helarctos malayanus*), three species of Otter (*Lutra perspicillata, Lutra sumatrana* and *Aonyx cinerea*), five species of Civet cat (*Viverra tangalunga, Arctictis binturong, Paradoxurus hermaphroditus, Hemigalus derbyanus*, and *Prionodon linsang*), Leopard Cat (*Felis bengalensis*), Flying Lemur (*Cynocephalus variegates*), and Pangolin (*Manis javanica*).

Bats are common, inhabiting the caves within PSFR. There are more than 27 species identified for caves in Kinabatangan. One particular species, the Wrinkled Lipped Bat (*Tadarida plicata*) forms large colonies – of up to one million or more – which form large flocks that stream out of the cave in spectacular cloud-like formations at dusk every day.

2.2.3.2 Birds

There are over 208 species of birds recorded in the area. Of special significance are the eight species of hornbill, which can be found in the area including the rare Helmeted Hornbill (*Rhinoplax vigil*) and the Wrinkled Hornbill (*Rhyticeros corrugatus*).

Other rare birds that are not uncommon in PSFR include the Storm Stork (*Ciconia stormii*), Bornean Bristlehead (*Pityriasis gymnocephala*), Greater Argus (*Argusianus argus*), and Oriental Darter (*Anhinga melanogaster*). Birds, such as the numerous hornbill species found in PSFR are national icons and significant drawcards for all tourist market's segments. Other spectacular birds present in PSFR include the Paradise Flycatcher (*Terpsiphone paradisi*), the Asian Fairy Bluebird (*Irena puella*), Trogons (Trogonidae), Kingfishers (Alcedinidae), Broadbills (Eurylaimidae), Sunbirds (Nectariniidae) and so on. The diverse list of avian wildlife found in PSFR provides a significant attraction to bird watchers (a special interest visitor segment).

Other birds of special interest in PSFR are the swiftlet species, *Aerodramus fuciphaga* (White Nest Swiftlet) and *Aerodramus maximus* (Black Nest Swiftlet) which are important for the edible bird's nests. These are found nesting in small numbers within the caves of PSFR along with the Mossy-nest Swiftlet (*Aerodramus salanganus*) and the White-bellied Swiftlet (*Collocalia esculenta*). The first three species were classified under the genus *Collocalia* previously.

2.2.3.3 Reptiles and Amphibians

Along the Kinabatangan River, there is every indication of a rich reptile fauna, including tortoises, freshwater terrapins, lizards and crocodiles. Generally, Monitor Lizard, *Varanus salvator*, is the most frequently sighted reptile, occasionally seen resting on the tree branches along the tributaries. The Estuarine Crocodile, *Crocodylus porosus*, is probably one of the most exciting inhabitants that can be sighted along the Kinabatangan River in PSFR. It is the largest reptile in the world, with a length of up to eight meters.

The caves are host to unique fauna, such as *Oxycephala gonyosoma* and *E. taeniura* (elapid snakes or cave racers), which are confined only to caves. The riverine area is also important habitat for amphibians (Hutton 2004), such as Malaysia's largest frog (*Rana malesiana*)

2.2.3.4 Fish and Other Aquatic Life

It has been reported that almost 40% of Borneo's freshwater fish species are endemic to the island. The most isolated among the island's watersheds, the Kinabatangan River has the highest levels of freshwater endemism on the island (Hance 2013). Among the fishes highlighted by a researcher, Poh T-M. in Hance (2015) are the Spotted Archerfish (*Toxotes chatareus*), the giant Freshwater Whipray (*Himantura polylepis*), the giant Red-tailed Gourami (*Osphronemus laticlavius*), a Bornean endemic *Kryptopterus sabanus* and the Great-tooth Sawfish (*Pristis microdon*), which is thought to be locally extinct in the Kinabatangan River.

Within the PSFR, fish diversity was found to be comparatively low. Only five species (Cyprinidae) were recorded in Tungog Lake (Casey et al, 2017). This lake is massively invaded by *salvinia molesta*. Casey et al, (2017) compared the finding by Lee et al (2016) where 24 species (11 families) and 16 species (8 families) encountered in *Salvinia molesta* free ox bow lake at Luagan Rompong and Kalanduan respectively.

2.2.3.5 Invertebrates

Studies on invertebrates have focused specifically on moths, butterflies, leaf-litter ants, and fireflies (Chey 2004, Chung 2004, Jalil *et al*. 2003, Mohamed 2003, Dawood *et al*. 2003) and land snails (Schilthuizen *et al*. 2003). Many of the land snails with ornate shells are endemic to specific limestone outcrops in the Kinabatangan (Schilthuizen *et al*. 2003).

Most of these studies have been preliminary in nature and looked at identifying and describing the diversity of species in the area. All of these studies show a high diversity in each of the separate orders. For an example, 87 species of ground and leaf litter ants have been collected in surrounding forests from 39 genera, not including arboreal species (Chung 2004, Mohamed 2003 & Hashimoto *et al*. 2003). There have also been 206 butterfly species identified along with 34 moth species and 48 beetle species (Chung 2004, Chey 2004, Jalil *et al*. 2003). Apart from this also common in the area are fireflies of the species *Pteroptyx tener* (Dawood *et al*. 2003). Of particular interest for ecotourism development would be the large and charismatic Swallowtail Butterflies (Papilionidae), Rhinoceros Beetles (Scarabaeidae) and Stick Insects (Chey, pers. com.; Chung, pers. com.).

2.3 CONSERVATION TARGETS

2.3.1 Landscape Conservation Targets

2.3.1.1 Landscape Connectivity

Pin-Supu Forest Reserve consists of three units of land separated by highway and rivers at a considerable distance. In the mosaic landscape of the Kinabatangan, Blocks A and B border onto other protected areas, such as Lot 7 in the east and Lot 8 in the west of the Wildlife Sanctuary, respectively (Figure 9). However, Block C is completely isolated and is surrounded by oil palm estates.

At the landscape level, PSFR forms an important link in the ecological network of the Kinabatangan floodplain ecosystems that conserve biodiversity and provide sustainable use of natural resources. The reserve provides functional ecological connectivity that supports the movement of both biotic processes (animal movement, plant propagation, genetic exchange) and abiotic processes (water, energy, materials) and can be species or process specific.

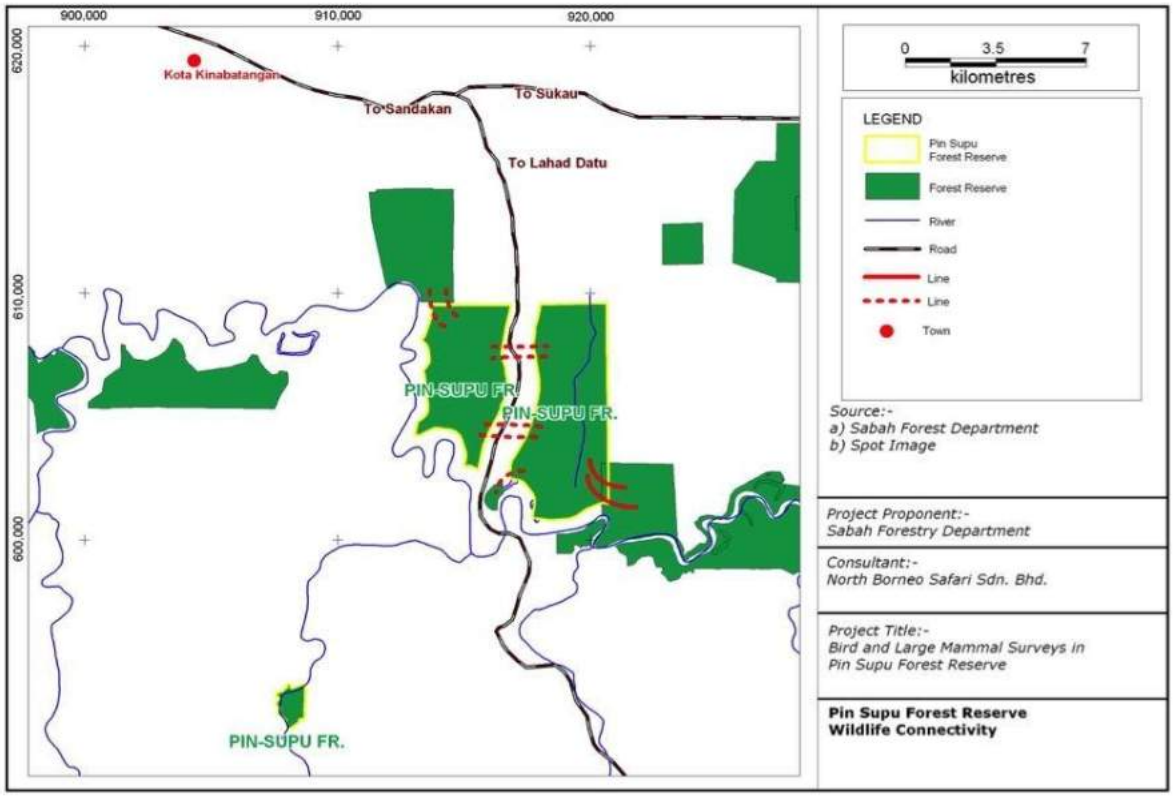


Figure 12: Potential connectivity and wildlife corridor (red dash and solid lines) between forest reserve units in PSSFM area, Sabah (Source: Prudente 2009).

With the management that focuses on the protection and conservation of biodiversity, PSSFM area would inevitably become a critical link from the aspects of plant species dispersal, wildlife foraging and migratory pathways between the different forest complexes

of the patchy and fragmented forest landscape of the Kinabatangan. By creating connectivity among clusters of the reserves, it will provide more habitat and path movement for wildlife in the landscape level around these areas (Figure 9).

Considering the potential and prospect of wildlife diversity and its importance at the landscape level, recommendations will be provided on the management and monitoring level in the short term before exploring broader landscape level connectivity. However, creating connectivity on adjacent alienated land to PSSFM area is likewise one of the biggest challenges to the Department as it involves both private lands plus a major highway. Even so, Blocks A and B of PSSFM area are important in ecological connectivity and potential for linking fragmented forested areas along the Kinabatangan floodplain.

2.3.2 Ecosystem Conservation Targets

2.3.2.1 Lowland Forest Ecosystems

All of PSSFM lowland forest area is estimated to be below 200m a.s.l. As mentioned earlier, the area previously covered with mixed dipterocarp, seasonal freshwater swamp and freshwater swamp forests with secondary vegetation of various qualities (Figure 9). The forest ecosystems harbour rare, endangered, threatened and also endemic species as mentioned in section 2.7.1. These forest areas are also categorised as HCV 3, an important and prioritised ecosystem that requires immediate conservation management (see section 2.7.3) These forests have experienced severe disturbances in the past and hence, management prescriptions within this Management Plan involve both protection measures (to prevent further loss) and restoration measures to enhance the natural regeneration processes and ensure no further deterioration to these important forest ecosystems.

2.3.3 Species Conservation Targets

2.3.3.1 Selected Plants

For pragmatic monitoring purposes, two species, namely the Bornean ironwood and Keruing Kasigui were selected as plant species conservation targets. Details of the two species and the rationale for choosing these species are highlighted below. Other species with potentials for conservation targets are also discussed.

Eusideroxylon zwageri Wood (Lauraceae) or locally known as '**Belian**' is a medium to large emergent tree that can reach up to 50 m tall. The bole is tall, cylindrical with large and stout buttresses (Plate 1). The species is easily recognized by its reddish-brown smooth bark with reddish young shoot. *Eusideroxylon zwageri* occurs either scattered or in groups and grows within the lowland primary and secondary forest up to 625 m altitude. It prefers to establish in well-drained (commonly found along rivers and foot hills), sandy to clay-

loam, and sometimes limestone derived soils that received an average annual rainfall of 2500–4000 mm.

This very important tree is one of the most durable and heaviest timbers in the world. The timber is very hard and highly demanded for post and outdoor furniture. It is now threatened by over-exploitation and population decline due to lack of regeneration and difficulties in cultivation. It is found in Borneo, Philippines and Indonesia. It is threatened by habitat loss. IUCN Red List categorised the species as Vulnerable (VU). It is listed as a protected species under the forest rules.

Plate 1: *Eusideroxylon zwageri* (Lauraceae): The trunk (left); The leaves (right). (Photo: J.B. Sugau)

Plate 2: *Dipterocarpus validus* (Dipterocarpaceae): (Photo by J.B.Sugau)

Dipterocarpus validus Dyer (Dipterocarpaceae) or locally called '**Keruing Kasugoi**' is a large emergent tree that can reach up to 50 m tall and has large-sized leaf (Plate 2.3.2). This species is distributed in Borneo and the Philippines. In Borneo, it is occurring in Sabah and Kalimantan. The species is common in both primary and secondary forest, often occurring along rivers and in freshwater swamps. It yields wood-oil and is cut for keruing timber. The species is listed as Critically Endangered (CR) in IUCN Red List. *Keruing kasugoi* is also highly demanded for timber but is only locally abundant, sometime gregarious in flood plain behind the mangrove. The species is endangered by land conversion.

Besides the selected target species, *Shorea smithiana* Symington (Dipterocarpaceae) can be selected as potential conservation target species. Locally known as '**Seraya timbau**', it is a large emergent tree that can reach up to 60 m tall. It is easily recognized by its deeply boat-shaped fissured bark. The leaves are thickly coriaceous and with prominent veins beneath the leaf. This species is endemic to Borneo and is occurring in all territories. It is locally common in lowland mixed dipterocarp forest. The species is threatened by land conversion and felling for timber.

2.3.3.2 Selected Wildlife

For pragmatic monitoring purposes, two wildlife species, namely Proboscis Monkey and the Bornean Pygmy Elephant were selected as wildlife species conservation targets. Details of the two species and the rationale for choosing these species are highlighted below. Other species with potentials for conservation targets are also discussed.

Proboscis Monkeys belong to the order Primates, from the family Cercopithecidae and subfamily Colobinae (Bennett & Gombek, 1993). In the Old World, monkeys are divided into two groups known as cercopithecines and colobines. The reddish-brown proboscis monkeys are colobines, with stomachs similar to that of a cow. They feed on young shoots and leaves. Males with distinctive enlarged nose and belly are much larger than females. The arboreal proboscis monkeys usually live in a harem which comprises one adult male, several females, and their offspring, but sometimes the male and female proboscis monkeys move between social groups. The Proboscis Monkey, *Nasalis larvatus*, is a common inhabitant along the Kinabatangan River. Locally known as 'Bangkatan', the latest estimate was about 5,907 individuals in Sabah (Sha *et al.* 2008). They are found only in Borneo. Many are found in the mangroves, riverine areas and swamp forests. Thus, the riverine areas within PSFR are suitable habitats for these monkeys. It is one of the Totally Protected Species under the Wildlife Conservation Enactment (WCE) of the Sabah Wildlife Department and it is classified as Endangered under IUCN Red List. Hence, with all these reasons, the Proboscis Monkey is selected as a target species for conservation monitoring.

Plate 3: A male Proboscis Monkey (below), with its protruding nose and a female (Photo: AYC Chung).

Plate 4: A Bornean Pygmy Elephant and its offspring feeding on vegetation beside the Kinabatangan River (Photo: AYC Chung).

The Bornean Pygmy Elephant, *Elephas maximus borneensis* is a subspecies endemic to Borneo, which is smaller than the Asian Elephant, with a shorter trunk that does not touch the ground. Estimated population is about 1,000 and they are found mainly in Sabah, with very few in northern Kalimantan but none at all in other parts of Kalimantan, Sarawak or Brunei. In Sabah, they are found in lowland dipterocarp and riverine forests, including along the Kinabatangan River. The Pygmy Elephant is an iconic wildlife in promoting ecotourism in Sabah and it is often sighted in PSFR. It is also a Totally Protected Species under the WCE and is classified as Endangered under IUCN Red List.

Besides the selected target species (Proboscis Monkey and Bornean Pygmy Elephant), the Clouded Leopard and two species of swiftlets for the edible bird's nests are also potentially significant as a conservation target species for this forest reserve. It has been sighted within PSFR but it is shy and infrequently seen. It is the largest cat species in Borneo, with impressive large cloud-shaped blotches over its body. Recently, scientists have discovered that the Clouded Leopard of the subspecies *Neofelis diardi borneensis* is only confined to Borneo. This species is a protected species under Schedule 2 of WCE and is classified as Vulnerable under IUCN Red List.

At least two species of swiftlets from the genus *Aerodramus* are known to occur in the caves of PSFR that produce the highly sought-after edible bird's nests. The species are *Aerodramus fuciphaga* (White Nest Swiftlet) and *Aerodramus maximus* (Black Nest Swiftlet). Due to the commercial value of their edible nests, it is important to monitor the population of these birds to ensure the sustainability of the harvesting procedures. Both swiftlets are protected under Schedule 2 of WCE and are classified as Least Concern under IUCN Red List.

In addition to the above other potential target species for Pin-Supu Forest Reserve could include other rare and threatened mammals such as Pangolin (*Manis javanica*) (IUCN Critically Endangered), three species of Otter (*Lutra perspicillata* (IUCN Vulnerable), *Lutra sumatrana* (IUCN Endangered) and *Aonyx cinereal* (IUCN Vulnerable)), Sunbear (*Helarctos malayanus*) (IUCN Vulnerable), Hose's Langur (*Presbytes hosei*) (IUCN Vulnerable), Binturong (*Arctictis binturong*) (IUCN Vulnerable), Banded Linsang (*Prionodon linsang*) (IUCN near Threatened), Banded Palm Civit (*Hemigalus derbyanus*) (IUCN Near Threatened). For birds species, Storm Stork (*Ciconia stormii*) (IUCN Endangered), Oriental Darter (*Anhinga melanogaster*) (IUCN near Threatened), Bornean Ground-cuckoo (*Carpococcyx radiceus*) (IUCN Near Threatened) associated with wetlands in PSFR.

This list is meant to outline some of the current key species to focus attention and is not meant to be finite. All the species mentioned in this section can be found in Pin-Supu Forest Reserve and all deserve focuses conservation attention given their known & documented population decline across the region. Targeting selected species for attention will be discussed further in proceeding sections about HCVF & management prescription.

2.4 SOCIAL IMPACT ASSESSMENT

The local community and land immediately adjacent to the Pin-Supu Forest Reserve is known administratively as Mukim Batu Puteh. There are 4 villages in the vicinity of PSFR (refer to Table 2.4.1 below). The four active villages include Kg. Batu Puteh, Kg. Mengaris, Kg. Perpaduan and Kg. Sentosa Jaya which are located adjacent to the FR. No village is located inside the Pin-Supu Forest Reserve.

The community is centered around Batu Puteh Village with the school and health clinic being at the center and with Mengaris Village at the Kinabatangan Bridge being the next main concentration of dwellings. The villages of Perpaduan, Sentosa Jaya and Singga Mata are spread along the Sandakan Lahad Datu Highway through the centre of the reserve. These later villages share the bigger portion of the forest reserve. Development in these villages is not concentrated but spread-out along the 8km of highway, which runs through the center of the reserve.

Table 2.4.1: List of Local Communities Adjacent to Boundary of PSFR, Kinabatangan

Name of Village	Locality Relative to PSFR	Population	No Households	Features of Note
Kg Batu Puteh	South & Western Boundary	898	65	Limestone caves/ burial caves
Kg Mengaris	South & Eastern Boundary	368	47	Kinabatangan Bridge & River
Kg Singgah Mata	Mid-centre Boundary	N/A	35	Local Farming & Oil palm
Kg Perpaduan	Mid-centre & North Boundary	347	45	Oil palm Plantation

(Source: Kinabatangan District Office, 2010)

The village of Batu Puteh was officially recognised in 1956, with the earlier settlement of Kg Laab (1km upstream from Batu Puteh) being established a few years earlier. Today there are approximately 319 households throughout Mukim Batu Puteh. Based on the government census of 2010, the population of the three main villages of Batu Puteh, Mengaris and Perpaduan is more than 2,145 people.

The low level of household income is still a major concern for the local population with more than 40% of average household income below RM1000/month and roughly another 30% below RM2000/month. This has caused major implications for long-term sustainable forest management in this area. Low level of household income has been equated to unsustainable resource depletion in many instances, whereby local population is forced to revert to harvesting or extracting local natural resources to supplement household needs. Low level household income also equates to low levels of education and further extends the poverty trap and often long-term depletion on natural resources.

More details on local socio-economy is summarized in Appendix VIII in the Social Impact Assessment (SIA) carried out in 2017-2018.

2.5 FOREST RECREATION

2.5.1 Introduction

PSFR has already been identified as having potential for the development of ecotourism & forest recreation activities. Tourists are particularly interested in the natural characteristics of the area including the high diversity of forest types, the high concentration of wildlife, specifically the rare and endemic species of primates and bird life. Besides that, scenic interests also include oxbow lakes, the flooded forest and sheer cliffs of the limestone outcrops in the western part of the reserve. Apart from the natural surroundings, the cultural and historical attractions are of particular interest and include the ancient burial caves and ornately carved coffins found in the caves of Agop Batu Tulug and Supu Hill. The beautiful view from the top of Agop Batu Tulug are also one of the attractions adjacent to to PSFR. (Plate 5)

Plate 5: View from top of Agop Batu Tulug.

The following section outlines in brief the potential natural attractions of interest (Table 2.5.1) and potential forest recreation activities, which are suited to these natural features (Table 2.5.2). In the process of identifying these features and attractions it is noted that there is a broad scope for integration of forest-based recreation activities and ecotourism with the other forest management activities within the reserve, whereby these activities can both be enhanced directly through the injection of funds or indirectly via increased awareness and sense of appreciation. However, these activities are not limited to other activities such as forest rehabilitation, tree planting, research, raising local awareness and monitoring.

It is recognized that before any substantial development or changes to the current low-impact activities within the Pin-Supu Forest reserve, the following list of recreation activities will require individual detailed planning to ensure the appropriate design of activities and facilities. Hence, this will bring upon zero impact on sensitive habitat and wildlife and ecosystem services. Thus, the proceeding section of this document is meant as an "outline only" of some basic appropriate physical and management requirements to ensure the protection and enhancement of the reserves outstanding features.

2.5.2 Natural Attractions and Corresponding Nature Recreation Activities

Table 2.5.1 List of Natural Attractions for Pin-Supu Forest Reserve.

Attraction	Description / Qualifying Feature	Distance from Kinabatangan Bridge
Floodplain Forests	o One of the major strengths of Pin-Supu Forest Reserve is the presence of 7 different forest types within the single reserve. o Unusual and unique flooded forest, which is accessible by boat in frequent floods throughout the year.	0-8 km
Rivers	o The Kinabatangan River along with its smaller tributaries provides a unique form of access to observe many forms of wildlife – such as the primates. o The main river and its tributaries also provide access to the flooded alluvial swamp forests, such as in the Ulu Girang Nunuk River. o Kinabatangan River also provides potential to many possible forms of water recreation activities, such as kayaking, fishing and river cruises.	0-26 km
Lakes	o There are 7 oxbow lakes within Pin-Supu Forest Reserve. These lakes provide picturesque and attractive landscapes that have aesthetic appeal to attract visitors to the area. o The lakes are home to their own unique aquatic ecosystem and a host of rare and unique fauna are associated with the lakes such as rare water birds (Storms Stork, Oriental Darter), 3 Otter species, water monitor lizards, as well as ornamental fish such as the "Giant Gourami" (Kalui - *Osphronemus goramy*) and "Marbled Goby" (Ubi - *Oxyeleotris marmorata*).	1-6 km
Limestone Caves	o The limestone caves of PSFR provide an unusual natural and scenic attraction for visitors. There are more than 11 recorded caves within the Supu Limestone Complex. o Many of these caves in the Supu Complex have unique cave formations, ancient artefacts and unusual cave fauna, all of which are significant attractions.	18 km
Scenic Vistas	o There is an area within the west side of the Pin-Supu Forest Reserve where the top of the Sapat Taring Limestone outcrop can be viewed. o Another interesting scenic view can be found from the top of the small Pin Tokoro Hill adjacent to the Kinabatangan Bridge. o Other scenic highpoints can be found from the steep sandstone ridges along the Sandakan-Lahad Datu	8 km

	Road, as well as from the Laab Hills (west of Kg. Batu Puteh)	
Wildlife	○ Pin-Supu Forest Reserve hosts more than 75 species of mammal, over 206 species of birds, and over 160 species of reptiles, amphibians and fish (Chai, 1994; Payne, 1989). ○ The notable flagship species present in the reserve include: Orangutan (*Pongo pygmaeus*), Elephant (*Elephas maximus*), ○ Sun Bear (*Helarctos malayanus*), Estuarine crocodile (*Crocodylus porosus)* and three otter species. ○ The endemic Proboscis Monkey (*Nasalis larvatus*) & Bornean Gibbon (*Hylobates muelleri*) are also common, along with the Maroon Langur (*Presbytis rubicunda*), Silver Langur (*Presbytis cristata*) and rare Hoses Langur (*Presbytis hosei*). ○ Many other rare and attractive wildlife are also present in PSFR such as civets, wildcats, otters, pangolin etc. ○ Rare, spectacular and flagship species of birds are common in PSFR such as 8 species of hornbills, including the Rhinoceros Hornbill (*Anthrococeros coronatus*), the rare Wrinkled Hornbill (*Rhyticeros corrugatus*), Helmeted Hornbill (*Rhinoplax vigil*) and White Crested Hornbill (*Berenicornis comatus*). ○ Other rare and threatened birds found in PSFR include the Storms Stork (*Cicona stormi*), the Oriental Darter (*Anhinga melanogaster*), the Borneon Bristlehead (*Pityriasis gymnocephala*) and the Sunda Ground Cuckoo (*Carpococcix radiceus*).	0-8 km

Table 2.5.2 List of potential forest recreation opportunities for Pin-Supu Forest Reserve.

Recreation Opportunity	Description / Qualifying Feature
Wildlife Observation & Photography	○ The high concentrations of wildlife in PSFR such as Proboscis Monkey, Langurs and Orangutan are an extremely attractive asset for tourism and has the potential to carry out wildlife observation safaris within the reserve. ○ The proximity of the reserve to the Kinabatangan River provides immediate access and a unique viewing platform to observe mammals and birdlife of the area. ○ Establishing riverboat cruises, walking trails and observation platforms are the immediate measures to put in place to facilitate wildlife observation.

Long Distance Trekking	○ Pin-Supu Forest Reserve is particularly suitable to design long distance walking trails because of its relatively flat terrain and small hills. ○ Notably simple walks could be designed to follow traditional trails along the meandering riparian forest of the Kinabatangan River, forming at least a 21km walk starting from Kg Batu Puteh. The Laab hills are also a suitable place for long distance walking trails with a potential 14km in this area. There are also a further 18km of potential trails in the eastern part of the reserve around the lakes and swamp forests of this part of the reserve.
Canoeing & Kayaking	○ Given the proximity to the Kinabatangan River, picturesque forested landscapes, and relatively large size of lakes and tributaries within PSFR, there is potential to carry out canoeing or kayaking trips throughout the reserve. ○ Field surveys have confirmed the navigability of the Kaboi and Girang Nunuk Rivers in the eastern part of the reserve, along with Biandong, Tungog and Kaboi Lakes.
Adventure Caving & Speleology	○ Speleology is the exploration and study of caves. There is a large cave complex within Supu Hill that could form the basis for exploratory caving, cave mapping, and the study of the cave's formations and origins.
	○ Speleology is a recreational activity in many parts of the world, and enthusiasts will travel long distances to explore, map and carry out formal studies of caves. Speleologists are often members of caving clubs that organise expeditions to often-remote location to explore new caves.
	○ Caving (popularly referred to as "adventure caving") is also offered to tourists in many famous cave locations, for example Mulu National Park as an adventurous "outing", "excursion", or one-day activity. ○ Adventure caving can be offered in at least 3 long caves within the Supu Hills (personal experience).
Rock Climbing & Abseiling	○ The limestone outcrops, cliffs, bluffs, sinkholes and sheer rock faces within Pin-Supu Forest Reserve provide the ideal setting for both rock climbing and abseiling activities. ○ In particular along the eastern side of Sapat Taring and Supu Hill, there are numerous bluffs of sheer vertical rock and overhangs. The limestone rock of PSFR is very fine-grained calcite. It is dense and mechanically very ridged. There are numerous climbing routes available from beginner level through intermediate and advanced levels (personal experience).

2.5.3 Forest Recreation & Tourism Management Implication

The Pin-Supu Forest Reserve is located in the geographic centre of the Lower Kinabatangan. The Lower Kinabatangan is famous for its wildlife and features as a major drawcard for visitors to Sabah, being promoted heavily by both the Sabah Tourism Promotion Board (STB) and the Sandakan Municipal Council (MPS) (in its bid to establish Sandakan as a Nature City and tourism hub). Located next to the main highway between Sandakan and Lahad Datu, the Pin-Supu Forest Reserve is the most accessible floodplain forest along the Kinabatangan.

Due to its location, the Pin-Supu Forest Reserve has the possibility of becoming a major tourist drawcard to Sandakan, complimenting other local attractions. Given the present lack of mainstream ecotourism development that caters for local Sabahans and domestic tourists in the Lower Kinabatangan combined with the accessibility of this site, this site could immediately become a major site to launch nature recreation, interpretation and environmental education for the general public of Sabah.

The natural attractions and recreation opportunities within PSFR are significant and warrant consideration for the development of ecotourism within the reserve. Suitable sites and appropriate infrastructure should be developed to capitalise the attractions of PSFR, and generate income for the local people and the State Government. Planning includes comprehensive zoning of all activities to be carried out in the reserve (ie. rehabilitation of forest, research and ecotourism) to ensure the compatibility of all activities within the reserve and to minimise negative impact on sensitive resources.

There are numerous natural features within the Pin-Supu Forest Reserve. The natural features are summarized in Table 2.5.1. These features are significant and attractive enough to lure visitors for sightseeing to the Kinabatangan and consequently provide economic opportunities for local people. The alleviation of poverty in communities adjacent to forest reserves via the provision of adequate economic activities (and incentives) is key to advancing both education and the understanding of the significance of conservation of the forest resources.

If these activities are developed to directly link maintaining and enhancing the forest resource, then there is additional economic incentive to invest in and preserve the forest resources for future generation. This is critical for people adjacent to forest resources, and when considering alterative utilization of the forest resource and/or alternative land-use for these area. Importantly, the benefits of keeping the resource intact must be considered enough to outweigh alternative scenarios.

In the case of Pin-Supu Forest Reserve, the local community has been involved for the last 20 years in developing a number of tourism products within and around the forest reserve. This includes; the Miso Walai Homestay Program, Tungog Rainforest Eco Camp, Supu Adventure Camp, alongside Boating and Guiding services and a range of activities

that both suit the innate natural attractions, whilst enhancing their positive benefits such as restoring ecosystem services of this forest reserve.

2.5.4 Current Activities and Facilities

There are selected activities and facilities offered by the Community Cooperative KOPEL Bhd for visitors:

i. Traditional Malaysian Homestay Service (Miso Walai Homestay) (web site: www.mescot.org) is operated in the community adjacent to PSFR. In this program tourists stay with local families as a cultural experience to learn about local way of life, experience local cuisine and local cultural stories. The Kinabatangan River and Pin Supu Forest Reserve forms the backdrop for the village homestay program whereby visitor activities are most often associated with forest restoration activities.

ii. Tungog Rainforest Eco Camp (TREC) (See section 2.9; web site: www.mescot.org). This low impact facility is located in Supu A adjacent to the Tungog Lake (a freshwater oxbow lake 1.8km length). TREC is designed for maximum of 30 people on site, with nine (9) A-Frame Camp Platforms (capacity 18 people) plus another mixed accommodation for 12 people. The camp is designed to be reversable with minimal impact on site using local materials and traditional building techniques. There is zero cooking on site, and zero washing laundry on-site to minimize impacts. 100% of rubbish is removed from the site. Bioremediation of grey water is established via rock and sand filters and reed bed. Power is generated via solar power, and all proceeds from this camp support the forest restoration programs and similar conservation activities within PSFR.
    - Nature Trails: Tungog Lake Loop Trail (3.5km); Eco Camp Loop Trails (500m); Boundary Trail (2.2 km); Kaboi Lake Connecting Trails1.8km

iii. Supu Adventure Camp (SAC): This adventure camp was constructed in 2012 with funds secured by Sabah Forestry Department under the 9th Malaysia Plan. The small-scale forest camp is situated in Supu B with carrying capacity of 20 visitors at one time (Figure 10). The facilities in this camp are as follows:
    - Camping Hut: Camp Beds (Hammock) for 20 persons; 2 bathrooms; 2 toilets; jetty; Mid Deck and Lower Deck
    - Nature trails: Sepat Taring Loop Trail (1.3 km); Coffin Trail (1.8 km); Kingfisher Trail (1.2 km); Ridge Trail (1.6km); and Cliff Trail (1.6 km).
    - The activities for visitors in this camp are forest trekking, caving, and climbing to limestone pinnacles of Supu summit, visit ancient burial site (coffin), bird watching, river cruise and tree planting.

iv. Mayah Do Talod Boat Service: KOPEL Bhd has 8 boats with the capacity of 10 people per boat and the service is allocated on a rotation basis.

v. Menumpos Culture Group: Since the formation of this cultural group that consists of 20 village youths in 2000, they perform traditional dance and music for tourists. The group is also performing for government and private official events.

vi. Tour Guide Service: Kopel Bhd runs a forest nature guides service to conduct tourism activities within PSFR in a safe and controlled manner, to monitor all activities, minimize all impacts and maximize the experience for visitors. At present there are 12 registered as nature guides.

vii. KOPEL Riverside Café (Food & Catering Services): Kopel Bhd prepares food and beverages for tourists staying at the Eco Camp (TREC) and other camps, i.e Hammock Camp and Supu Camp shown. Part of the tourist attraction is teaching tourist to prepare traditional orang Sungai and Sabahan dishes.

viii. Tulun Tuko Handicraft Shop: The handicraft shop is operated by two KOPEL Bhd permanent staff. The shop sells variety of local handicraft, such as bracelets made from the seeds of a kind of grass known locally as 'dalai dalai'.

ix. Hammock Camping: Hammock Camps is the most popular choice among the school groups due to their size. More than 500 visitors on average chose to stay in the hammock camp, annually. The tourist mostly students are coming in pre-booked groups, with groups are mostly from UK and Australia. Peak season for hammock camp is usually in July and August. Hammock Camping was introduced to accommodate tourists especially the groups of students to do forest restoration works and teaching them the forest functions and ecosystem. The students would stay for 2 to 5 nights only.

2.6 THREATS ANALYSIS

Several potential threats were identified that have direct impact to the biological resources, socio-economic and community needs and cultural value of PSFR (Table 2.6.1).

a. One of the major threats is periodic forest fire. **Forest fires** have occurred cyclically during periods of extended drought every 15-20 years since the 1960s. These fires have caused catastrophic long-term damage to the forest and ecosystem in this reserve.

b. Given that much of the forest is low-lying or swampy, **hydrological changes** are another major threat to the forest causing long-term catastrophic damage to the forest. Damage to the hydrology has caused subsequent changes to soils and habitat for trees and in some cases completely changed the forest composition. This has been caused by drain dredging by adjacent landowners as well as by previous logging activities that blocked or disturbed the natural water course.

c. **Illegal harvesting** of forest resources is currently negligible, however there is a long history of extraction of forest resources both legal and non-legal in this reserve over the last 40 years. In some cases, this has caused catastrophic damage to forest & forest ecosystems. This remains a threat (albeit minimal at present) especially given the expanding population and persistent poverty levels in the surrounding communities.

d. Ecological threats such as **forest simplification** are an ongoing long-term threat. This includes large scale loss of biodiversity, the long-term decline in wildlife population, the influx of **invasive species**, and the decline in ecosystem services.

The following section in this document outlines a summary of the known threats.

Table 2.6.1 Summary of overall threats on selected conservation targets, socio-economic and community needs and cultural value of Pin-Supu Forest Reserve.

Targets / Threats	Biological					Socio-Economic	Community needs/ values	Overall threat level
	Lowland Forest	Belian (Bornean Ironwood)	Keruing Kasigoi	Proboscis Monkey	Bornean Pygmy Elephant	Ecotourism Activities	Freshwater fish & edible bird nest	
Wildfire	H	H	H	H	H	H	H	**H**
Forest simplification	H	H	H	H	H	H	H	**H**
Dredging and drainage	H	M	H	L	L	M	H	**M**
Water Pollution	M	L	M	L	L	H	H	**M**
Illegal harvesting of natural resources	H	H	H	L	L	H	M	**M**
Invasive Species (*Salvinia molesta*)	M	L	L	L	L	H	H	**M**
Overall threat status for targets	**H**	**M**	**M**	**M**	**M**	**H**	**H**	

Notes: The threat levels are indicated "**H**" as high; "**M**" as medium and "**L**" as low.

2.6.1 Wildfire

In the Southeast Asian tropical rain forests, long drought events are associated with the atmospheric and oceanic anomaly known as the El Niño – Southern Oscillation* (ENSO) phenomenon (Walsh, 1996). Frequent occurrences of this severe drought event have increased the susceptibility of vegetation to wildfire. During this drought event, it is likely that the threats become more serious. The Pin-Supu Forest Reserve has a history of major

forest fire damage both in the fires of 1983 and 1998. The impact of these fires was concentrated on the peat-swamp forests of the north-east of the reserve. Even so, fire damage is very evident on the sandstone ridges known as the Laab Hills and in the western segment of the reserve in the peat and limestone forests adjacent to the Supu Hills. Field observations indicated that the forest recovery on the worst degraded secondary vegetation that was caused by uncontrolled tree harvesting is still considerably slow. Therefore, fire is considered as a major threat to natural forest conservation and management of the VJR as there are a large number of key conservation species present in the reserve.

2.6.2 Forest Simplification

About 70 % of the total reserve area is secondary vegetation with various degrees of degradation. These areas are very much degraded with low diversity and productivity and so the threat of forest simplification may be inevitable. The simplification of the forest could have a direct impact to the physical and terrestrial (biological) ecosystem throughout the forest landscape. Direct impacts include the large-scale loss of biodiversity, the long-term decline in wildlife population, the influx of invasive species and overall decline in ecosystem services.

2.6.3 Dredging and Drainage Disturbance

There are already three man-made drainage canals made through the eastern block A of PSFR. These man-made watercourses are designed to drain the surrounding waterlogged land for agricultural development. These drainage canals (along with other road access development) have already caused major impact to the hydrology of the reserve, especially in the peat-swamps in the north-eastern part of the reserve. The impact of these channels is most noticeable during the next El-Nino drought event causing extensive drying out of peat swamps in the reserve and increasing the fire danger of these peat areas. This remains one of the critical ecological impacts to deal with in the Pin-Supu Forest Reserve. In addition to this logging and bulldozer trail impacts area evident in many locations across the reserve, with damming of small streams being the most severe impact of this activity on local hydrology. There are numerous cases of water pooling & localized swamps caused by bulldozer trails across the reserve.

2.6.4 Water Pollution

The Global Palm Oil Mill is located right on the edge of the North-east boundary of the Pin-Supu Forest Reserve. The mill is located immediately adjacent to (just outside) the forest reserve boundary). There is no buffer zone between the mill and the forest reserve. Apart from noise pollution, overflow from the mill's effluent treatment ponds flows directly into the forest reserve via a channel to the Girang Nunuk River. This small river flows through the entire eastern part of the Pin-Supu Forest Reserve (from north to south) and enters the Kaboi Lake in the south- eastern part of the reserve before entering the Kinabatangan River. Apart from this, the reserve acts as a sponge for other agro-chemicals and fertilizers from surrounding agriculture activities.

2.6.5 Illegal Harvesting of Natural Resources

Although these activities are not prevalent nor carried out on a large scale, there is evidence of small-scale poaching, illegal harvesting of forest products, and illegal hunting within Pin-Supu Forest Reserve. Some of these activities include, the illegal harvesting of edible birds' nests; the small-scale poaching of timber for domestic building needs and hunting activities. There is no current evidence of illegal extraction of vulnerable or endangered species from Pin-Supu Forest Reserve. Ongoing monitoring is considered essential in this area with such extensive boundaries with local communities.

2.6.6 Invasive Species

Aquatic weeds such as Giant *Salvinia* (*Salivinia molesta*) grows entirely on the surface of the water and can form dense floating mats. These dense floating mats cause severe ecological impacts due to the ongoing long-term increase in biological oxygen demand (BOD) and the major reduction in dissolved oxygen (DO2) levels necessary to sustain aquatic life. In many cases the DO2 drops below 0.5ppm causing displacement of species or death even to aquatic invertebrates or zooplankton.

Multiple impacts are mostly due to the rapid growth of this invasive plant. Floating mats will invariably cover the entire surface of the waterbody blocking light penetration through the water column and greatly reducing oxygen production that is primarily contributed by phytoplankton and water borne plants. Decaying organic debris from this plant (detritus) increase further biological oxygen demand (BOD) endangering fish and other aquatic animals. Thick floating mats prevent wildlife from accessing natural feeding grounds and local people from their traditional fishing resources. To date this remains one of the major management issues facing the large water bodies or ox-bow lakes in the reserve.

2.7 HIGH CONSERVATION VALUE (HCV) AREA

The High Conservation Value (HCV) assessment report for Pin-Supu Forest Reserve was completed on March 2015. The assessment was carried out by a multidisciplinary team from the Sabah Forestry Department and the report was peer-reviewed. Table 2.7.1 is a summary of HCV findings based on Malaysian HCV Toolkit 2009. There were 5 HCV elements which were elaborated for PSSFM area.

Table 2.7.1 HCV Findings based on Malaysian HCV Toolkit 2009.

HCV	Description	Present	Not Present
1	1.1 Protected areas	Yes	
	1.2 Threatened and endangered species	Yes	
	1.3 Endemic species	Yes	
	1.4 Critical temporal use	Yes	
2	Globally, regionally or nationally significant large landscape-level forests	Yes	
3	Forest areas that are in or contain rare, threatened or endangered ecosystems	Yes	
4	4.1 Forests critical to water catchments	Yes	
	4.2 Forests critical to erosion control	Yes	
5	Community needs		No
6	Cultural values	Yes	

2.7.1 HCV 1: BIODIVERSITY VALUES

According to the HCVF toolkit for Malaysia (2009), category HCV 1 is defined as: *"Forest area contains globally, regionally or nationally significant biodiversity values (e.g. endemism, endangered species, sites of critical temporal use)."*

2.7.1.1 HCV 1.1: Protected Areas

Definition:
All forest areas that have been legally gazette as Protected Areas under Malaysia legislation (either federal or state), are HCV 1.1., the Master List of Protected Areas in Malaysia, commissioned by the Ministry of Natural Resources and Environment has listed all areas that fall under this category and should therefore be the first point of reference. However, it is noted that in Sarawak there is no overlap between FMUs and TPAs.

Finding:
Pin-Supu Forest Reserves are Class VI Virgin Jungle Reserve (Figure 11).

Management prescription:

- Conduct periodic patrolling and surveillance in all designated HCV areas to curb illegal activities, such as encroachment and poaching.

Monitoring prescription:

- Periodic monitoring and control should be carried out to prevent encroachment in the buffer zone. Any signs of encroachment should be reported and dealt with immediate actions.
- Quarterly progress reports in reporting of the progress of activities as prescribed in the approved Annual Work Plan (AWP), encompassing reporting of monitoring results of known HCV attributes.

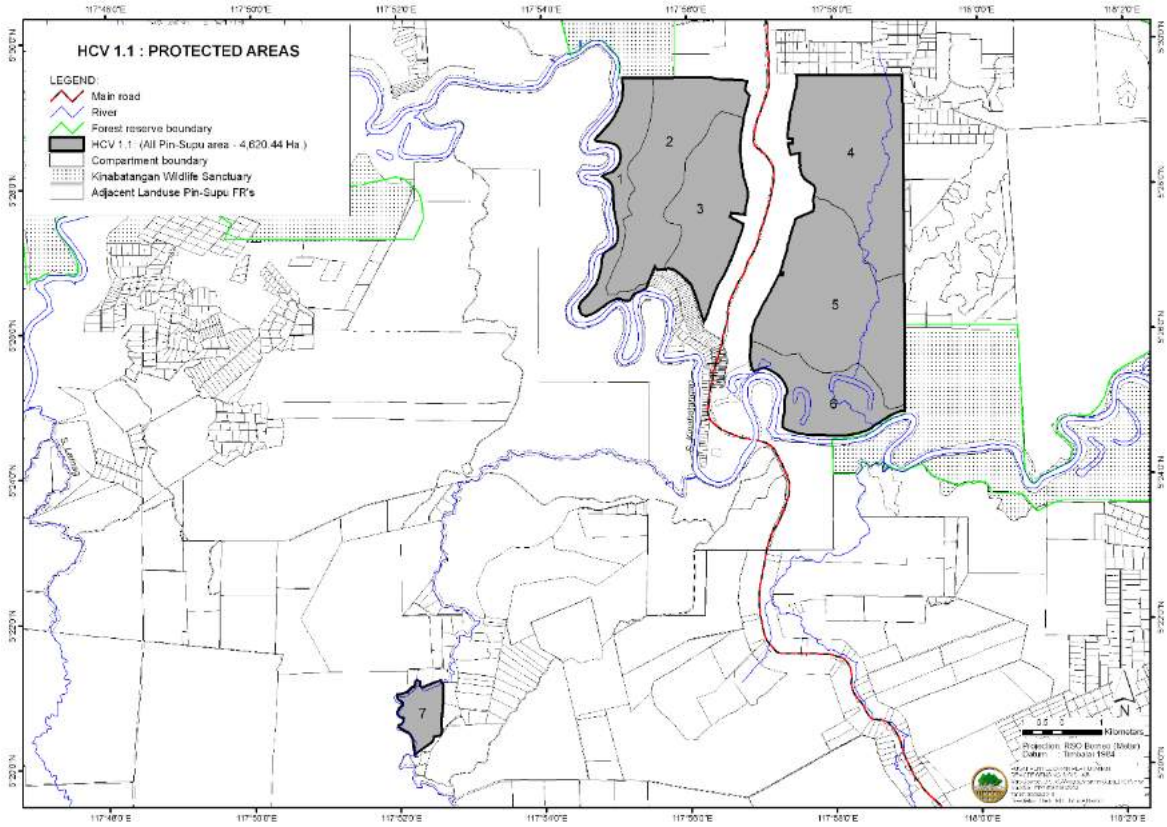


Figure 13: HCV 1.1 – Protected Areas

The whole PSSFM area should be designated as HCV 1.1 due to the totally protected status of the reserves.

2.7.1.2 HCV 1.2: Threatened and Endangered Species

Definition: Any species categorized as either Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) on the IUCN Red List, Appendix I of CITES or listed as protected under Malaysian legislation (federal or state), is HCV 1.2. However, for practical reasons forest managers may want to limit field surveys of fauna to mammals (particularly large ones, over 20kg in weight), birds and herpetofauna, unless literature indicates that there are other species in the area which require specific attention. This does not mean that other taxa are unimportant, and wherever possible, if the expertise and survey protocols are available there should be covered too. It is also recommended to cross check the IUCN Red list with the Malaysian Red Data Book, once that is available. Where there may be difference between the Malaysian Red Data Book and the IUCN Red List, the Malaysian Red Data Book should always take precedence.	
Finding: The presence of considerably high number of high conservation significant fauna and flora from both past research findings and the recent	**Management Prescription:** • Conduct periodic patrolling and surveillance in all designated HCV areas to curb illegal activities, such as encroachment and poaching.

HCV assessment may conclude that PSFR is an important natural plant habitat and for wildlife nesting and foraging habitats (Figure 12).	• Establish a long-term biodiversity monitoring system for critical forest ecosystem, flora and fauna. • If the management team discover high conservation value plant species (IUCN red list, prohibited species under Sabah Foretry Department, CITES and Sabah Wildlife Enactment) as listed in Appendix II, in permanent sample plots and nature trails in PSSFM area, they should be clearly marked on the ground and on the maps. • Migratory pathway of wildlife on logging roads, along streams or wildlife trails in the forest should be marked on the map and kept ensuring wildlife are able to use it for movement within and between forest reserves. • Collaboration amongst department, neighboring private landowners and individuals surrounding the proposed wildlife crossing is crucial in setting up connectivity that will allow movement of wildlife between Block A and Block B of PSFR. • Field staff is required to attend training courses on plants and wildlife to further enhance their botanical and wildlife knowledge on species that are currently listed in the threatened, endemic and forestry prohibited lists to ensure they do not harvest or damage and also for monitoring purposes. • Update current biodiversity conservation status to management team of the upgrade or downgrading of threat status locally and globally.
	Monitoring Prescription: • Periodic monitoring and control should be carried out to prevent encroachment in the buffer zone. Any signs of encroachment should be reported and dealt with immediate actions. • Quarterly progress reports in reporting of the progress of activities as prescribed in the approved Annual Work Plan (AWP), encompassing reporting of monitoring results of known HCV attributes. • Periodical monitoring by conducting re-enumeration of the trees in the permanent sample plots to be conducted once every three years to get

	an indication of changes in tree structure and species assemblages. • Periodical monitoring of endangered, endemic and migratory wildlife species will be practiced using Wildlife Management System adopted by the management team. Any changes in terms of population count or migratory pathways observed by researchers or ground staffs, the management team must be alerted. Similarly, this monitoring prescription also applies to endangered and endemic plant.

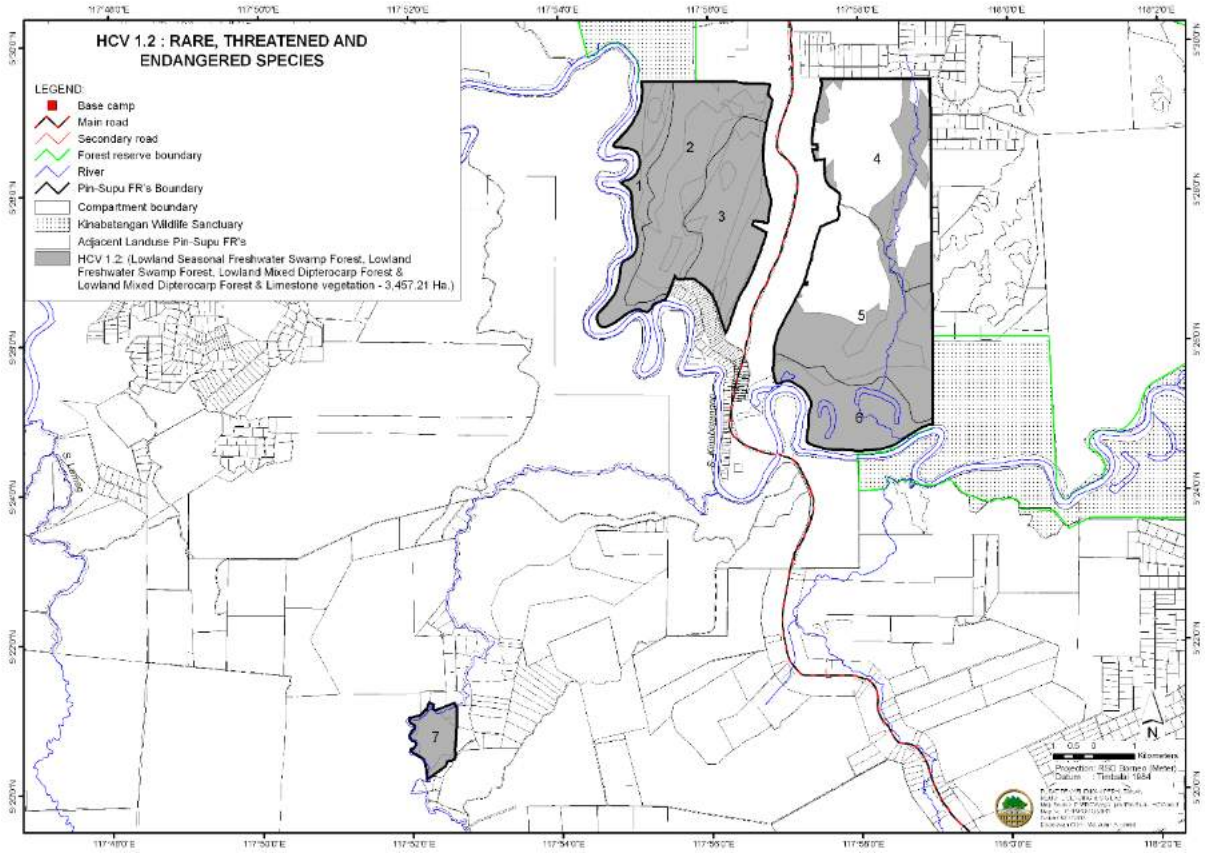


Figure 14: HCV 1.2 – Rare, Threatened and Endangered Species

The previously mixed dipterocarp, seasonal freshwater swamp and freshwater swamp forests in PSSFM area should be designated as HCV 1.2 due to its important habitats for high conservation value flora and fauna.

2.7.1.3 HCV 1.3: Endemic Species

Definition: Any forest containing endemic species as identified by FRIM, MNS, SFC, Forestry Departments and published literature, particularly in high concentration or highly restricted distribution, can be considered HCV 1.3.	
Finding: The presence of considerably high number of endemic fauna and flora from both past research findings and the recent HCV assessment may conclude that this FMU unit is an important natural plant habitat or for wildlife nesting and foraging habitats (Figure 14).	**Management prescription**: • Similar as prescribed for HCV 1.2 **Monitoring prescription**: • Similar as prescribed for HCV 1.2

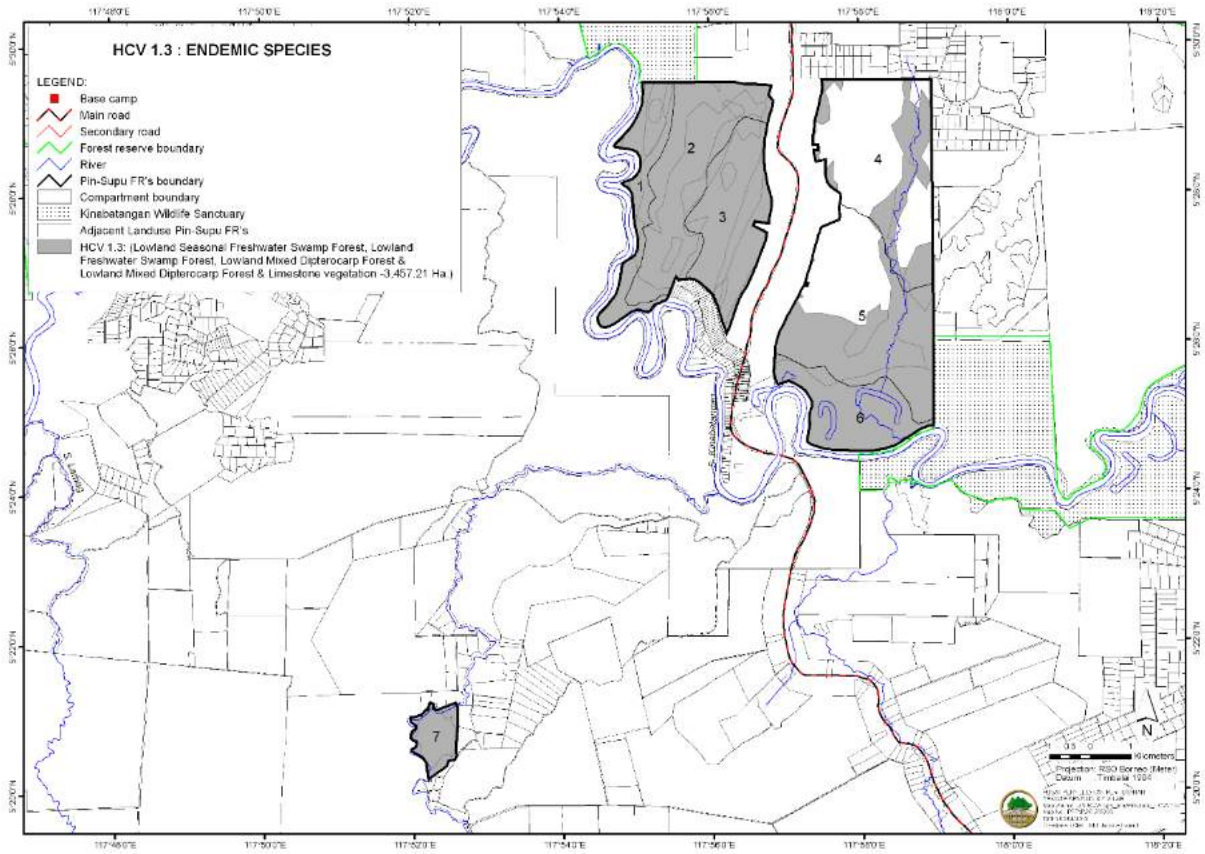


Figure 15: HCV 1.3 – Endemic Species

The previously mixed dipterocarp, seasonal freshwater swamp and freshwater swamp forests in PSSFM area should be designated as HCV 1.3 due to its important habitats for endemic flora and fauna.

2.7.1.4 HCV 1.4: Critical Temporal Use

<table>
<tr><td colspan="2">Definition:
Any forest area which is important to wildlife for feeding, nesting, roosting, and migration or contains saltlicks is HCV 1.4. Limestone hills, although important as habitat, are captured under HCV 3 Ecosystems.</td></tr>
<tr><td rowspan="2">Finding:
Salt lick presence in Block A at coordinate latitude N 5.49014˚ and longitude E 117.96294˚.</td><td>Management prescription:
• Install clear signage along existing road, foot trails and navigable rivers/streams indicating critical values
• Conduct periodic patrolling and surveillance in all designated HCV areas to curb illegal activities, such as encroachment and poaching.
• Set up wildlife monitoring system to investigate potential wildlife that frequents the HCV site.</td></tr>
<tr><td>Monitoring prescription:
• Periodic monitoring and control should be carried out to prevent encroachment in the buffer zone. Any signs of encroachment should be reported and dealt with immediate actions.
• Quarterly progress reports in reporting of the progress of activities as prescribed in the approved Annual Work Plan (AWP), encompassing reporting of monitoring results of known HCV attributes.
• Periodical monitoring of endangered, endemic and migratory wildlife species will be practiced using Wildlife Management System adopted by the management team.</td></tr>
</table>

2.7.2 HCV 2: Landscape Level Forest

<table>
<tr><td colspan="2">Definition:
Forest area contains or is part of a globally, regionally or nationally significant large landscape level forest where significant populations of most if not all naturally occurring wildlife species exist in natural patterns of distribution and abundance.
Any forest area that forms or is part of a linkage between larger forest complexes and can thus provide connectivity between fragments or act as a wildlife corridor for the movement of animals from one complex to another, is considered HCV 2. This HCVF can serve as a buffer zone to protected areas. Its identification and management should be tailored towards the needs of umbrella species i.e. sensitive, wide ranging wildlife that are particularly susceptible to forest fragmentation and human population pressures.</td></tr>
<tr><td>Finding:
Though Pin Supu is not a large forest, however Block A and B of PSFR should be categorised as HCV</td><td>Management Prescription:
• Conduct periodic patrolling and surveillance in all designated HCV areas to curb illegal activities such as encroachment and poaching.</td></tr>
</table>

2 due to its crucial location potential for linking Kinabatangan Floodplain between Lot 8 in the west and Lot 7 in the east of the Kinabatangan Wildlife Sanctuary (Figure 16).	• Establish a long-term biodiversity monitoring system for critical forest ecosystem, flora and fauna. • Migratory pathway of wildlife on logging roads, along streams or wildlife trails in the forest should be marked on the map and kept to ensure wildlife are able to use it for movement within and between forest reserves. • Collaboration between the Sabah Forestry Department, neighboring private landowners surrounding the proposed wildlife crossing is crucial in setting up connectivity that will allow movement of wildlife between Block A and Block B of PSFR.
	Monitoring Prescription: • Periodic monitoring and control should be carried out to prevent encroachment in the buffer zone. Any signs of encroachment should be reported and dealt with immediate actions. • Quarterly progress reports in reporting of the progress of activities as prescribed in the approved Annual Work Plan (AWP), encompassing reporting of monitoring results of known HCV attributes. • Periodical monitoring by conducting re-enumeration of the trees in the permanent sample plots to be conducted once every three years to get an indication of changes in tree structure and species assemblages. • Periodical monitoring of endangered, endemic and migratory wildlife species will be practised, using Wildlife Management System adopted by the management team. Any changes in terms of population count or migratory pathways observed by either researchers or ground staffs, the management team must be alerted. Similarly, this monitoring prescription also applies to endangered and endemic plants. • Long term monitoring of PSFR landscape using remote sensing technology and to be conducted once every three years to detect changes within the reserve and also vicinity areas. If threats are detected, precautionary approached will be taken and potential mitigation measures will be incorporated in the management plan.

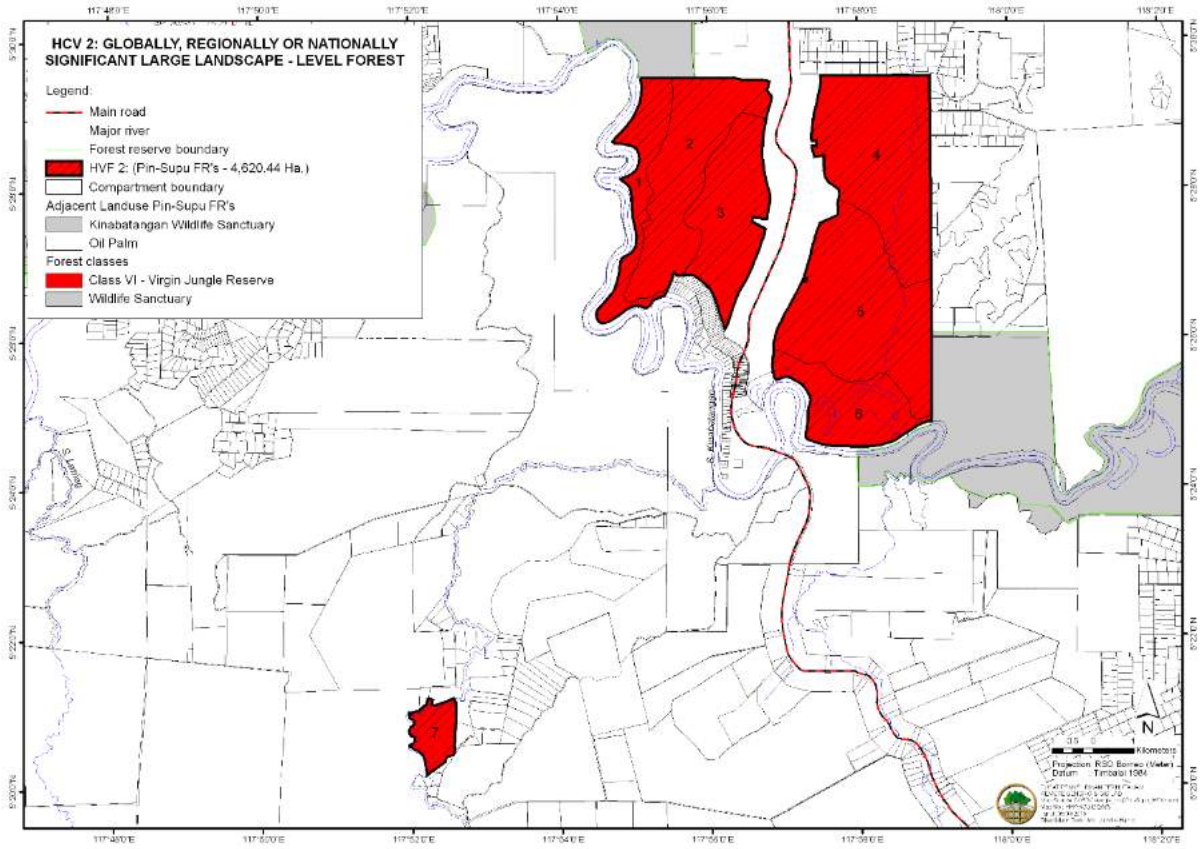


Figure 16: Map showing Block A & B of Pin-Supu FR categorised as HCV 2.

2.7.3 HCV 3: Ecosystems

Definition:
Forest areas that is in or contains rare, threatened or endangered ecosystem. Any forest area that contains an ecosystem/habitat type identified as a priority for protection by National Conservation Strategy (NCS), PERHILITAN Ecosystem Assessment Report, Forestry Departments, FRIM or SFC, and/or is confirmed as such by current expert opinion, is HCV 3. Some ecosystems are naturally rare, but some others are becoming increasingly threatened by pressure from human activities. Due to rapid changes, existing data may be outdated and some particularly threatened ecosystems may already need to be considered Priority 1. A good example of this would be Lowland Dipterocarp Forests, Peat Swamps Forests and Limestone Habitats. Always refer to current expert opinion for confirmation.

Finding:	**Management Prescription**:
The forests located below 200 m a.s.l contain rare, endangered, threatened and also endemic species and thus appropriate to be categorised as HCV 3 (Figure 17).	• Conduct periodic patrolling and surveillance in all designated HCV areas to curb illegal activities such as encroachment and poaching. • Establish a long-term biodiversity monitoring system for critical forest ecosystem, flora and fauna.

	Monitoring Prescription: • Periodic monitoring and control should be carried out to prevent encroachment in the buffer zone. Any signs of encroachment should be reported and dealt with immediate actions. • Quarterly progress reports in reporting of the progress of activities as prescribed in the approved Annual Work Plan (AWP), encompassing reporting of monitoring results of known HCV attributes. • Periodical monitoring by conducting re-enumeration of the trees in the permanent sample plots to be conducted once every three years to get an indication of changes in tree structure and species assemblages.

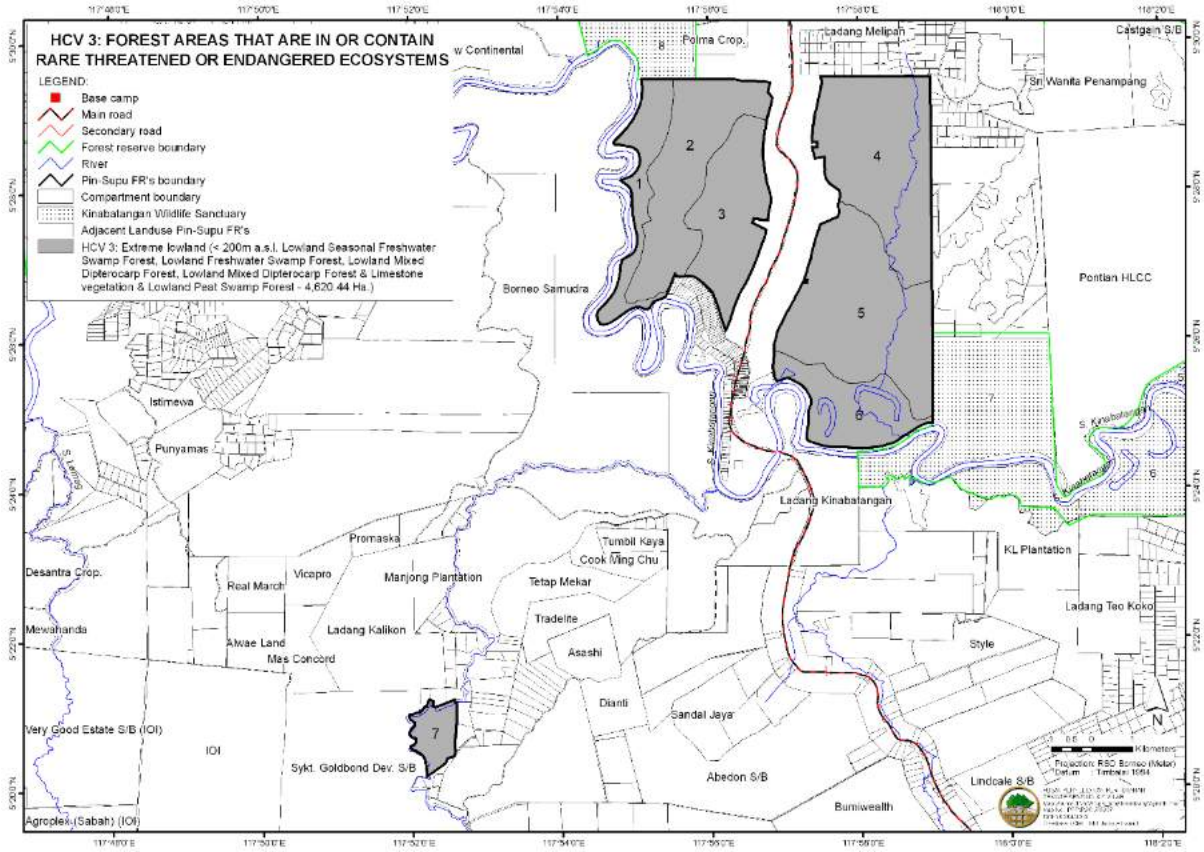


Figure 17: The location of extreme lowland forest that are categorised as HCV 3 in PSSFM area, Sabah.

2.7.4 HCV 4: Services of Nature (Ecosystem Services)

It is defined as "*Forest area provides basic services of nature in critical situations*."

2.7.4.1 HCV 4.1: Forest Critical to Water Catchments

<table>
<tr><td colspan="2">Definition:
Dam catchment areas and any forest area legally gazetted as a Protection Forest for water catchment under the National Forestry Act 1984, water protection area under the Sabah Water Resources Enactment 1998 or Class I Protection Forest Reserve under the Sabah Forest Enactment 1968.</td></tr>
<tr><td rowspan="2">Finding:
No forest area in PSSFM area are categorised as HCV 4.1.</td><td>Management prescription: None</td></tr>
<tr><td>Monitoring prescription: None</td></tr>
</table>

2.7.4.2 HCV 4.2: Forest Critical to Erosion Control

<table>
<tr><td colspan="2">Definition:
Forest areas that have been legally facetted for soil protection or conservation under federal and state laws e.g. the National Forestry Act 1984 (Peninsular Malaysia), forest areas, situated on slopes over 25 degrees (Sabah), areas classified as Terrain Class 4 in First Schedule: Forest Management Plan, Forest Timber License, and riparian areas covered under the DID (Department of Irrigation and Drainage) guidelines.</td></tr>
<tr><td rowspan="2">Finding:
All areas with slopes >25° and 30 m riparian buffer strips should be categorised as HCV 4.2 for their importance in erosion control (Figure 18).</td><td>Management prescription:
• Conduct periodic patrolling and surveillance in all designated HCV areas to curb illegal activities such as encroachment and poaching.
• Demarcation of HCV boundaries on the ground and installing clear signage along existing road, foot trails and navigable rivers/streams indicating critical values, especially 30 m strip riparian reserve along both sides of the river.</td></tr>
<tr><td>Monitoring prescription:
• Periodic monitoring and control should be carried out to prevent encroachment in the buffer zone. Any signs of encroachment should be reported and dealt with immediate actions.
• Quarterly progress reports in reporting of the progress of activities as prescribed in the approved Annual Work Plan (AWP), encompassing reporting of monitoring results of known HCV attributes.</td></tr>
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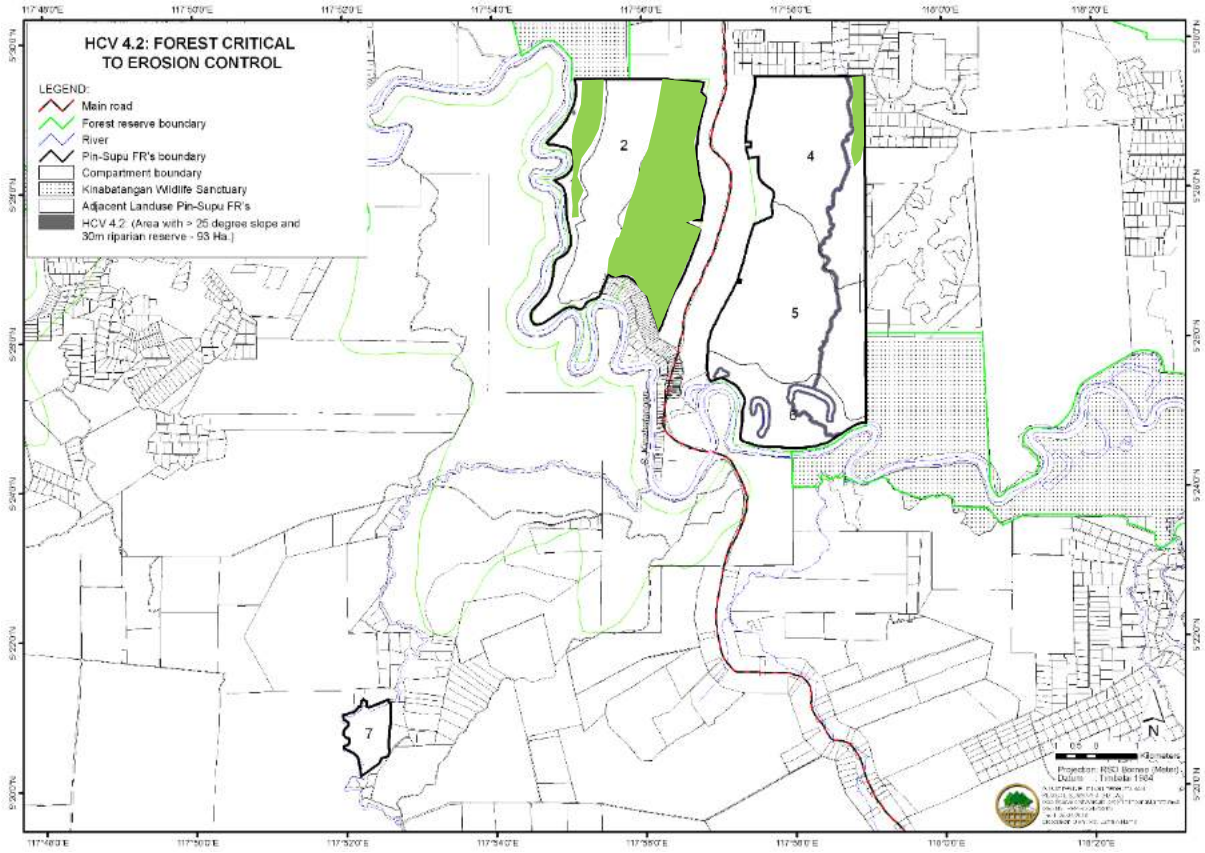

Figure 18: The location of areas with slopes >25° and riparian reserve are categorised as HCV 4.2 in PSSFM area, Sabah.

2.7.4.3 HCV 4.3: Forest Providing Barriers to Destructive Fire

Definition: Any specific areas that can act as barriers to provide protection of forests, especially forests with high conservation values, from fire, in areas that are generally fire prone and where the consequences are potentially severe, can be considered HCV 4.3.	
Finding: The natural forest of PSSFM was affected by fire in the past. Buffer strips of 50 m inside PSSFM boundaries that border local community land and northern boundary that bordering oil palm estate are categorised as HCV 4.3 (Figure 19).	**Management prescription**: • Conduct periodic patrolling and surveillance in all designated HCV areas to curb illegal activities such as encroachment and poaching. • Demarcation of HCV boundaries on the ground and installing clear signage along existing road, foot trails and navigable rivers/streams indicating critical values, especially 50 m strip firebreak forest. • The Forest Fire Management Plan is available and should be implemented and updated periodically. • Forest restoration of indigenous tree species as part of the remedial action to increase forest

	structural diversity and mitigate any forest fire incidence spreading into the FMU core area, especially area dominated with lalang grassland and ferns.
	Monitoring prescription: • Periodic monitoring and control should be carried out to prevent encroachment in the buffer zone. Any signs of encroachment should be reported and dealt with immediate actions. • Quarterly progress reports in reporting of the progress of activities as prescribed in the approved Annual Work Plan (AWP), encompassing reporting of monitoring results of known HCV attributes. • Ensure that all fire prevention procedures (monitoring, fire drills, public awareness campaign, etc.) to be practiced on a regular basis (at least once a year), especially during the drought season.

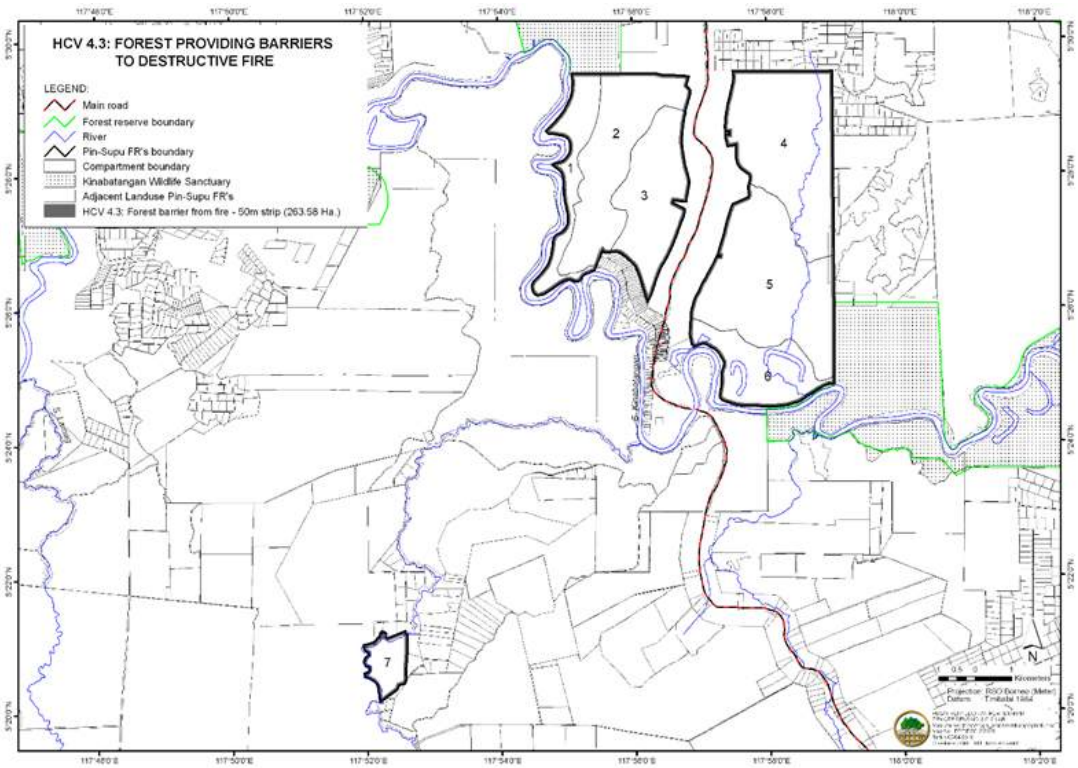

Figure 19: The location of HCV 4.3, buffer strips of 50 m inside PSSFM boundary providing barriers from fire from adjacent areas.

2.7.4.4 HCV 4.4: Forest Providing Flood Mitigation

<table>
<tr><td colspan="2">Definition:
Any specific areas that can act as flood mitigation, absorbing heavy rainwater from catchment areas (in this case extensive more than 25% of the State of Sabah) and preventing flooding of populated areas HCV 4.4.</td></tr>
<tr><td rowspan="2">Finding:
The natural forest of PSSFM acts as a buffer for flooding of populated areas along the Kinabatangan HCV 4.4 (Figure 17).</td><td>Management prescription:
• Conduct periodic patrolling and surveillance in all designated HCV areas to curb illegal activities such as dredging or building of canals or levees.
• Demarcation of HCV boundaries on the ground and installing clear signage along existing road, foot trails and navigable rivers/streams indicating critical flood mitigation values.</td></tr>
<tr><td>Monitoring prescription:
• Periodic monitoring and control should be carried out to understand the hydrological functions throughout the forest reserve. .
• Quarterly progress reports in reporting of the progress of activities as prescribed in the approved Annual Work Plan (AWP), encompassing reporting of monitoring results of known HCV attributes.
• Ensure periodic patrolling to prevent dredging or the construction of levees or buns.</td></tr>
</table>

2.7.5 HCV 5: Basic Needs of Local Communities

<table>
<tr><td colspan="2">Definition:
Forest area is fundamental to meeting basic needs of local communities. A forest area may be considered HCV 5 if it contains or is adjacent to settlements which depend on produce from that forest for basic subsistence or health needs. Examples include hunting grounds or areas from which minor forest products such as bamboo, rattan and medicinal plants are collected, and which are regularly visited by community members for this purpose. The community may be living either in or adjacent to the forest. However, identification and management of this HCV must always involve participation of the communities themselves.</td></tr>
<tr><td rowspan="2">Finding:
No community basic need is indicated within PSSFM area.</td><td>Management Prescription: None</td></tr>
<tr><td>Monitoring Prescription: None</td></tr>
</table>

2.7.6 HCV 6: Cultural Identity of Local Communities

<table>
<tr><td colspan="2">Definition:
Forest area is critical to local communities' traditional cultural identity. A forest is considered HCVF 6 if it has been important for a local (particularly indigenous) community's cultural, ecological, or religious activities. The community may be living either in or adjacent to the forest. Examples of such sites within a forest include burial grounds or sacred areas, which cannot be replaced with alternative and/or would cause drastic cultural change within the community. Identification and management of this HCV must always involve participation of the communities themselves.</td></tr>
<tr><td rowspan="2">Finding:
Sustainable harvesting of edible bird nests and protection of Supu Caves by KOPEL (Figure 18).</td><td>Management Prescription:
PSSFM management teams are to constantly conduct meeting with the village representatives to mitigate any potential issues pertaining to the management of HCV 6.
Boundary of the Supu Caves in PSSFM area should be clearly marked on the ground and on the map (HCV 6).</td></tr>
<tr><td>Monitoring Prescription:
The designated HCV 6 should be jointly monitored and maintained by the PSSFM management team and local communities.</td></tr>
</table>

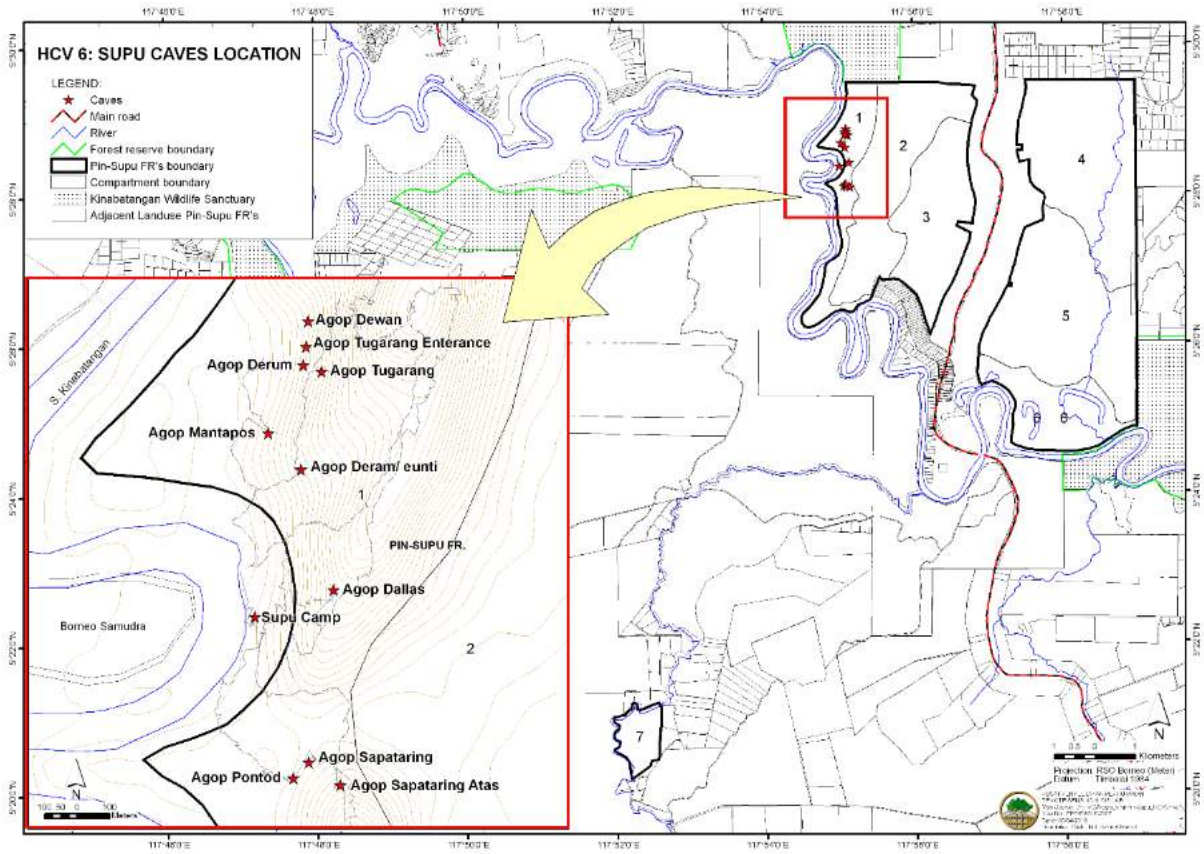

Figure 20: The location of Supu Caves that is categorised as HCV 6, an important area for cultural value for Kg Batu Puteh communities.

2.7.7 Measurable Indicators for HCVF Monitoring in PSFR

For the purpose of monitoring of HCVF in the reserve, SFD and KOPLE has listed the measurable indicators to be systematically monitored. There were 9 categories of HCV that have to be monitored monthly, quarterly, yearly and every 3–5 years with specific methodologies. For example, the protected area will be inspected every quarter of the year to determine the level of damage on site. This activity will be carried out by the District Forest Officer of Kinabatangan with his staff and data will be recorded properly. The summary list of measurable indicators for monitoring the HCVF area in the reserve were listed in Table 2.7.2.

Table 2.7.2 Summary List of Measurable Indicators for Monitoring the HCVF Area in Pin Supu Forest Reserve.

Item	Category	Measurable Indicator	Methodology	Frequency	Responsibility
1	HCV 1.1 Protected Area Maintained	Visible Area or Site damage.	Physical inspection and direct measurement of area encroached.	Quarterly	DFO Kinabatangan
2	HCV 1.2 Threatened & Endangered Species	Population density remains consistent or increases • Clouded Leopard (*Neofelis nebulosa*) • Proboscis Monkey (*Nasalis larvatus*)	Clouded Leopard: Non-intrusive camera trapping in selected location Proboscis Monkey: direct sightings – Census via river boat census	Monthly monitoring, yearly analysis, long-term trend analysis every 5 years	FRC and DFO Kinabatangan and KOPEL
		Population density remains consistent or increases. • Belian (*Eusideroxylon zwageri*) • Keruing Kasigoi (*Dipterocarpus validus*)	Long-term monitoring via Permanent Sample Plots (PSP) and population census	Monitoring every 3years, trend analysis once over the 10 year management period	FRC and DFO Kinabatangan and KOPEL

3	HCV 1.3 Endemic Species	Population density remains consistent or increases. • Replicates Indicators from 1.2	Same as per HCV 1.2	Same as per HCV 1.2	Same as per HCV 1.2
4	HCV 1.4 Critical Temporal Use	Key & Threatened Habitats • Oxbow Lakes such as Tungog Lake	Aerial & Drone Assessment of coverage of invasive water weed *Salvinia molesta* Monitoring of Biological Control (*Cyrtobagous salviniae*) as per Sabah Agriculture Department SOP	Annual assessment of coverage of invasive water weed *Salvinia molesta* Monthly monitoring of control measures, yearly analysis, Long-term trend analysis every 5 years	KOPEL and DFO Kinabatangan
5	HCV 2 Landscape Level	Population density remains consistent or increases. • Belian (*Eusideroxylon zwageri*) • Keruing Kasigoi (*Dipterocarpus validus*)	Long-term monitoring via Permanent Sample Plots (PSP) and population census	Monitoring every 3 years, trend analysis once over the 10 year management period	FRC, DFO Kinabatangan and KOPEL
6	HCV 3 Eco Systems	No reduction in extent and quality of HCV3	Remote sensing, field truthing Regular boundary & ground patrols Aerial (helicopter) patrolling	Every 5 years with satellite data	FRC, DFO Kinabatangan and KOPEL

		Forest health	Establish long-term ecological research plots (PSP) and monitor forest dynamic & trends	Detailed PSP monitoring every 3 years.	FRC, DFO Kinabatangan and KOPEL
		Oxbow Lakes such as Tungog Lake (Consistent with HCV 1.4)	Aerial & Drone Assessment of coverage of invasive water weed *Salvinia molesta* Monitoring of Biological Control (Cyrtobagous salviniae) as per Sabah Agriculture Department SOP	Annual assessment of coverage of invasive water weed *Salvinia molesta*, Monthly monitoring of control measures, yearly analysis, long-term trend analysis every 5 years	KOPEL and DFO Kinabatangan
7	HCV 4 Forest Services	Water quality	Water physical and chemical analyses	Monthly monitoring, analysis and reporting annually. Trend analysis done on yearly basis	KOPEL
		Prolong drought	Fire Danger Rating System (FDRS)	Monthly, analysis monthly and feedback into management	DFO Kinabatangan
8	HCV 5 Community Utilization	Eco Tourism Statistics	Visitor arrival and Financial Analyses	Yearly trend analysis done every 5 years	KOPEL
9	HCV 6 Cultural Identity	Harvesting of edible bird nest	Population count of edible bird nest species.	Annually	SWD and KOPEL

2.8 ENVIRONMENTAL IMPACT ASSESSMENT

Sustainable forest management involves a range of activities where some may affect the environment. The severity of impact varies depending on the type and scale of the disturbance. In the case of the Pin-Supu Forest Reserve, this is a protected area set-aside for scientific research and biodiversity conservation. In this case logging activities are not permitted, which means direct large-scale impacts should not be present. Even so, the focus of impacts in the current management context is on all the other permitted activities within the 10-year Forest Management Plan as well as on activities outside but impacting on the reserve. Environmental impact from activities within the PSFR includes impacts of scientific investigation, conservation interventions, restoration activities, and/or recreation and tourism development. In addition to the activities within the reserve impacts from adjacent land-use also fall within the purview of this environmental impact assessment.

The key direct environmental impacts identified during the implementation phase of previous PSSFM project include soil erosion, water pollution and waste pollution as well as the long-term impacts of fire and forest degradation on forest ecosystem services, flora, and wildlife. As the activities within PSSFM area are on forest protection, forest rehabilitation, low-impact ecotourism, it is envisaged that the impact on the environment will be minimal. In long term, the impact from the above activities towards the existing environment will be positive.

2.8.1 The Impact on Environment During Implementation Phase

Key environmental impacts and mitigation measures during the implementation phase of the FMU are summarized as follows:

Key Environmental Impacts		**Key Mitigation Measures**
Physical	Soil erosion *(Minor Impact)*	Application of engineering erosion control
	Water quality degradation and waste pollution *(Minor Impact)*	Proper sanitary and waste management
Ecological	Improvement of degraded forest ecosystems and HCVF areas *(Major Impact)*	Management activities already prescribed mitigation measures to improve degraded forest as follows: • Proper silvicultural treatment • Enrichment planting with native species • Protection of high conservation value areas from forest fire and encroachment

	Improvement of low flora diversity *(Major Impact)*	Management activities already prescribed mitigation measures to improve degraded forest as follows: • Evaluate status of conservation of threatened plants • Zero removal of plants of high conservation value • Replanting of target conservation species • Remove invasive species • Prevent occurrence of forest fire
	Improvement of fauna diversity *(Major Impact)*	Management activities already prescribed mitigation measures to improve degraded forest as follows: • Improve Habitat Condition & Health • Silviculture to enhance food source for wildlife • Wildlife monitoring • Prohibition of hunting • Prevent of occurrence of forest fire
Social	Local community *(Major Impact)*	Management activities already prescribed mitigation measures to include adjacent local community participation as follows: • Ongoing & long-term employment of local community must be the main priority • Employment should follow rule of law with adequate work conditions & remuneration schemes put in place • Community provided adequate opportunities to participate in sustainable forest management • Community kept informed of SFM, HCVF, Certification, Mitigating Impacts (especially adjacent to the reserve)
	Workers health and safety *(Minor Impact)*	• Provide safe work environment and implement safe work practices • Provide proper safety equipment

	Visitors safety *(Minor Impact)*	• Raise awareness about HCV of PSFR, the mitigation impacts and SFM measures put in place. • Ensure visitors of appropriate behavior within the reserve • Inform visitors of the safety and security measures of the facilities and activities

It is essential and practical to incorporate a monitoring program to provide information that will aid impact management and to achieve a better understanding of cause-effect relationships besides improving impact prediction and mitigation methods.

The project management team will formulate Environmental Monitoring Program (EMP) and will be coordinated by an environmental officer. It is anticipated that biodiversity and ecosystem monitoring will correspond to the management and monitoring as prescribed in the HCV. This monitoring will involve site inspection activities by the designated project personnel and the environmental officer will prepare a monitoring compliance report annually. The recommended impact-monitoring program is as listed in the framework tabulated as follows:

Key Environmental Components in the EMP	**Recommended Impact Monitoring**
Soil erosion	□ Compliance guidelines and regulation during construction of infrastructures, i.e. road, nature trail, building, etc.
	□ Regular infrastructure maintenance inspection
Water quality	□ Long-term monitoring on water quality of one river (i.e. Girang Nunuk) and the 3 ox-bow lakes (Kaboi, Tungog and Biandong)
Waste pollution	□ Regular inspection on sanitary structure □ Regular inspection on management operations that involve chemical usage
Forest ecosystems	□ Site specific procedure in forest restoration to meet habitat enhancement objectives □ Monitoring extent of significant forest ecosystems □ Forest fire prevention program □ Monitoring of forest ecosystem health □ Prevention of encroachment
Flora	□ Status of conservation of significant flora □ Compliance guidelines and regulation on removal of plants

Wildlife	□ Implementation of wildlife management and monitoring program □ Compliance guidelines and regulation during the implementation of forestry activities, i.e. silvicultural treatment and chemical usage
Social aspects	□ Compliance with the guidelines and regulation for workers health and safety □ Documentation on meetings or dialogues with the participating local communities

2.8.2 The Impact on Environment After Implementation Phase

At the end of 2023 which is the management period of PSSFM project, it is anticipated that the implementation that supported conservation of flora and fauna, recreation and natural forest management will improve flora and fauna diversity, forest structural diversity and local community well-being. These management activities will ultimately give a positive impact to the environment.

2.9 INFRASTRUCTURE

2.9.1 Buildings

Main Base / Kinabatangan District Forest Office

The main office that administers PSFR is in Kinabatangan District Forestry Office itself, which is located within the Kota Kinabatangan township and about 20 km from the reserve. All the basic facilities, such as electricity, water and telecommunication are available. Most of the management team of PSFR, residential quarters, vehicles and field equipment is based in this office.

Plate 6: The Kinabatangan Forestry District as main administration office Pin-Supu FR.

b) Field Checking Station

There were two field checking stations established located in Block A and B of Pin-Supu FR along the access road to Global Agricultural Plantation Sdn Bhd (Plate 7). The function of the building is to create presence of forestry personnel in the vicinity of the reserve and also as a field base for border surveillance and patrolling. The outpost is equipped with water tank (rainwater) and generator (electricity supply).

Plate 7: Field Checking Stations

c) Tungog Rainforest Eco-Camp

The establishment of Tungog Rainforest Eco-Camp was established by the local community via the community cooperative KOPEL Berhad in 2006. The camp has limited

accommodation for only 30 eco visitors. An eco-friendly and low-impact design was implemented to minimize impacts on this site. Site management including zero waste, zero chemicals, low noise, rainwater harvesting & solar power. The Eco Camp design was approved by 6 separate Government Departments before being approved by the Sabah Forestry Department in 2005.

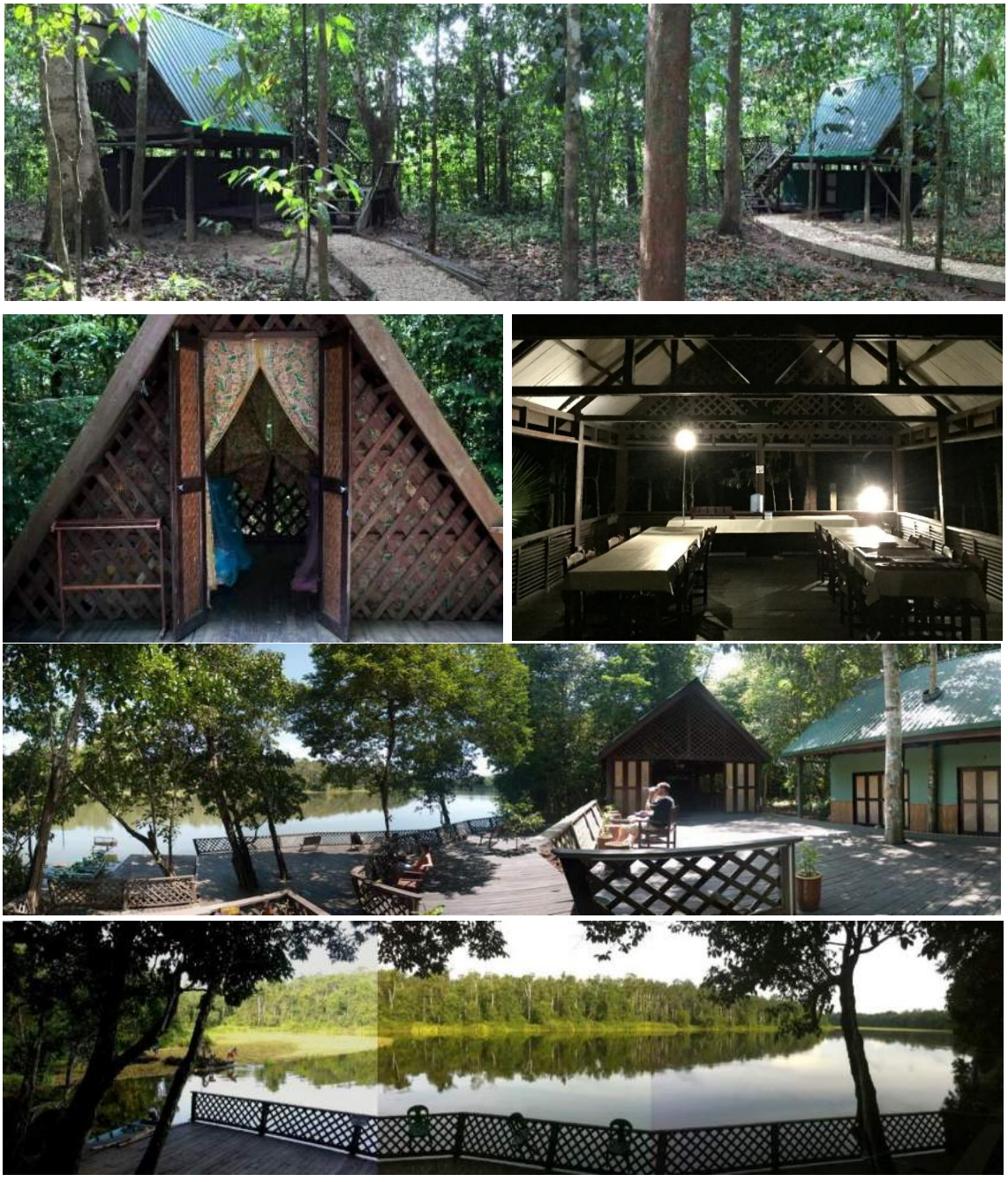

Plate 8: An example of images of the camp and the surrounding natural setting of the Tungog Rainforest Eco-Camp at Pin Supu Forest Reserve

There are ten live-in observation platforms called "camp-platforms". The camp is situated at the most scenic lake in the reserve, i.e. Tungog Lake. The ox-bow lake is surrounded with mature phase secondary forests that are still rich in wild fruit trees, promising bountiful wildlife sighting opportunities.

d) Supu Adventure Camp

Supu Camp was established by KOPEL at the foothill of the major limestone outcrops of Supu and Sapat taring hills with the fund provided from the 9th Malaysian Plan under the purview of the Sabah Forestry Department. The camp was built for the purpose of monitoring and protecting the caves within the Supu Limestone complex. The camp has a maximum capacity of 20 eco visitors in addition to 4 staff on-site. The outdoor adventure camp is of low impact activity to the limestone environment and expose greater nature experience.

Plate 9: Permanent Ranger Hammock Camp was constructed at the foothill of Supu Hills, a limestone hill with significant cultural and archaeological heritage.

e) Multi-Purpose Tower

A multi-purpose tower was established in one of the highest point at Block A of PSFR through the 9th Malaysian Plan project fund (Plate 10). The tower is mainly used for the detection of forest fire and surveillance purposes. Wildlife periodic observation for monitoring purposes may also utilize the tower for a better scoping viewpoint.

Plate 10: Multipurpose tower was constructed in Block A of the reserve to detect forest fire, including conducting surveillance and wildlife monitoring purposes.

f) Jetty

Two openwork timber jetties were constructed for easy docking for boats at KOPEL base and Tungog Rainforest Eco-Camp (Plate 11). This infrastructure facilitates traffic movements for passengers or visitors and loading of cargoes. Throughout the management period, both jetties were damaged during the worst flood period in 2011. Since the completion of the jetties, twice remedial action was made to maintain these important facilities.

Plate 11: Openwork timber jetties that consist of a platform and bridge in the area.

2.9.2 Road, Trails and Bridge

Due to boundary issues in the past, the access to Global Agricultural Plantation Sdn Bhd's palm oil mill was aligned slightly inside and peripheral to the northern boundary of Block A of PSFR. This unsealed road occupies about 8.79 ha in size or about 4.398 km in length. The company paid an occupation permit of RM 2,250 per year to the department for the right of access to their mill (Plate 12).

With a distance of 700 m of graveled road and a wooden bridge were constructed by the department for vehicle access to the Field Checking Station (Plate 6). Several nature trails have been constructed by KOPEL for the implementation of monitoring

activities, such as phenological monitoring, and for select cases for eco-tourism activities within the reserve (Plate 13).

Plate 12: A & B – Unsealed road to Global Agricultural Plantation S/B that aligned within and peripheral to the northern boundary of Block A of Pin-Supu FR. The management team has planted numerous trees along the boundary of the reserve.

Plate 13: Other infrastructure within the Pin-Supu FR**: A**. wooden bridge to access field checking station; and **B**. an example of the many nature trails for recreation facilities.

PART III

REVIEW OF PAST MANAGEMENT PLAN (2008 – 2017)

3.1 PAST MANAGEMENT REVIEW

3.1.1 Overview

The first Forest Management Plan (FMP) was developed for the management year of 2008 to 2017. The purpose of the FMP was to ensure that forest ecosystems, resources and functions are managed on a sustainable basis into the distant future. Optimizing these resources for economic, social and environmental benefits to the people and State of Sabah is inherent with the approach of Sustainable Forest Management. The objectives of the FMP were as follows:

1. To support other forest resource conservation activities within the reserve.
2. To support forest restoration in degraded sites within the reserve.
3. To proactively support and enhance the local community involvement in the management and protection of the reserve through KOPEL Bhd. and the MESCOT Initiatives.
4. To enhance and showcase the community forestry initiatives.
5. To enhance and maximize the benefits from community-based ecotourism activities in PSFR.
6. To protect the Pin-Supu Forest Reserve by delineating forest reserve boundaries.
7. To enhance the capacity of the District Forestry Office.
8. To showcase SFM and community involvement in SFM in Sabah.

The key management prescriptions, outlined in this FMP include:

- Boundary demarcation
- Creating an ongoing presence in the reserve
- Raising public awareness
- Surveillance of the reserve's boundaries & HCVs
- Restoration of degraded forests
- Enhancing the Community Based Ecotourism Activities in the reserve.
- Monitoring activities in and outside the reserve (especially environmental indicators)
- Forest fire prevention and control
- Controlling activities in the reserve (such as edible birds nest collection)
- Developing adequate communication mediums & signage
- Minimizing pollution and other negative impacts on the forest ecosystem

Management interventions was designed under the following key headings; (a) zoning, (b) forest protection interventions, (c) forest fire prevention & control, (d) forest & habitat restoration, (e) visitor management & forest recreation.

3.1.1.1 Zoning

Pin-Supu Forest Reserve (PSFR) was zoned based on the suitability of activities in appropriate location. Figure 21 showed Map of the initial Management Zones & Buffer Zones used within PSFR. However, through revision processes, this zoning was simplified into (i) Management Zone and (ii) Community Use Zone in the revision of the FMP as shown in Figure 22.

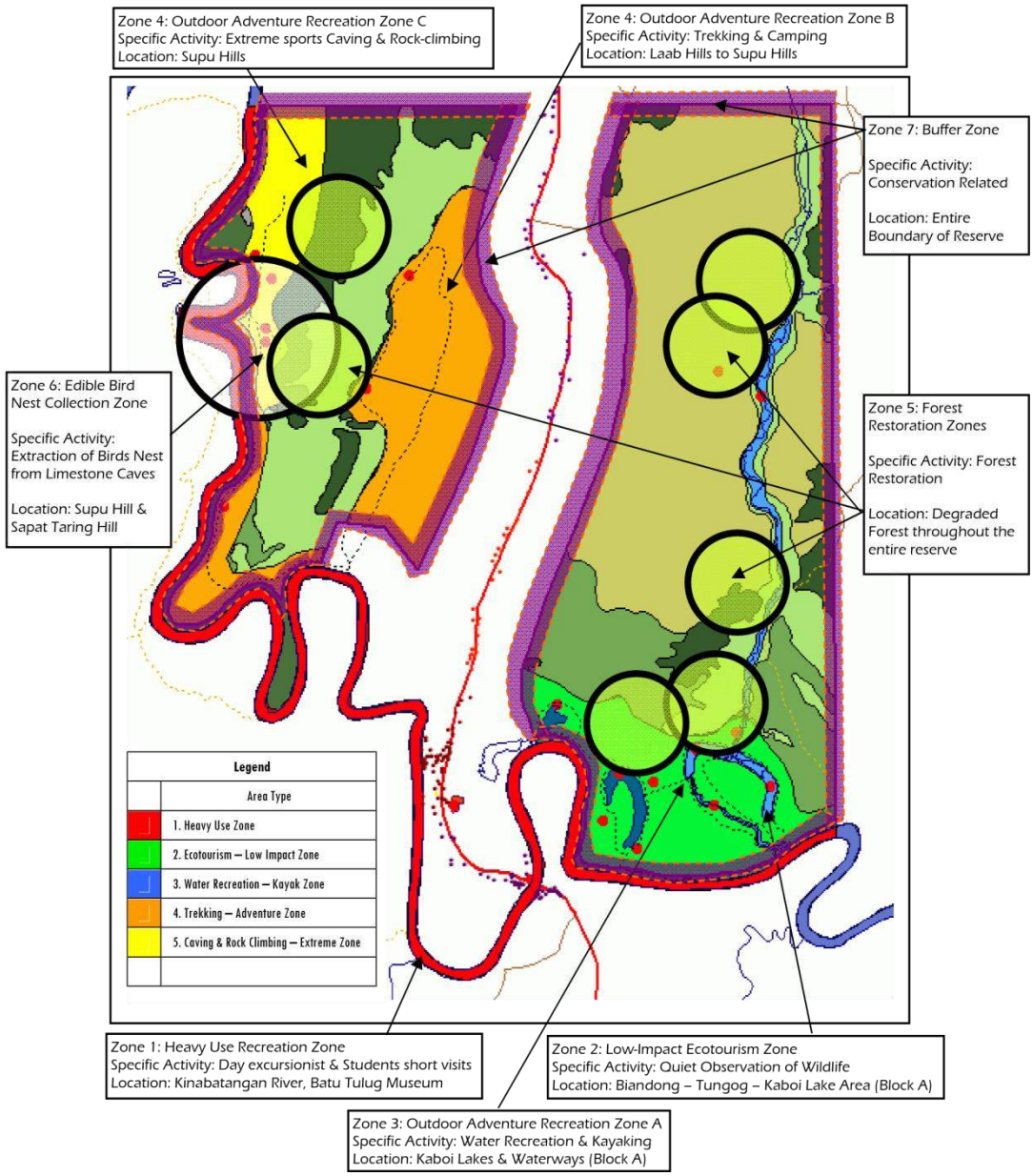

Figure 21: Map of Initial Management Zones & Buffer Zones within PSFR

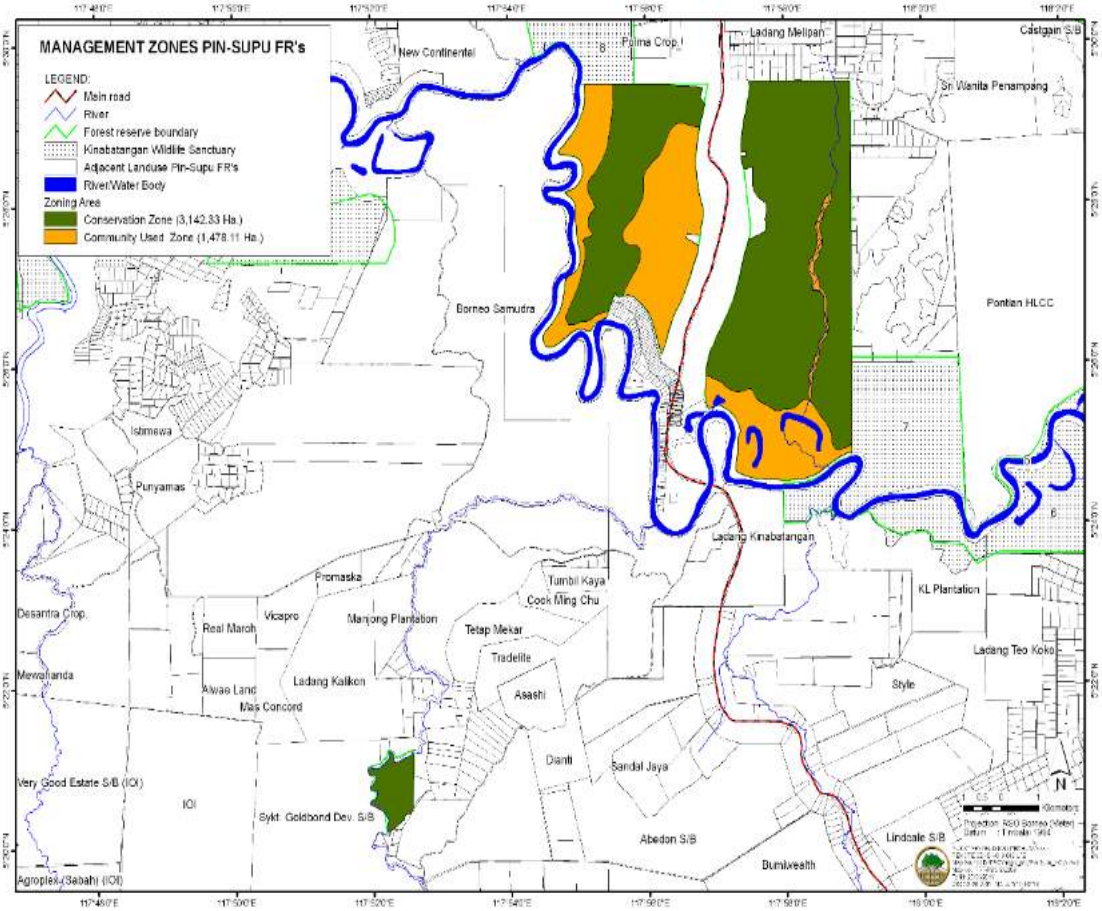

Figure 22: Revised Zoning of PSFR

3.1.1.2 Forest Protection Interventions

PSFR is classified under Class VI Virgin Jungle Reserve that has the status of being a Totally Protected Area (TPA). Protection interventions carried out in the previous FMP were as follows:

(i) Boundary Demarcation and Maintenance

Boundary demarcation was completed in 2010. This included the laying of boundary stones which are not easily dislodged by animals or humans. To avoid conflict with the surrounding communities who have established oil palm farms on the fringes of the reserve, a total of 75.56 hectares have been excised from the reserve. Figure 23 showed the excised area within PSFR. Thus, re-survey of the excised area needs to

be conducted. Maintenance of boundary was carried out on annual basis. This is to ensure that the boundaries are clear at all time.

Plate 14: Boundary stones were laid during boundary demarcation

(ii) Installation of Signage

PSFR is surrounded by villages as well as plantations. Although the boundaries are kept visible, the installation of signage is vital. Thus, signage has been installed along the boundaries. Small yellow signages are attached at 50 metres intervals along the boundary of the reserve to provide additional notice of the boundary and notice of prohibited entry into the forest reserve.

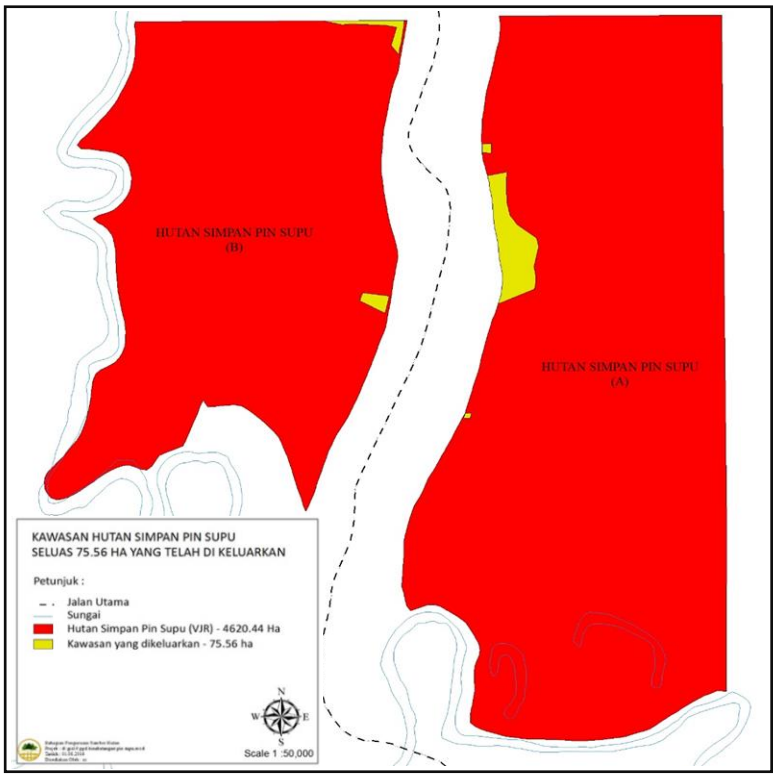

Figure 23: Map showing the excised area within PSFR

Plate 15: Signages are attached at 50 metres intervals along the boundary

Plate 16: Large signboards are installed at strategic locations

(iii) Monitoring and Enforcement

The key forms of monitoring which have been carried out in the Pin Supu Forest Reserve include:

- Physical boundary monitoring on foot or using boats. This activity also combined with boundary maintenance activities.
- Periodic aerial surveillance by helicopter focusing on all boundaries around Pin Supu Forest Reserve was conducted at least twice a year.
- Environmental monitoring including wildlife monitoring using camera trapping and water quality monitoring. Collection and analysis of water samples were conducted by the local community partner organization KOPEL Bhd. This monitoring enhances the overall monitoring and protection of this forest reserve.
- Environmental monitoring data are analyzed and reported regularly. Over the FMP period, there have been no major changes to management based on the outcome of this monitoring. Although one water pollution incidence suspected was caused by nearby oil palm processing mill was reported with corrective action taken.

3.1.1.3 Forest Fire Prevention & Control

PSFR has a long history of fires, with fires recorded in both 1983 and 1998 in many parts of the reserve. Since the fire has been very destructive, preparedness to prevent forest fires or control them is of paramount importance. In the implementation of the previous FMP, Kinabatangan District Forestry Office has carried out the followings:

i. Procurement and upgrading of fire-fighting equipment.
ii. Building a store for safekeeping of the equipment.
iii. Conduct periodic inspection and maintenance of equipment.
iv. Annual fire drills
v. Conduct appropriate forest fire control training of forestry personnel and personnel of the community cooperative KOPEL to sure-up knowledge, skills and safety. For example, ensure all forest fire fighting personnel are qualified with basic first-aid skills.
vi. Construct 3 units fire-tower in a strategic location within the forest reserve. These towers are manned during dry weather and periods of drought for monitoring and prevention of fires within the reserve.
vii. Installation of Electronic weather Station to establishment a FDRS Index for the reserve, and greatly increase the preparedness for forest fires
viii. Issuing notices to neighbouring villages and plantations to restrict burning especially during the dry periods.

Plate 17: Forest fire control training of Kinabatangan District Forestry Office personnel and the community.

3.1.1.4 Forest and Habitat Restoration

There are five fundamentally important reasons why the forest in this reserve should be restored as mentioned in the previous FMP.

i The reserve functions ecologically to support some of the last remaining populations of lowland wildlife in the Lower Kinabatangan. The total land area available to sustain a viable long-term wildlife population survival is already very small in the Lower Kinabatangan. Even amongst scientists there is great uncertainty as to the long-term sustainability of wildlife populations under these conditions. Degraded forests within the present wildlife corridor along the Kinabatangan further exacerbate food scarcity and habitat fragmentation for wildlife populations.

ii The incredible diversity of forest types and hence the biodiversity of the PSFR is a major asset to the State of Sabah for all the economic values associated with biodiversity conservation such as future gene pool, potential medical and industrial compounds, as well as ecosystem services.

iii Benefit to the society such as, water purification, disease control, biological pest control, pollination, flood mitigation, and the prevention of erosion.

iv Degraded forests are more prone to fire and greatly increase the risk of forest fire to occur. This threat will damage the rest of the reserve and affect the livelihood of local people in the area.

v The reserve function to support economic revenue generation activities for the State of Sabah vis a vis the eco-tourism industry.

There were a total of 1,754 ha of degraded forests in the Pin-Supu Forest Reserve determined in previous FMP. Approximately 425 ha were severely degraded (devoid of all tree cover) and 1,329 ha were highly degraded. Thus, restoration work was recommended on both sites.

Restoration work focused on sites which have a clear history of problems associated with their natural regeneration. Intensive work including blanket vine & grass cutting along with intensive tree planting. Less intensive approach of liberation treatment, combined with minor enrichment planting, was also carried out on less degraded sites within the reserve.

Table 3.1.1 and Table 3.1.2 showed silviculture treatment and tree planting restoration paid by State Government Funds alone implemented since 2009 until 2015 respectively.

All works were contracted out to the community through KOPEL Bhd. These approaches were proactively support and enhance the local community involvement in the management and protection of the reserve.

Table 3.1.1: Silvicultural Treatment Implemented 2009 - 2015

Block name	Year	Area (ha)
Block A Biandong	2009	100
Block A Biandong	2010	100
Block B Biandong	2010	100
Block B Biandong	2011	100
Block D Kg Perpadauan	2012	200
Block E Laab	2013	100
Block F Laab	2014	100
	Total	**800 ha**

Table 3.1.2: Tree Planting Forest Restoration Implemented Since 2009

Block name	Year	Area (ha)
Biandong Block A	2009	63
Biandong Block A	2015	47
Laab Block G	2016	3
Laab Block G	2017	7
Total		**120**

3.1.1.5 Visitor Management and Forest Recreation

The Community Based Tourism (CBT) initiative was initiated by the surrounding local community of Batu Puteh in 1996. It was designed to provide employment and opportunities to generate revenue to the community surrounding Pin Supu Forest Reserve and incentivize the protection and long-term conservation of this reserve within the community.

What is unique in this reserve is that forest restoration activities and other conservation activities has evolved to be one of the core visitor's activities within Pin Supu Forest Reserve. These conservation activities were developed by the local community in around the years 1998-2002, whereby these activities pre-date, and provided the impetus for the first Forest Management Plan for this reserve. Apart from providing employment and direct revenue into the local community, these activities were developed to help preserve

local traditional culture and help reduce the rural-urban migration especially with village youth across the communities.

Over the management period, the main visitor's activities within Pin Supu Forest reserve remain the same, namely:

i. Volunteer tourism carried out tree planting & forest restoration activities.
ii. Tungog Lake conservation project and removal of Invasive Water Species.
iii. Tungog Rainforest Eco Camp (Accommodation for 30 people)
iv. Supu Adventure Camp (Accommodation for 30 people)
v. Excursions to the Sepat Taring Bat Cave & Supu Burial Overhang site.
vi. Other recreation and nature tourism activities to observe wildlife along the Kinabatangan River and in adjacent forests.

The tourism activities within PSFR are designed to be minimal (zero) impact and have been certified at the ASEAN level and awarded State and National Eco Tourism Awards and ASEAN Sustainable Tourism Awards. There were no significant tourism infrastructure developments within the reserve over the management period from 2008-2017. Even so, upgrading was made to the Tungog Rainforest Eco Camp and the Supu Adventure Camp during this period. Apart from that, a number of small projects for site hardening of trails to mitigate environmental impact of foot-traffic and improve safety of visitors at specific sites.

Table 3.1.3: Total Visitors and Direct Revenue PSFR 2010-2017

Year	Total Visitors	Total Entrance Fees for SFD (RM)	Total Revenue TREC/Supu Camp
2009	na	*MOU Signed Dec 2009*	*TREC Not yet Launched*
2010	972	26,241.00	70,295.32
2011	2,442	14,299.00	108,299.07
2012	3,356	20,944.00	91,708.13
2013	1,858	15,689.00	70,589.30
2014	1,769	13,523.00	73,751.31
2015	1,359	10,773.00	67,327.08
2016	1,892	25,839.00	110,009.84
2017	1,965	24,733.00	178,151.01

On average 1,951 visitors per year visit within Pin Supu Forest Reserve. In 2017 a total of 1,965 visitors entered the Forest Reserve. Annual revenue from entrance fees has increased over the period averaging RM18,782.00 per year (for the previous 4 years). To date 2016 recorded the most entrance fees reaching RM25,839.00. See Table 3.1.3 below.

The number of visitors has been kept very low compared to other destination in Sabah such as Sepilok Orangutan Rehabilitation Centre and Poring Hot Spring. This is to ensure minimal impacts on the endangered and threatened wildlife of the lower Kinabatangan and high conservation value floodplain habitats.

The visitors to Pin Supu Forest Reserve are predominantly students, volunteers and pure eco-tourists, who have chosen this destination especially because of the local community involvement alongside the opportunity to contribute to the places they travel. This niche market is very conscious about minimizing their impacts during their stay and very much support conservation efforts through direct support or volunteerism. There are no plans to turn PSFR into a mainstream high-volume destination.

It is noted that a major decline in visitor numbers & revenue occurred in 2013 due the Kg Tanduo insurgency incident. The subsequent shut-down on tourism to the east coast of Sabah in 2013 was then perpetuated by the Sandakan kidnapping incident in 2015. The years 2016 and 2017 demonstrate only a moderate recovery, whereby numbers of visitors are still reported to be down 40% compared to 2012.

3.1.1.6 Results, Recommendations and Lessons Learned

Pin Supu Forest Reserve is a unique Forest Management Unit for the Sabah Forestry Department. It is a forest reserve that includes the active involvement of the local community in its management in an organized and collective manner. This has been implemented through the incorporation of a community-based organization (KOPEL Bhd), in the form of a cooperative. The organization aims to expand local active involvement and participation in forest protection and restoration alongside providing income generation opportunities especially through tourism activities that support and strengthen the wider forest conservation efforts.

It should be noted that not all members of the community are involved in the village cooperative KOPEL Bhd, and many community members seek income and employment via other means such as through local government services, such as schools and health services or via local employment as farmers or fisherman. Even so, KOPEL remains open to all members across the community, and currently has 320 active shareholders, and employs more than 140 people across the community.

On average more than 140 people are employed monthly through KOPEL activities. This makes it the single biggest employer in across the entire Mukim Batu Puteh. This organization is considered a small to medium scale enterprise. Recent study shows KOPEL has the potential to expand and grow into a larger and more diverse ecologically sustainable social enterprise. What makes this organization unique is that on average 40% of its revenue annually is spent on forest and biodiversity conservation activities, whereby these activities are engrained in the fundamental ethos of this organization and are part of the product sold to visitors to this forest reserve.

Due to the long-term work of KOPEL in this forest reserve and the relationship established in this reserve between SFD & the community cooperative (KOPEL Bhd), the legal arrangement between the Sabah Forestry Department and KOPEL Bhd was formally recognized via an Memorandum of Agreement signed at the International Heart of Borneo Conference in November 2016. In parallel with this, KOPEL has been recognized at the State and National level with numerous certificates of achievements and awards, alongside this it has attained a number of international standards and awards and is an active partner with the SFD in the FSC certification process for PSFR.

The current management approach within Pin Supu Forest Reserve involving the Community Co-operative (KOPEL Bhd) continues to form a unique and active partnership and has developed to be a model for other forest management units both in the state of Sabah and across Malaysia. This is already impacting positively on other forest management units and for other communities. Each year, about 10 - 20 communities from across the region visited KOPEL for awareness or training programs. To strengthen this, in 2016, KOPEL Bhd established its own training center for Ecologically Sustainable Tourism particularly focuses on natural resource protection and environmental restoration.

In the PSFR case, both the Sabah Forestry Department and the local community surrounded by PSFR have stood to gain a lot from the current management approach and the unique partnership with the local community. Importantly the forest reserve itself has also gained through investments in restoration, research, and monitoring. This injection of funds comes both from the State Government and also from the long-term and sustainable revenue earned via tourism activities organized by KOPEL Bhd. Not surprisingly, even the wider public as gained a lot via increased awareness about forests, biodiversity and forest management in Sabah through the visitor activities in this reserve.

Although the aforementioned outcomes of the management approach of the Sabah Forestry Department are extremely positive (i.e. benefiting all stakeholders), monitoring efforts have been stepped-up to ensure the long-term success of the approach with the local community. One such example of this is the Hornarary Forest Ranger training program which was conducted in 2016. This has had a very positive effect on strengthening the involvement of the local community in monitoring and protection activities.

In addition to this, Sabah Forestry Department alongside KOPEL Bhd are continually looking at ways to build and strengthen the partnership with the local community to enhance forest protection. Providing increased opportunities to uplift the skills and capacity of the local community involving more monitoring data gathering, science, experiments and technology will be critical to the long-term sustainability of the partnership with the community surrounding PSFR. This includes enhancing opportunities for graduates to return to the community and contribute in meaningful ways and enhance forest and biodiversity conservation in this forest reserve and support efforts for PSFR to continue to be a model for other forest reserves and communities across Sabah and the region.

PART IV

MANAGEMENT PRESCRIPTIONS

4.1 MANAGEMENT ZONES

As stipulated in the Sabah Forest Enactment 1968, Pin-Supu Forest Reserve is classified as a Class VI Virgin Jungle Reserve with the main function to protect and conserve the forest ecosystem for forestry research and biodiversity conservation. With an area of 4,696 ha, most of the forested area was disturbed by timber extraction and partly was burnt during significant drought event in the past, leaving forest stands of different quality and dominated by pioneer and mid-seral trees.

Due to its location, the PSFR has a vital function in the broader landscape of the Kinabatangan Floodplain especially as a major link in the corridor of forest connecting the forest areas of Deramakot-Segaliud-Lokan to the Ramsar Wetlands in the lower estuarine reaches of the Kinabatangan River. In this respect, the PSFR provides one of the largest contiguous forests along the lower Kinabatangan, next to Gomantong-Batangan forest area. At the landscape level, PSFR provides a sanctuary of significance due to its size and the relative difficulty of access. On its own and in terms of its innate function, the PSFR provides a highly diverse array of ecosystems and habitats, with its own unique biodiversity.

In the context of this landscape scale, local communities that have been accessing and utilizing the rivers, lakes and forests along the Kinabatangan both traditionally and historically. Currently the forest is fringed by community farmland adjacent to the boundary and geographically through the centre of the reserve, essentially dividing this reserve into two parts. In addition to this, the fringe on the north and north-east of the reserve are bounded by large-scale industrial agriculture activities.

The objective of the Pin Supu Forest Reserve management strategies is to develop a protection and conservation approach that involves the participation of the adjacent local community in a planned and orderly manner. In this case, the Sabah Forestry Department has an ongoing long-term initiative that involves the local community, generates employment and bring economic benefits from this forest reserve in a manner that promotes the conservation of the forest, its function, and the biodiversity within.

This approach has supported the development of a community organization in the form of a co-operative – that being the Batu Puteh Community Tourism Cooperative – KOPEL Bhd. The cooperative is self-funded vis a vis tourism activities. Tourism activities have been established not only to provide income and employment for the local community but to provide direct conservation and restoration interventions that support the monitoring protection and conservation of this unique forest reserve.

4.1.1 Ecosystem Management Objectives

The ecosystem management objectives for Pin-Supu FR are as follows:

- To provide high levels of protection for the natural processes that sustain habitat types representatives of the reserve;
- To maintain biological diversity through emphasis on the protection and preservation of the uniqueness, rarity or fragility;

- To maintain a sound ecosystem monitoring programme and regularly report the state of the ecosystems in the reserve;
- To work jointly with other local government agencies and communities in the surrounding area to achieve local sustainable resource use, in order to maintain the reserve ecosystem integrity and resource diversity.

4.1.2 Management Zones for Pin-Supu Forest Reserve

The management zones within the reserve have been simplified to be divided into conservation-zone and community-used zones (Figure 22). A summary of the management zones with reference to their conservation objectives is given in Table 4.1.1. Preparation and implementation of an annual work plan for each activity stipulated in the conservation strategies will be necessary for managing PSFR.

Table 4.1.1 Summary of management zones in Pin-Supu Forest Reserve.

Zone	Programme
Conservation	Protection of lowland forest ecosystems
	Maintaining biological diversity
	Monitoring of key conservation target species
	Sustainable harvesting of forest produce (planting material collection for forest restoration)
Community-use	Sustainable harvesting of forest produce (fish and edible bird's nest) Eco-tourism

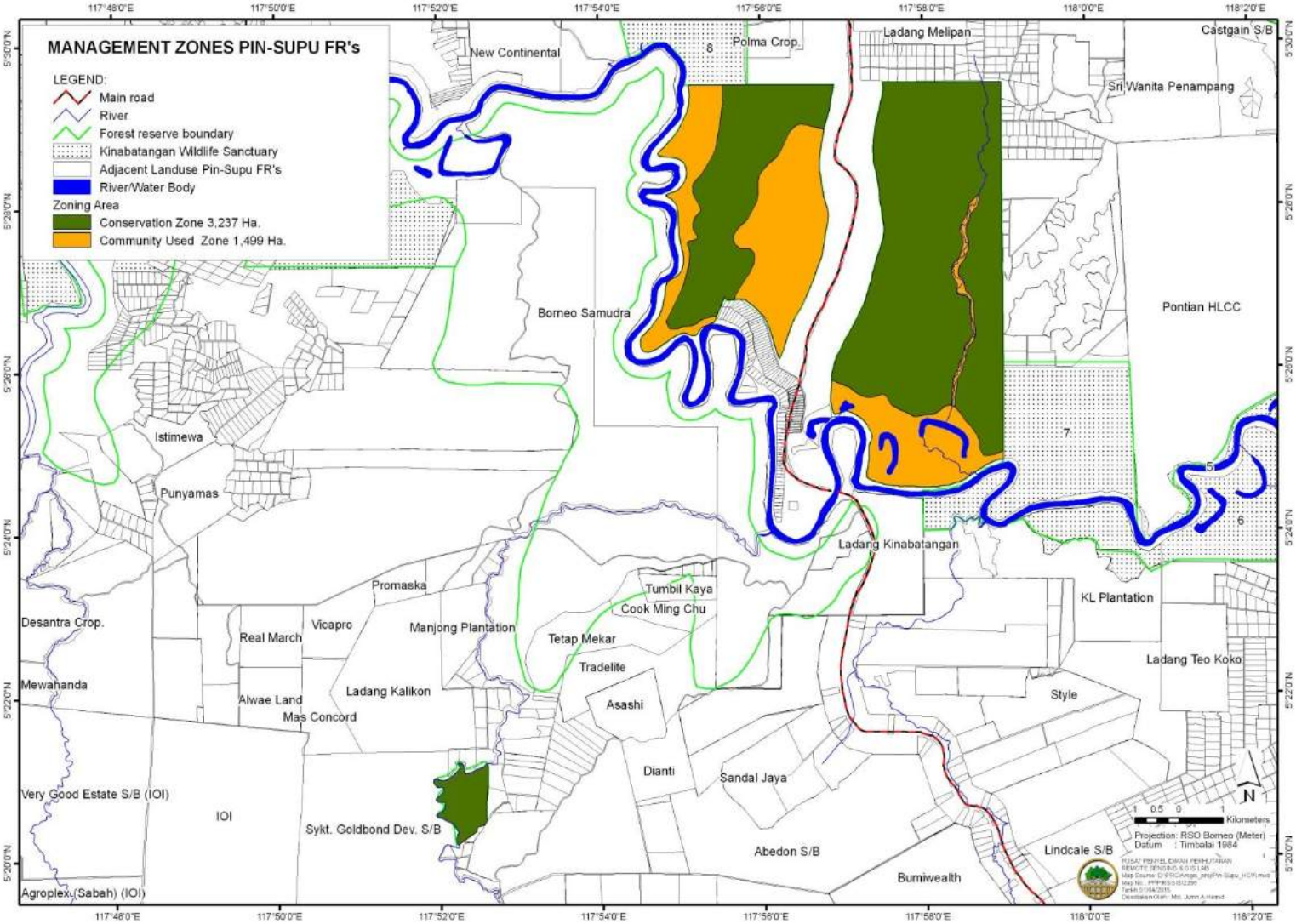

Figure 22: Management zones of Pin-Supu FR.

4.2 BIODIVERSITY CONSERVATION

4.2.1 Protection of Lowland Forest Ecosystems

4.2.1.1 Monitoring Forest Health and Function

To monitor forest health and overall functionality of the existing forested area, establishment of long-term ecological research plots or permanent sample plots (PSPs) is a scientific approach for documenting detailed changes in forest structure and composition. The output of the plot could provide baseline information on distributions of species and habitats of a particular site. The long-term monitoring activities such as assessment of the standing trees of these plots, would provide valuable information on the changes in plant diversity and richness, growth, mortality, regeneration and dynamics of the sampled forest. This information on forest changes is an indicator of forest health and functionality.

The results of systematic monitoring of PSP over the previous management period proved that the ongoing technique was susceptible to damage by wildlife, especially elephants, which destroyed the PSPs established by Forest Research Centre in 2009. The two 1.2 ha sampling area that located adjacent to Danau Kaboi consist of 30 composite blocks (20 m × 20 m per block) per plot and utilized numerous PVC posts to demarcate the plot boundary. All the posts were removed and trampled by the elephants. Based on these outcomes, the management team is adopting the 20 m radius circular plot with only one PVC post that indicates the plot center and re-established the plots.

In April 2015, ten (10) new PSPs were established to monitor forest health and functionality. The management team will establish more PSPs throughout the management period to increase spatial data and improve accuracy of information regarding forest ecosystems. The details of monitoring protocol are described in Section 4.4 and Appendix VII.

4.2.1.2 Monitoring Extent of Lowland Forest Ecosystems

Based on the results of monitoring the effectiveness of monitoring approach and indicators the forest management plan revision has recommended enhancements to the techniques to include broader landscape level and ecosystem level monitoring. The management of the reserve, based on an ecosystem approach, essentially requires inventory and monitoring of large areas of natural landscapes at fine scales. Increasingly, remote sensing combined with GIS are used as a management tool to examine spatiotemporal processes, such as old growth forest, disturbance, and species dynamics. Ultimately, this tool is anticipated to produce a stand-based mapping of vegetation types and structure as the baseline for monitoring purposes in the management of this conservation area. Though the methodology of this monitoring is still under research within Sabah Forestry Department, it is anticipated the tool will be utilized for forest ecosystem monitoring in PSFR area. This will be deployed during the management plan period 2018-2027.

4.2.1.3 Monitoring of Key Conservation Target Species

The formulation of a monitoring programme for the four conservation target species as described in section 2.3 is required to evaluate the conservation status of these species. This monitoring program will be one of the objectives and activities in the proceeding management period. Monitoring at species or population level in order to measure trends may be most relevant if the management strategies are able to maintain population and viability of the three target species. The details of monitoring protocol are described in Section 4.4 and Appendix VI.

Table 4.2.1 The list of permanent sample plot that were established in April 2015 in Pin-Supu Forest Reserve.

Block	Plot	Lat	Long	Altitude (m)	Forest Condition
C	PSU 1	5 20 35.2	117 52 26.2	112	Regenerating/advance growth Mixed Dipterocarp Forest
C	PSU 2	5 20 39.9	117 52 28.1	89	Regenerating/advance growth Mixed Dipterocarp Forest
B	PSU 3	5 26 28.6	117 55 08.1	23	Secondary Forest (Seasonal Freshwater Swamp Forest)
B	PSU 4	5 26 32.8	117 55 10.1	7	Secondary Forest (Freshwater Swamp Forest)
B	PSU 5	5 26 30.1	117 54 34.4	15	Secondary Forest (Lowland Mixed Dipterocarp Forest -Alluvial Terrace)
B	PSU 6	5 28 32.7	117 55 05.3	54	Regenerating/advance growth Lowland Mixed Dipterocarp Forest (limestone outcrops)
A	PSU 7	5 25 01.2	117 57 41.8	25	Secondary Forest (Seasonal Freshwater Swamp Forest)
A	PSU 8	5 25 13.5	117 57 36.4	20	Secondary Forest (Seasonal Freshwater Swamp Forest)
A	PSU 9	5 29 24.8	117 57 48.6	31	Regenerating/advance growth Mixed Dipterocarp Forest
A	PSU10	5 29 28.2	117 58 54.1	19	Secondary Forest (Seasonal Freshwater Swamp Forest): Talisai Paya Swamp

4.2.2 Maintaining Biological Diversity & Forest Function

4.2.2.1 Forest Restoration (Tree Planting)

Forest restoration has become an important management strategy in many conservation efforts. Restoration activities such as silviculture activities or the planting of indigenous trees attempts to re-establish and enhance forest structure and diversity, thus improving habitat for wildlife and general ecosystem function. This practice has become a common approach in combating the negative impacts of forest degradation, to restore forest system function and productivity.

Based on the monitoring results of previous restoration efforts, combined with the current forest condition as shown in Figure 9 (p20), about 1800 ha of the reserve is totally degraded due to timber extraction and forest fire in the past. Much of the severely degraded area of PSFR are within permanently waterlogged swamp and seasonally flooded alluvial

and mixed alluvium-peat soil associations. These conditions are very difficult for restoration steps such as enrichment planting with tree species. This is mostly due to the fluctuation of water levels on site, whereby these low-lying sites can be completely inundated with water depths from 50cm to 5m deep. This is also in-part due to saturated soil conditions and the unsuitability of traditional tree planting methods on these sites.

Other highly degraded sites within the reserve are very scattered. Some of these sites occurring on steep sandstone ridges in the Laab Hill complex, and along the foot of the Supu Limestone Complex. With other highly degraded scattered along the meander-belt zone and areas adjacent to Kaboi Lake.

The Restoration Management Prescription for forest restoration in PSFR will take-on a mixed approach, combining "vine liberation treatments" with tree planting. Where traditional tree planting methods are difficult to carry out, due to site limitations such as hydrology, or where previous attempts have experienced poor success using traditional planting methods, a precautionary and experimental approach will be undertaken, combining planting trials, monitoring and further research and development of restoration techniques for these unique forest habitats.

In designing forest restoration activities, the measures will include an approach based on local site characteristics and the development of method best suited to these conditions. Simply applying on a broad scale, the standard methods from other forest reserves in Sabah such as Mixed Dipterocarp forests will be avoided in the case of PSFR. A standard approach for restoration design will include the following key components

- ***Identify what limits natural recovery—***It is necessary to identify potential biotic and abiotic stresses that limit recovery and then developing restoration solutions to support or enhance the natural recovery.
- ***Using local species—***Local species have co-evolutionary animal linkages which consists of a web of interactions not only between plant species but also animal species. Exotic species that could accidentally become widespread and invasive should be avoided.
- ***Conserving genetic variation—***Using local tree species or neighboring forest communities may reduce deleterious consequences on the genetic integrity of the local genotype (genetic erosion of a local gene-pool) and the genetic diversity of the local population.
- ***Creating diverse vegetation structure—***The aim is diverse vegetation structure in any habitat restoration project.
- ***Monitoring & Feedback Loops to improve success—***The progress of restoration can be evaluated through monitoring of planted trees and natural flowering and fruiting in trees after planting using a silvicultural-approach. Likewise, an ecological/environmental approach for the monitoring programme should be established to evaluate changes in trophic linkages between other plant or wildlife species, soil productivity and hydrological processes, and functional groups.
  (based on methodology by Lamb & Tomlinson, 1994)

In this restoration programme, the following activities are required to achieve the overall aim in enhancing the protection of the lowland mix dipterocarp forest and seasonal freshwater swamp forest ecosystems:

- ***Restoration area*** – The feasible area for forest restoration activities is targeted to cover at least 500 ha. This will include a mix of restoration approaches on a mix of degraded sites such as Lowland Mixed Dipterocarp Forest, Meander-Belt Dipterocarp Forests, Limestone Dipterocarp Forest, Seasonally Flooded Alluvial Forest and Permanent Freshwater Swamp Forests as well as Peat Swamp Forests.
- ***Species selection*** – Tree species given in Appendix III that are found in Pin-Supu FR are suitable for restoration programmes. The large wildlife sanctuary to the north (Lot 8 LKWS) and east (Lot 7 LKWS) is an appropriate potential donor site, especially when used for seed and wildling collection. Enrichment of forests with species found in this area prior to logging and fire events will be of vital importance to ensure the original structure and function of the respective forest ecosystems.
- ***Procurement of planting materials –*** The successful implementation of any planting programme, be it forest restoration or forest plantation is dependent on the continuous availability of planting materials. Initially, locating and marking potential seed production stands in areas mentioned above prior to regular phenological observations could be conducted to determine patterns of flowering and fruiting within the Pin-Supu FR. In this exercise, the establishment of a nursery is necessary at the site to raise seedlings prior to planting.

  The nursery stage and the techniques applied in raising healthy seedlings are crucial in ensuring success during transplanting to the field. Planting materials derived either from seeds or wildlings are raised in polyethylene bags. This technique has been proven effective for reintroducing tree seedlings where harsh mirco-environmental conditions may prevail at a restoration site. As it is important to prepare seedlings for outplanting, preconditioning or acclimatization of the seedlings (hardening process) to higher light regimes and periods of water stress is necessary for improving seedling survival during field planting.
- ***Silvicultural treatment and site preparation*** – On degraded sites, weed species (climbers or vines, invasive trees) may predominate limiting the colonization or establishment of tree species. The removal of this biotic stress is an important start for preparing the site for planting. Usually, this is carried out manually through selective removal of the weeds by cutting them back or with herbicides. Light adjustments, another manipulative technique that involves the removal of above ground biomass (secondary species tree cover), depending on the light requirements of the planted seedling, are carried out to facilitate tree growth or natural regeneration.
- **Planting –** The planting design is a key aspect in creating a stand of complex structure. Current practices similar to mixed dipterocarp forest (MDF), require many species (fruit trees, timber trees, mid-storey, upper-storey) to be planted

consecutively but selected based on their preferential light environment. The current restoration practices of enrichment planting in MDF forests usually require the planting of tree seedlings in a cluster and at a higher density of seedlings (200– 1,000 planted trees/ha), depending on the cover of the forest. In open degraded sites, that are chocked by herbaceous plants and climbers, the planting of a mix of pioneer tree species is practiced at a higher density planting (900-2500tree/ha) to help rapidly establish a closed-canopy in order to shade-out the competing plant species.

The use of fertilizers is also encouraged to assist the initial establishment of planted seedlings. This planting exercise should be carried out during the favourable season or rainy season to increase seedling survival.

- ***Maintenance*** – Weeding around planted seedlings is necessary to prevent seedlings from being suppressed by secondary vegetation. Secondary vegetation, such as woody vines, shrubs and sedges, usually has higher relative growth rates compared with many forest tree species. Therefore, the frequency and duration of many maintenance regimes are dependent on the growth of planted seedlings, to the stage where the plant can competitively exclude or suppress weed species.

As describe in section 2.4, to date about 350 ha of severely degraded areas have been planted with almost 350,000 tree seedlings that derived from 33 native tree species in Block A & Block B of PSFR.

4.2.2.2 Silvicultural Treatment

Silvicultural treatment (otherwise known as "vine liberation treatment") is essential in areas where the forest is severely overwhelmed or mostly covered by herbaceous and semi-woody climbers. The persistence of thick climber cover has been observed to slow down the process of natural forest regeneration. The objective of silviculture treatment is to create favorable conditions for the regeneration and growth of climax trees species and enhance the structure of the forest.

Climbers species and herbaceous plants that are removed in the silviculture treatment process are considered at low risk to lose within the management unit, due to the extent of their cover and the silviculture protocols employed. Notably, this treatment is one-off and designed to provide short-term additional benefits which include in increasing light quality for both the naturally regenerating trees and planted tree seedlings. The treatment has been observed to reduce competition and consequently improve tree growth, enhance the natural regeneration of tree species within the site, and as well as to reduce climber regeneration in the site though not necessarily eliminating them.

Even though a "blanket" treatment is applied to climbers, the focus of the prescribed treatment is the removal of high-density vines, that proliferate in abundance in areas that once severely disturbed by past logging activities or affected by forest fire. These high-density vine thickets have been observed to severely diminish the natural regeneration of

mid & upper canopy layer tree cover and hence, impacting severely on plant diversity, habitat richness and carrying capacity.

It should be noted that the treatment also includes steps to avoid the removal of climber species listed for their high conservation value, for example *Uncaria* spp. (Rubiaceae) and *Willughbia* spp. (Apocynaceae), which are important food source for wildlife, especially for primates, alongside certain species of *Calamus spp*. (rattans). Generally, procedures also specify that large woody liana that have more than 10 cm stems in diameter should be retained. Therefore, silvicultural activities in PSFR area is designed primarily for the overall improvement of forest composition and structure, and to reduced areas of over-abundance of weedy climbers in specific sites and their negative impact on natural forest regeneration.

Table 4.2.2: The list of silviculture working blocks from 2009-2015 in Pin-Supu Forest Reserve

Block name	Year	Area (ha)
Block A Biandong	2009	100
Block A Biandong	2010	100
Block B Biandong	2010	100
Block B Biandong	2011	100
Block D Kg Perpadauan	2012	200
Block E Laab	2013	100
Block F Laab	2014	100
Block C Tungog	2017	171
Block F Laab	2018	274
Total		**1,245 ha**

It should also be noted that the presence of these endemic flora in this protected area does not ensure the long-term stability of population. Therefore, long-term monitoring activities by using permanent sample plots will be critical to determine long-term population trends, such as the increases or decreases related to human disturbance or severe weather events or catastrophic events such as forest fire.

Thus far, 1,245 ha of forest that consist of six working blocks have had silviculture treatment between 2009 – 2018 (Table 4.2.2).

Based on the results of monitoring the effectiveness indicators during the previous management plan period it is recognized that the establishment of permanent sample plots (PSPs) within the restoration sites will be vital to record changes to the forest health, forest diversity and forest ecosystem within these sites. In this case Permanent Sample Plots will

be established in the silviculture sites to monitor the effectiveness of these interventions. This monitoring will be compared to control sites to further enhance the effectiveness of this technique.

4.2.2.3 Removal of Invasive Species

Currently, there is only one major invasive species threatening the HCV within Pin-Supu Forest Reserve. This invasive species is commonly known as Salvinia while in North America, it is known as Giant Salvinia (*Salvinia molesta*). Salvinia is a floating fern that spreads through wetland ecosystems especially causing problems in closed waterbodies such as lakes and swamps or slow-moving waterways. Salvinia originates from South America and is listed in the top-100 most invasive species on our planet based on the IUCN Invasive Species Data Base. This plant grows and reproduces rapidly forming large infestations and floating mats that cover the entire waterbody. It is extremely difficult to eradicate or manually by hand, due to the volume and wet weight of the floating mats.

In small ponds and streams, it is possible for this weed to be kept under-control by hand before it becomes widespread and difficult to eradicate. The plants can be physically removed from the surface of the water and left to dry-out into dry compost. Out of the water, the plant dries out and decomposes rapidly similar to leaf-litter on the forest floor.

A number of methods can be employed to eradicate the Salvinia, including mechanical, chemical or biological control. In the case of Pin-Supu Forest Reserve the partner organization KOPEL Berhad has been working since 2004 to eradicate Salvinia from the Tungog Lake. In 2007, KOPEL managed to completely clear the Tungog Lake and keep it clear for seven years till 2013 utilizing a locally designed semi-manual-mechanical method with small boats. In 2013 with the drastic down-turn in tourist arrivals the weed removal was halted for 5 months resulting in the subsequent re-infestation of the Salvinia at a large scale. At present the Salvinia mat covers 90% of the Tungog Lake.

A collaborative program between Sabah Agriculture Department, the Community Co-operative KOPEL Bhd and the Sabah Forestry Department has established an MOU to release the Biological Control on the Tungog Lake. In this case the biological control agent is a weevil (beetle) *Cyrtobagous salviniae.* This is a host specific organism – meaning it cannot survive without its symbiotic relationship with the Salvinia plant. Extensive research established by MARDI (Malaysian Agriculture Research and Development Institute) established the release of this beetle in Peninsular Malaysia in 1998. In the Sabah case, a further three years of research, investigation and quarantine has established Sabah State Weevil Breeding Facility at the Agriculture Research Centre in Tuaran in 2016. Final, approval for release on Tungog Lake was provided after the outcomes of the FSC Audit process in September 2018. Conditions for release revolve around release protocols and monitoring protocols. The first release of this biocontrol agent on Tungog Lake was done on October 27, 2018. The process is being closely monitored by KOPEL Bhd in partnership with the Sabah Agriculture Department and Sabah Forestry Department.

4.3 COMMUNITY FORESTRY

4.3.1 Objectives

The objectives are as follows:

i. To enhance adjacent community's participation in the management of PSFR.
ii. To develop and manage forest resources in a sustainable manner especially within the community forestry zone.
iii. To enhance corporation between SFD and communities in forest protection activities.

4.3.2 Strategies

In the case of Pin-Supu Forest Reserve an ongoing long-term relationship has been established with the local community. This began with a pilot program in 1997 via the MESCOT Initiative. In 2003, the community associations formed through this initiative incorporated the community organization KOPEL Berhad as a cooperative, which has at present 320 members from the surrounding community and acts as formal legal entity for conducting community-based tourism and community forestry activities within the Pin-Supu Forest Reserve. With the endorsement of the first Forest Management Plan in 2008 an agreement (MOU) was established with KOPEL Berhad to co-manage the Pin-Supu Forest Reserve. This was in part due to the already long-standing input by this community group into the protection, conservation and restoration of forests in PSFR.

In 2016 the MOU between KOPEL Berhad and the Sabah Forestry Department was upgraded to a Memorandum of Agreement signed with the Chief Minister of Sabah at the Heart of Borneo Conference in November 2016. This arrangement is conditional and binding requiring KOPEL Berhad to:

a. collect entrance fees from visitors entering the reserve for ecotourism activities
b. monitor environmental indicators in support of SFM and HCVF
c. monitor all overall impacts within the reserve
d. support surveillance & protection and enforcement activities
e. provide regular feedback and reports to the Sabah Forestry Department
f. enhance community understanding and sense of appreciation and conservation of this unique forest reserve.

In this MOA agreement, KOPEL Berhad was given the license to conduct forest management activities that can generate sustainable income to support the management of the reserve such as:

a. eco-tourism activities,
b. forest restoration activities
c. forest monitoring and research activities
d. management of edible bird nests within the Supu Limestone Complex

This unique situation provides a market-based mechanism through tourism to sustainably fund ongoing management and restoration of PSFR. KOPEL Berhad itself is a hybrid organization being a community-based conservation oriented social enterprise funded through tourism business ventures and other aligning strategies. KOPEL Berhad itself has a long-term strategic development plan that includes strengthening relationship with Sabah

Forestry Department, enhancing benefits for the PSFR via developing further strategies to improve monitoring, research, restoration activities. This is all being co-developed in the context of improving internal administrative and management capacity at the community level and providing meaningful long-term employment opportunities at the community level. In this process, KOPEL has complied to all Malaysian legal requirements in terms of employment, minimum wages, workplace health & safety and providing EPF & SOCSO benefits across the organization.

To further enhance and provide a check & balance in the management of this reserve, a Community Forestry Committee will be formed to manage and monitor community involvement and social forestry activities. The management structure of the committee is shown in the following chapter as Figure 24. The term of reference that provide a framework of function and authorities of this committee have been established. The chairman will report directly to the Director of Sabah Forestry and all minutes of discussion in the meeting will be made available to the Kinabatangan District Office and respective state assemblyman.

4.3.3 Community Forestry Activities

4.3.3.1 Forest Restoration

The Forestry Department has planned forest restoration including tree planting & silviculture activities within the PSFR. The local communities through the community organization KOPEL Berhad will be given the opportunity to secure the forestry work contracts as part of the community forestry programme.

4.3.3.2 Ecotourism

The management committee of PSSFM has developed several key ecotourism programmes in the reserve, including Tungog Camp and Supu Camp. At present, all ecotourism products found within PSFR are solely managed and operated by local communities through the community organization KOPEL Berhad.

4.3.3.3 Forest Protection

Active engagement of the local community in the activities above will create a presence within the reserve to enhance and support the Sabah Forestry Department in monitoring potential illegal activities within the reserve.

4.3.3.4 Environmental Monitoring, HCV Monitoring, Research & Development

As described in section 4.3.2 the community organization, KOPEL Berhad is obligated to provide feedback on monitoring to the Sabah Forestry Department. This is expected to contribute to the monitoring of HCV indicators as specified in section 4.4.2 of this document. At present, KOPEL Berhad has already developed research techniques since the year 2012 and staff capacity to monitor forest restoration sites via permanent sample plots (PSPs), monitor wildlife via camera traps and monitor water quality via water quality sampling techniques. This information is compiled and reported to the District Forestry Office. The scope of KOPEL's monitoring and research activities will be scaled up during the ongoing management plan period to ensure the development of skills within the

community and community organization to improve restoration impacts, mitigate environmental degradation, reverse species decline, and involve more effectively with the Sabah Forestry Department in SFM with PSFR.

4.3.3.5 Sustainable Harvest of Edible Bird Nest

As described in section 2.4, the community, through the community organization KOPEL Berhad is given the permission to manage Supu limestone caves and harvest edible bird nest sustainably.

4.3.3.6 Showcasing Community Forestry Partnerships

As described in the objectives for PSFR 1.1.3 & 1.1.5, the community forestry programme developed with the KOPEL is an important component of the Sabah Forestry Department's strategy to showcase and develop community forestry programmes across the state. In this case, KOPEL Berhad and the partnership with SFD in co-managing PSFR has an important role to raise awareness with other forest bound communities and to provide training or development facilitation to these other communities. This will be able to alleviate poverty, relieve pressure on forest resources and provide a supportive framework for SFM across the state.

4.4 HCV MANAGEMENT, MONITORING AND RESEARCH

4.4.1 Management Prescription

The HCV management prescription emphasizes the maintenance and enhancement consistent with the precautionary approach to minimize the risk of irreversible loss of the identified critical HCV's environmental and social values. The current management approach within this FMP consists of management restrictions and/or requirements during the implementation of community engagement, restoration & silviculture, nature recreation and biodiversity monitoring activities. This provides a broad guide for management are as follows:

4.4.1.1 Protection of Critical Values

- All designated HCV areas are managed under natural forest management and no timber extraction and conversion of forest is permitted.
- Demarcation of HCV boundaries on the ground and installing clear signage along existing road, foot trails and navigable rivers/streams indicating critical values, especially 50 m strip firebreak forest (HCV 4.3), and 30 m strip riparian reserve along both sides of the river (HCV 4.2). The HCV boundaries should also be clearly indicated on the map. In the event that any salt licks and potential nesting sites are found within the PSSFM area in the future, management measures for HCV 1.4 element to be applied.

- Conduct periodic patrolling and surveillance in all designated HCV areas to curb potential illegal activities, such as encroachment or poaching.
- Establish a long-term biodiversity monitoring system for critical forest ecosystem, flora and fauna (HCV 1.2, 1.3, 2 and 3). The monitoring of selected target species will be carried out through the deployment of camera traps. Camera trap systems provide the least disturbance to the target species, whilst providing the broadest coverage 24/7. This provides the most effective systematic monitoring. The installation of the camera traps is being expanded targeting specific species in specific sites based on outcomes of previous monitoring. Besides that, the equipment is being modified to extend the length of deployment to further minimize disturbance to the habitat and enhance the effectiveness of this approach. It is hoped that the modifications made in PSFR can be deployed in other forest reserves around the state. These improvements are based on the results of the previous monitoring efforts. Further improvements are expected to be made through the ensuing management plan period to further enhance the effectiveness of the monitoring approach.
- If the management team discovers high conservation value plant species (IUCN red list, prohibited species under Sabah Forestry Department, CITES and Sabah Wildlife Enactment; endemic) as listed in Appendix II, in permanent sample plots and nature trails in PSSFM area, they should be clearly marked on the ground and on the maps (HCV 1.2 & 1.3).
- Migratory pathways of wildlife on logging roads, along streams or wildlife trails in the forest should be marked on the map and kept to ensure wildlife are able to use it for movement within and between forest reserves (HCV 1.2, 1.3 & 2).
- The Forest Fire Management Plan is available and should be implemented and updated periodically (HCV 4.3).
- PSSFM management team is to constantly conduct meetings with the village representatives to mitigate any potential issues pertaining to the management of PSSFM area and made aware of the designated HCV elements in the FMU, although no HCV 5 element is indicated.
- Collaboration amongst other department, private land-owners and individuals surrounding the proposed wildlife crossing is crucial in setting up connectivity that will allow movement of wildlife between Block A and Block B of PSFR (HCV 1.2, 1.3, 2).
- PSSFM management team are to constantly conduct meeting with the village representatives to mitigate any potential issues pertaining to the management of HCV 6.
- Boundary of the Supu Caves in PSSFM area should be clearly marked on the ground and on the map (HCV 6).

4.4.1.2 Modifications or Constraints on Operation

- Any threats to the HCVs, especially related to HCV 1.2 & 1.3, that may be posed by operations or other activities in the forest will need to be identified and documented. Furthermore, the operation constraints in managing HCV areas and also addressing potential threats to the HCVs should also be examined.
- The decision to adopt any particular operation must be made based on the precautionary approach whereby sufficient data and analysis should be carried out to maintain critical values. On this measure, engagement of experts is encouraged.
- Any potential improvement of managing and monitoring of HCVs will be adopted for the next revision of the management plan.

4.4.1.3 Enhancement Efficiency and Effectiveness

- Field staff is required to attend training courses on plants and wildlife to further enhance their botanical and wildlife knowledge on species that are currently listed in the threatened, endemic and forestry prohibited lists to ensure they are not disturbed and also for monitoring purposes (HCV 1.2 & HCV 1.3).
- Enhancements of monitoring techniques based on the results of previous monitoring efforts is summarized as:
  a. Improvements to methods for establishing Permanent Sample Plots (PSPs) to monitor forest condition, forest ecosystem health and target species.
  b. Improvements to the camera trapping techniques including expanded deployment, targeted site deployment, targeted species deployment, enhancement of the equipment to improve effectiveness and minimize environmental impact.
  c. The introduction of remote sensing technology for landscape level forest monitoring alongside monitoring of forest health and effectiveness of restoration efforts.
  d. Enhancement of the monitoring systems around the invasive water weed *Salvinia molesta* and the introduction of the host specific biocontrol agent (beetle) *Cytobagous salviniae* – in partnership with Sabah Agriculture Department.
  e. The introduction of "drone technology" for monitoring of change in forest canopy cover, forest restoration effectiveness and more generally forest health.
- Update current biodiversity conservation status to the management team on the upgrading or downgrading of threat status (HCV 1.2 & HCV 1.3).

4.4.1.4 Restoration

- Forest restoration of indigenous tree species as part of the remedial action to increase forest structural diversity and mitigate any forest fire incidence spreading into the FMU core area, especially areas dominated with "lalang" grass and ferns along 50 m inside the boundary of PSFR (HCV 4.3).

4.4.2 Monitoring

- Periodic monitoring and control should be carried out to prevent potential encroachment in the buffer zone. Any signs of encroachment should be reported and dealt with immediate action (All HCVs).
- Quarterly progress reports in reporting of the progress of activities as prescribed in the approved Annual Work Plan (AWP), encompassing reporting of monitoring results of known HCV attributes.
- Periodical monitoring by conducting re-enumeration of the trees in the permanent sample plots is done once every three years to get an indication of changes in tree structure and species assemblages (HCV 1.2, 1.3, 2 & 3).
- Based on the results of wildlife monitoring in the previous management period, monitoring of endangered, endemic and migratory wildlife species will be enhanced via improvement to methodology – namely the camera trapping technique. These improvements will enhance the effectiveness of monitoring and provide a broader monitoring footprint with reduced impacts (disturbance) to wildlife, alongside richer detail in information – e.g. regarding conservation target species. Any changes in terms of population count or migratory pathways observed by either researchers or ground staff, the management team will be alerted to carry out further modifications. Similarly, this monitoring prescription also applies to endangered and endemic plants (HCV 1.2, 1.3 & 2).
- Long term monitoring of PSFR landscape using remote sensing technology is to be conducted once every three years to detect changes within the reserve and also vicinity areas. If threats are detected, precautionary approach will be taken and potential mitigation measures will be incorporated in the management plan (HCV 2). To enhance this method, the deployment of drones will be utilized to enhance the method and help detect changes and monitor forest health and finer scale through the management plan period.
- Long term monitoring of the effectiveness of restoration efforts will be developed in the management plan period such as monitoring the effectiveness of silviculture treatment and tree planting efforts. This is a result of outcomes of monitoring the effectiveness of monitoring approaches and recommendations to improve the effectiveness of the monitoring approaches.
- Ensure that all fire prevention procedures (monitoring, fire drills, public awareness campaign, etc.) to be practiced on a regular basis (at least once a year) and especially during the drought season (HCV 4.3).
- The designated HCV 6 should be jointly monitored and maintained by the PSSFM management team and local communities.

4.5 INFRASTRUCTURE MANAGEMENT

Prior to any construction of building structures within the project area, development plan of the project supported with technical site inspection, architectural and structural design of structures and associated engineering specifications on supporting structures, such as road, sewerage, drainage and plumbing according to acceptable government guidelines and standards should be prepared. Similarly, any construction of new roads and other associated structures, such as bridges and watercourses/drainage line crossing within the project area, the track alignment and their design are planned according to acceptable forestry standards. All infrastructure development plans should be submitted to the relevant committee in Sabah Forestry Department for approval.

The following schedule monitoring activities should be taken into consideration for all existing building or roads as part of an EIA monitoring process:

- inspect structure fitness and any serious observation should seek further advice from relevant authorities.
- monitor site changes (soil movement or drainage impediment).
- individual drainage facilities are to be inspected periodically for need of maintenance and repair works should start immediately.

For reporting and monitoring purposes, all schedule inspection reports are placed in the main base office.

4.6 FOREST PROTECTION

4.6.1 Forest Fire Prevention Programme

The goal of the programme is to create and use environmentally sound and economically efficient strategies that minimize the total cost to protect Pin-Supu FR from wildfire. This programme should maintain multi-faceted activities, such as fire prevention, detection, control and suppression activities, in order to provide effective protection against fire and maintenance of other forest values, such as water and watersheds, fishery, wildlife, recreation, aesthetic value, soil productivity and soil stability. The programme should encourage cooperation with public agencies with similar goals and inform the general public of the current and potential forest fire danger in the effort to protect people, property, and natural resources from wildfire.

- ***Prevention*** **-** Raising awareness among related public agencies and surrounding communities (oil palm plantation owners) regarding the importance and the fire protection programme of the reserve.

- ***Detection*** **-** Zoning area prone to forest fire for early detection and erecting an observation tower at a strategic point to monitor this threat. The department's statewide Fire Danger Rating System (FDRS) should be monitored constantly to detect fire especially during dry period.

- ***Preparedness*** -Training and provision of fire-fighting equipment. The following are to be employed:
    - Proper training in fire control techniques.
    - Conducting fire-drills and mock fire-fighting exercise.
    - Provision, proper maintenance and storage of the fire-fighting equipment. o Ensuring forest fire fighters remain safe and minimally exposed to risk.

- ***Suppression*** **-** Fire suppression strategy is aimed at swiftly suppressing any forest fire outbreak before it gets too serious or out of control. The following are to be focused on:
    - Identify easiest access points to any part of the reserve in order to reach target area in the shortest time.
    - Establish support units from SFD and related government agencies.
    - Identify sources that provide logistics support of machineries or transportation to assist during the fire outbreaks.

4.6.2 Forest Protection and Enforcement

Forest protection is a crucial component of the management to enforce the Forest Enactment 1968 and Forest Rule 1969 to ensure the security and protection of the reserve. For the protection of this reserve, scheduled surveillance programme including aerial, ground and river are implemented. All surveillance records are placed in the main base office.

The following main objectives are required in this programme:

- Outpost continuously manned to indicate the presence of forestry personnel;
- Boundary marking and maintenance
- Formulate enforcement strategies and carry out patrolling activities through air, land and by river, with sufficient provision of field equipment and communication facilities; and
- Enhance capacity of forestry personnel to remain competent in the enforcement activities through schedule development training and courses.

4.7 RESEARCH & DEVELOPMENT

Research will continue to be carried out in PSFR as per the recognized function of this forest reserve under the forest classification Class 6 and also as it is part of an on-going process in further understanding the tropical rainforest ecosystem. Data from R&D will contribute towards sustainable forest management in Pin-Supu FR, especially managing high conservation value areas and monitoring of biodiversity and ecosystem integrity.

As mentioned in previous sections of this document, the long-term monitoring studies on the dynamic of the various forest ecosystem and population of the selected conservation target species such as Bornean Ironwood, Keruing Kasigui, Seraya Timbau as

well as other selected species, such as proboscis monkey, clouded leopard and edible bird nest swiftlets will be incorporated as part of research and development programme. These studies will contribute towards better understanding of the population ecology and well-being of the selected flora and fauna in Pin-Supu.

Wildlife Management System to be enhanced through collaboration with wildlife experts, such as HUTAN, Danau Girang Field Centre, WWF and other research institutes. This is envisaged to support the wildlife monitoring carried out by KOPEL Bhd is currently on-going in the project area. Further to this, the development of fish diversity studies on existing ox-bow lakes is considered imperative and should be carried out with local or international experts as part of the R&D programme. Other research such as remote sensing to monitor forest condition, flora and fauna diversity, forest ecology, restoration and ecotourism will be carried out on an ad-hoc basis in collaboration with other agencies, universities and researchers from relevant institutions and agencies.

4.8 GENERAL PUBLIC AND STAKEHOLDER INVOLVEMENT

Southeast border of Block A of Pin-Supu Forest Reserve is adjoining with Lot 7 of the Lower Kinabatangan Wildlife Sanctuary (LKWS) and northern border of Block B with Lot 8 LKWS. However, most of Blocks A and B borders are surrounded with communal land and oil palm estate. Similarly, Block C of the reserve is mostly surrounded with oil palm estate.

Given the scale of the PSFR boundary with the local community and industrial agriculture companies, it is considered essential that adequate stakeholder involvement exists which encourages local government agencies, private sector, nongovernment organizations and the general public of Kinabatangan to participate and support the conservation programme of the reserve.

In this programme, the main threats as mentioned in section 2.6 can be addressed. Globally, the concepts of public and stakeholder participation are becoming increasingly common themes in project identification, work plans and project activities related to ecological research and natural resource management. This outreach effort will improve the understanding and appreciation of the significance of this forest reserve in the context of neighboring community and support the identification of methods for evaluating outreach methods to make any outreach efforts more efficient and effective. This process is one of the mechanisms to disseminate messages on environmental awareness to the general public.

PART V

IMPLEMENTATION & MONITORING

5.1 IMPLEMENTATION MECHANISM

5.1.1 Overview

The Pin-Supu Forest Reserve provides a unique case for sustainable forest management in Sabah. The key situation which separates the PSFR from other similar reserves in Sabah is the ongoing active involvement of the local community through an established community based organisation - in this case a cooperative - KOPEL Bhd. The community cooperative KOPEL Bhd. provides a highly suitable partner for the Sabah Forestry Department to support the long-term management of this reserve. Because of this situation, a key mechanism for implementing SFM in PSFR will capitalise on KOPEL's involvement.

The key advantages of involving the community cooperative KOPEL Bhd. (the MESCOT Initiative) in the long-term management of this reserve includes:

- The community cooperative is already well established and has remained committed to forest protection and conservation activities in PSFR for more than twenty (20) years.
- The community cooperative totally consists of local people from the surrounding three villages of the area. Supporting the economic development of rural indigenous residents is a key agenda of the State Government.
- Supporting this group not only supports the livelihood generation adjacent to the forest reserve (hence supporting the protection of the reserve) but also through the cooperative's core activities (ecotourism and habitat restoration), this program supports critical "awareness rising"– especially in the local community.
- The cooperative's core activities (ecotourism), and the involvement of volunteers, can be used to highlight the positive actions that the Sabah Forestry Department is taking towards sustainable forest management.
- This cooperative is highly organised and structured and is working towards a long-term vision of being able to sustainably fund forest habitat restoration in this reserve.
- This group has been working on forest fire fighting, monitoring and protection, and forest restoration activities for more than 10 years. No other local organisation can match the knowledge and experience of this group in dealing with SFM issues in PSFR.
- The community cooperative is self-funded and is unlikely to stop especially given the present rising income trend.
- The cooperative is in a strong position to generate its own funds to provide input into forest management and could in the long-term greatly reduce the cost of managing this reserve - to the Government of Sabah.

- Supporting these activities has the potential to generate substantial revenue for the Sabah Government. Establishing "smart partnerships" such as this is a key approach of the Sabah Forestry Department.

The Sabah Forestry Department is already supporting the community cooperative (KOPEL) through the development of a reception centre and jetty at the Kinabatangan River Bridge. Through the 9th Malaysia Plan, the SFD supports the ecotourism development and provides forest restoration contracts to the local cooperative.

Using these actions as a foundation to build on, the present partnership between SFD and KOPEL Bhd will be taken to the next level during the course of the second FMP - to involve this community-based organisation in the overall management of this reserve. This will be allowed to take shape in a step-by-step manner. The first straightforward step to take is to devolve the management of visitor activities in this reserve to KOPEL. At a later stage, if this proceeds smoothly and adequate revenue is being raised, KOPEL can step into a more holistic role of forest resource management in PSFR.

5.1.2 Management Structures

The proposed management structure for implementing this FMP will be similar to other FMUs, and based on a concrete "partnership" between the Sabah Forestry Department and the community cooperative KOPEL Bhd. The main authority responsible for this reserve will remain as the Sabah Forestry Department. The immediate Division responsible for overseeing the implementation from within the Sabah Forestry Department will remain to be the Kinabatangan District Forestry Office, with the support and input from other key Divisions in the Sabah Forestry Department such as the Forest Planning Division, Social Forestry Division (Community Forestry Section), Sustainable Forest Management Division, Forest Protection Section and the Project Management & General Services Division (Figure 25).

The implementers of management activities on the ground will continue, as it is at present, being jointly carried out by KOPEL Bhd. and the Sabah Forestry Department. In the future, KOPEL Bhd. is expected to grow financially into a position to take on additional forest management activities, most importantly generating its own funds to do so. In the long-term, this will greatly reduce the cost of managing this forest resource to the Government of Sabah.

The long-term staffing and logistical requirements of the reserve's management will eventually be arranged by KOPEL Bhd, similar to other FMU licensees. It is expected that in the future, KOPEL will appoint experienced personnel to look after; (a) boundary establishment and maintenance, (b) boundary surveillance, (c) forest restoration activities, (d) education & awareness activities, (e) collection & collation of environmental indicators and fire warning indicators, (f) forest fire monitoring (during dry periods only) and control, (g) extension activities, such as research development, (h) ecotourism activities, and (i) other conservation activities.

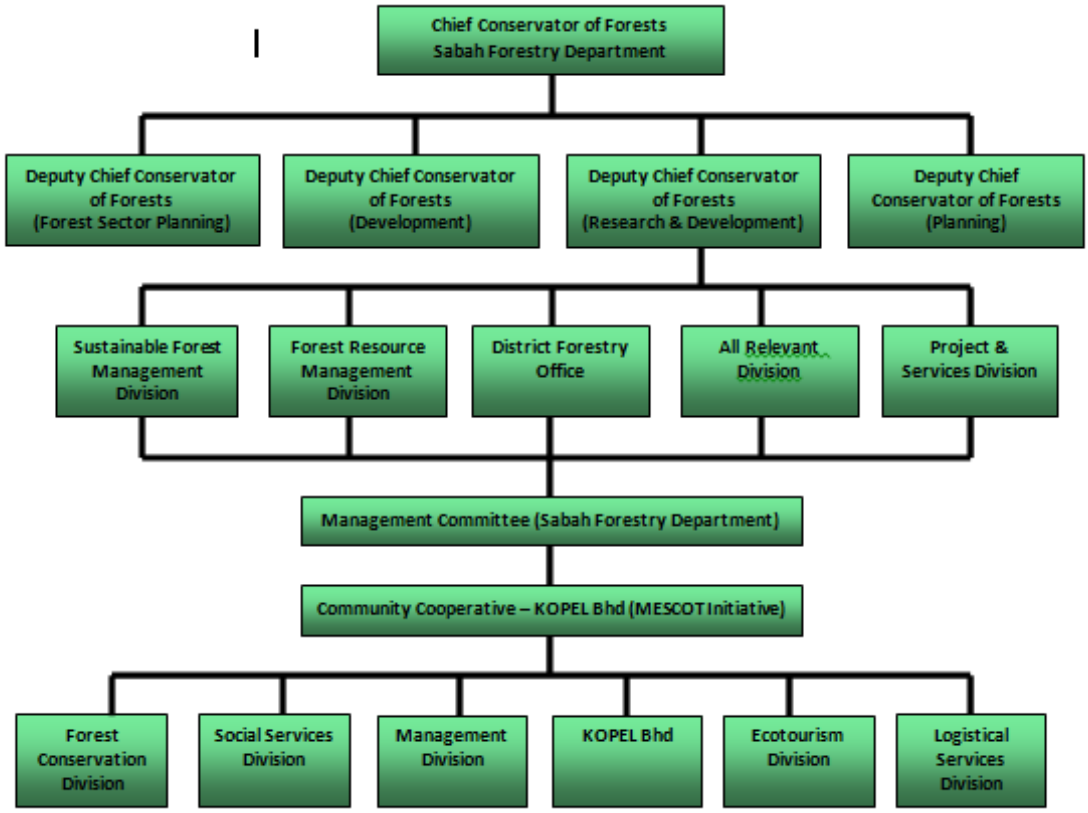

Figure 25 Management Organisation Chart for Pin-Supu Forest Reserve.

5.1.3 Legal Status

The partnership between the Sabah Forestry Department and the community cooperative KOPEL Bhd. will be legitimised in a formal agreement between these organisations. The exact format of this agreement is still "under discussion" as of the writing of this FMP and is an urgent matter that will be settled in the present management period.

It should be made clear that the agreement between the Sabah Forestry Department and KOPEL Bhd. is merely designed to support the management of this forest reserve. In doing so, there is no proposal to change the legal status of this reserve, or any of the enactments associated with its Governance. Any agreement with KOPEL Bhd. is only meant to legitimise the role of KOPEL and provide some immediate grounds for it to function more pro-actively to protect and manage this forest resource. Further to this, the authority of the Sabah Forestry Department will remain unchanged.

5.1.4 Involvement of Other Stakeholders

The involvement of other stakeholders is vital for the future success of sustainable forest management for Pin-Supu Forest reserve. This involvement will be encouraged to evolve and take shape in many forms, such as:

- Consultation, regular meetings, discussion forums or special committees. There are many agencies, organisations and activities in the surrounding district that impact the long-term conservation of PSFR. For example, the Kinabatangan District Action Plan Committee, the Kinabatangan District Tourism Development Committee and the Kinabatangan District Council.

- The involvement of other stakeholders will also take shape in the form of planned special events designed to raise awareness in the local community (schools, university, etc) and encourage more active participation in forest conservation activities. For example, tree planting programs.

5.1.5 Enhancing Management Capacity

Enhancing the management capacity of the Sabah Forestry Department at the Kinabatangan District office and also with KOPEL Bhd is seen as a vital step to ensure the long-term viability of the management prescriptions outlined in this Forest Management Plan. Without appropriate facilities, suitable machinery and effective people, it will be impossible to implement effective management of this resource.

The core management of this reserve, along with other valuable forest resources in the Kinabatangan takes place at the Kinabatangan District Forestry Office. The equipment, machinery and facilities at the District Forestry Centre need to be upgraded to increase the management capabilities of the Sabah Forestry Department – throughout the district. Requirements, such as vehicles, telecommunications, fire towers, access roads, trails and boats, all come under the purview of enhancing management capacity and will to put-in-place throughout the management plan period. Enhancing the capacity of KOPEL Bhd. is also a key agenda of this management plan.

5.2 TIME FRAME

This Forest Management Plan is for a period of 10 years and this document is the 2nd revision of the plan. The overall timing of management interventions is outlined in the management intervention timeline shown in FMP workplans in Table 5.2.1. A number of critical actions will need to be undertaken to establish an appropriate management environment for Pin-Supu Forest Reserve. The other actions are outlined in detail in the previous section (Part 3 Management Prescriptions) and are summarised in FMP Work Plan (Table 5.2.1).

Table 5.2.1 Work plan of management prescriptions and budgetary planning and funding disbursement for Pin-Supu FR 2018 – 2027.

MANAGEMENT PRESCRIPTIONS – PSFR	RESPONSIBILITY	RMK – 11			RMK – 12					RMK – 13		TOTAL BUDGET (RM)	FUNDING
	IMPLEMENTER	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027		
Community Forestry Programme (Management, Operations & Provision of Services)													
1. SFD to upgrade partnership with community cooperative KOPEL Bhd.	SFD/KOPEL Bhd												
2. KOPEL given role of managing all visitors in PSFR.	SFD/KOPEL Bhd												MoA was signed on Oct 2017
3. Establish "formal agreement" between SFD & KOPEL	SFD/KOPEL Bhd												MoA was signed on Oct 2017
4. Establish Permanent Overseeing Committee	SFD												
5. Periodical meeting													No cost incurred
Forest Protection													
Forest Reserve Boundary:													
6. Demarcate boundary	SFD												Completed in 2010
7. Demarcate problem boundary	SFD											30,000.00	Demarcation of excised area
8. Boundary maintenance (re-marking)	SFD											500,000.00	
9. Erect and maintain signboards	SFD											50,000.00	
10. Ground patrol along boundaries, part of core areas and HCV identified areas	SFD/KOPEL Bhd												No cost incurred
11. Remote sensing (obtain satellite images every three years and monitor land use changes within and adjacent of reserve)	SFD											60,000.00	
12. Aerial surveillance	SFD/KOPEL Bhd											150,000.00	
13. Water quality Monitoring	KOPEL Bhd												In kind - KOPEL

Management Zones													
14. Work with other agencies to establish buffer zone	SFD												No cost incurred
15. Monitor activities to ensure they are appropriate with zones	SFD												No cost incurred
Forest Fire Prevention & Control													
16. Obtain regular updates from Forest Protection Section SFD HQ	SFD											RM 0.0 – Key Dev.	RM 0.00 – No cost involved
17. Carry-Out education & awareness program adjacent community	SFD/KOPEL Bhd											To be identified	SFD & Other Partners
18. Maintenance of Electronic Weather Station	SFD											To be identified	SFD
19. Monitor FDRS Indicators & report to HQ if threat arises	SFD											RM 0.00	SFD
20. Prepare detailed map of fire risk zones within PSFR including areas identified as HCV 4.3 (forest providing barrier to fire)	SFD											RM 0.00	SFD
21. Prepared detailed fire control plan based on fire-risk map	SFD											RM 0.00	SFD
22. Ensure all modes of access open at all times of high risk	SFD											RM 0.00	SFD
23. Monitor water table in peat swamp forest	SFD/KOPEL Bhd											To be identified	SFD
24. Manning fire tower in strategic locations	SFD											RM 150,000.0 0	SFD
25. Upgrade boundary patrols and aerial surveillance when high risk	SFD/KOPEL Bhd											To be identified	SFD & Other Partners
26. Send staff for training, upgrade training and first aid	SFD/KOPEL Bhd											To be identified	SFD

27. Implement fire drills, mock fire exercises, Fire Awareness Day	SFD/KOPEL Bhd											To be identified	SFD & Other Partners
25. Clean & maintain all fire equipment in full working order	SFD											To be identified	SFD
28. Implement fire suppression (fire control) in case of fire	SFD/KOPEL Bhd											To be identified	SFD & Other Partners
29. Purchase & Upgrade fire-fighting equipment	SFD											To be identified	SFD

Forest Habitat Restoration													
30. Implement forest restoration in degraded area within the core areas and also area identified as HCV 4.3.	SFD/KOPEL Bhd											To be identified	SFD & Other Partners
31. Monitor silviculture treatments & tree planting work	SFD/KOPEL Bhd											To be identified	SFD & Other Partners
32. Initiate R & D (Experimental Sites) in PSFR & Limestone Forest	SFD/KOPEL Bhd											To be identified	SFD & Other Partners
33. Support other wetland habitat restoration work by KOPEL Bhd	SFD/KOPEL Bhd												RM 0.00 – No cost involved

Biodiversity Conservation													
34. Monitor extent of lowland forest ecosystem (part of HCV 3 management and monitoring): a) prepare stand-based map of all vegetation type; and b) monitor changes every 3 years intervals	SFD/KOPEL Bhd											To be identified	RM 0.00 – No cost involved
35. Forest health and functionality (part of HCV 3 management and monitoring): a) establish PSPs; b) renumerate trees every three years interval; and c) monitor changes over time	SFD/KOPEL Bhd											5,000.00	

36. Monitor key conservation target species (as of HCV 1.2, 1.3 & 2 management and monitoring): a) Bornean Ironwood; b) Keruing Kasigoi; c) Bornean Pygmy Elephant; and d) Proboscis Monkey	SFD/KOPEL Bhd											To be identified	RM 0.00 – No cost involved
37. Identify critical temporal use habitat (HCV 1.4) such as nesting area for migrating wildlife and saltlick area	SFD/KOPEL Bhd											To be identified	RM 0.00 – No cost involved
Research Strategy													
38. Carry-out wildlife population baseline studies & monitoring as part of HCV 1.2, 1.3 and 2 management and monitoring process.	SFD/KOPEL Bhd											RM 50,000.00	SFD (RMK12)
39. Carry-out forest restoration ecology study (soil & hydrological)	SFD/KOPEL Bhd											To be identified	SFD & Other Partners
40. Initiate study of fisheries population and related studies in ox bow lake as part of HCV 1.4 management and monitoring process.	SFD/KOPEL Bhd											To be identified	SFD & Other Partners
41. Initiate study of viability of edible bird nest collection as part of HCV 6 management and monitoring process.	KOPEL Bhd											To be identified	KOPEL Bhd
42. Initiate visitor perception studies	SFD/KOPEL Bhd											To be identified	SFD & Other Partners
Enhance efficiency and effectiveness													
43. Training and update plant and wildlife information especially those related to HCV 1.2, 1.3 and HCV 2.	SFD/KOPEL Bhd											9,000.00	
44. Periodical courses on sustainable forest management that relates to forest certification and high conservation value areas	SFD/KOPEL Bhd											9,000.00	
45. Training on safety and health of workers	SFD/KOPEL Bhd											9,000.00	

Infrastructure management													
46. Inspect structure fitness of drainage, buildings, road, bridges, and nature trails	SFD/KOPEL Bhd											To be identified	KOPEL Bhd

Visitor Management Intervention													
47. Collecting and returning entrance fees to SFD	KOPEL Bhd											State revenue	SFD & State Government
48. Monitor & collect revenue from entrance fees to SFD	SFD/KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd
49. Monitor visitor numbers comply with carrying capacity limits	SFD/KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd
50. (Monitor) KOPEL to prepare Risk Assessment & Safety Manual	KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd
51. (Monitor) KOPEL to prepare Standard Operating Procedures	KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd
52. KOPEL to manage and maintain sites within PSFR	KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd
53. (Monitor) KOPEL to prepare Interpretation Plan	KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd
54. (Monitor) Support marketing & Public awareness campaign	KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd
55. Visitor behaviour management	KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd

56. Signage, brochures, communication materials managed	KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd
57. Training of personnel	KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd
58. Site maintenance, trails, signage, cleaning	KOPEL Bhd											Future - Continuous	Annual Budget KOPEL Bhd
TOTAL (RM)												**872,000.00**	

5.3 BUDGET & FINANCE

There are three main components for financing the long-term management of the Pin Supu Forest Reserve.

- The Forestry Development Funds under the 10th Malaysia Plan is the current main funding for the management and operation of the reserve. Previous 10th Malaysian Plan were made available from 2011 – 2015. Initiate immediate management interventions. Refer to budget lines shown in work-plan for PSFR is outlined in Table 5.2.1.
- The community cooperative KOPEL Bhd. is already in a strong position to draw on external donor support for funding forest conservation activities such as forest habitat restoration, research and other conservation activities. This is likely to continue into the long-term for activities in this area.
- The community cooperative KOPEL Bhd. will also utilise ecotourism activities to generate income to fund forest management activities in PSFR. This is already taking place with the spin-offs of tourism income already being channeled into forest habitat restoration work. With the upgrading of KOPEL's position to be a more holistic forest resource manager, funds from tourism activities will eventually be dispersed into a more comprehensive forest management program.

The budgetary planning and immediate breakdown of funding disbursements for the Forestry Development Funds under the 11th and 12th Malaysia Plan is outlined in Table 5.2.1. These ongoing management interventions are expected to eventually be funded by the community cooperative's own fund-raising and income generation mechanisms.

5.4 MONITORING AND REPORTING

The implementation of this FMP will be followed up with monthly specific indicators and activities. The key areas for monitoring and subsequent reporting will include:

- The outcomes and achievements of management prescriptions require ongoing monitoring as per sections 4.2.2.1-Forest Restoration, 4.2.2.3-Invasive Species, 4.3-Community Forestry, 4.4-HCV1-4, 4.6.1-Fire Prevention, 4.7-Research & Development.
- The outcomes and achievements of visitor activities require ongoing monitoring as per details in section 4.3-Community Forestry, & section 5.1.2-Management Structure
- Any positive or negative impacts (enhancement or degradation) to the forests of PSFR as per sections 4.2.2.1-Forest Restoration, 4.2.2.3-Invasive Species, 4.3-Community Forestry, 4.4-HCV1-4, 4.7 Fire prevention, 4.8 Research & Development.

5.4.1 Monitoring Approach

Each management prescriptions will have its own specific set of indicators to determine if it is being carried out appropriately and effectively (refer to management prescriptions in the previous section of this FMP). Monitoring is necessary for an adaptive management approach and the successful implementation of ecosystem management. Applicable monitoring methods for the conservation targets are listed in Table 5.4.1. Outcomes and results will be included in the proceeding revisions of this Forest Management Plan document.

All knowledge, experience and outcomes will be reported to the PSFR Management Committee and the Chief Conservator of Forests. The District Forestry Officer (DFO) will be responsible for compiling and transmitting reports and recommendations to the Chief Conservator of Forests and Management Committee. For example, KOPEL Bhd. will be responsible for compiling and tabling reports on visitor figures and statistics, other environmental monitoring as prescribed above, as well as revenue raised in the process of forest recreation & ecotourism in the PSFR. KOPEL will be responsible for transmitting these reports to the District Forestry Officer.

5.4.2 Implementers of The Monitoring Programme

The monitoring programme is to be led by the Kinabatangan District Forestry Office in collaboration with KOPEL Bhd. Aside from collecting and compiling the monitoring data, SFD has to evaluate each of the conservation targets that have been proposed and subsequently report to all stakeholders involved in the conservation programme. Technical expert groups from the Forest Research Centre of SFD, Sabah Wildlife Department and Fishery Department are proposed to provide advice and support in the implementation of this management plan.

5.4.3 Plan Review

The first midterm review of this management plan will focus on the implementation and achievements in PSFR. The review includes:

- The implementation mechanisms,
- The coordination & management between key partners in the PSFR,
- The condition of the forest or changes (positive/negative) to forest health (soil, water, wildlife),
- Forest protection,
- The status and achievements of the visitor programs,
- The status and achievements of forest habitat restoration,

- The sustainability of funding mechanisms
- The timing (priorities) of interventions for the second half of the management period.

This process provides an opportunity to revise the implementation mechanisms, refine the FMP's management prescriptions or even introduce new interventions (in the case of changing circumstances). This will ensure that the management of PSFR is still in line with the objectives and vision for this protected forest area.

Table 5.4.1 Summary of the monitoring programme with reference to the conservation target on landscape and keystone species, including areas identified as HCV and also socio-economic values.

	Target	Indicator	Method	Frequency
Physical Environment	Water bodies and rivers	Water quality	Water physical and chemical analyses	Twice yearly
	Fire risk area (including HCV 4.3 areas)	Prolonged drought	Fire Danger Rating System	Monthly
Conservation of biological resources	Lowland forest ecosystems (pristine and disturbed, including HCV 3 areas)	No reduction in extent and quality	Remote sensing	Every 3 years
		Forest health	Establish long-term ecological research plots and monitor forest dynamic trend	Every 3 years
	Secondary vegetation	Burnt area reduced in size	Implement forest restoration programme	Annually
		Increased productivity of the restoration site	Silvicultural and ecological evaluation	Every 3 years
	Belian (*Eusideroxylon zwageri*): part of HCV 1.3 monitoring process	Population density remains consistent or increases	Permanent sample plots and population census	Every 3years
		Population health and reproduction satisfactory	Phenological observation	Annually
	Keruing Kasigoi (*Dipterocarpus validus*): part of HCV 1.3 monitoring process	Population density remains consistent or increases	Permanent sample plots and population census	Every 3 years
		Population health and	Phenological observation	Annually

		reproduction satisfactory		
	Bornean Pygmy Elephant (*Elephas maximus borneensis*)	Population density remains consistent or increases	Transect (direct sightings)	Annually
	Proboscis Monkey (*Nasalis larvatus*)	Population density remains consistent or increases	Transect (direct sightings)	Annually
Social	Community Forestry	Visitors to PSFR increase	Visitor arrival and appraisal	Monthly
		Eco-tourism revenue increase	Financial Analyses	Annually
		Local community acceptance of SFM	Participatory Rural Appraisal	Annually
		Sustainable harvesting of edible birdnest	Population count of edible birdnest species	Annually
	SFD Workers safety	Accident report	Report Analyses	Monthly
	SFD Workers competency	Preparedness and competency	Capacity building training, dialogue	Annually

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APPENDIX I

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APPENDIX II Summary of 12 Transects in Pin-Supu Forest Reserve

Description of size, soil association and forest ecosystem condition for 12 transects in Pin-Supu Forest Reserve (Nilus *et al.* 2006).

Block	Line	Distance (m)	Geographical Location	Soil Association	Original Vegetation	Disturbance	Vegetation Status
1	13	1000	N.5° 29' 30.77"; E.117° 58' 17.16"	Klias	Peat Swamp Forest	High	Higly Disturbed Peatswamp Forest & Seasonal Freshwater Swamp Forest
1	19	500	N.5° 24' 29.50"; E.117° 58' 00.49"	Tuaran	Mixed Dipterocarp Forest (Riparian Forest)	High	Early Secondary Forest: Previously Lowland MDF (Riparian)
1	20	500	N.5° 24' 29.56"; E.117° 57' 52.56"	Tuaran	Mixed Dipterocarp Forest (Riparian Forest)	High	Early Secondary Forest: Previously Lowland MDF (Riparian)
1	21	500	N.5° 24' 29.57"; E.117° 58' 08.71"	Tuaran	Mixed Dipterocarp Forest (Riparian Forest)	High	Early Secondary Forest: Previously Lowland MDF (Riparian)
1	22	300	N.5° 24' 30.63"; E.117° 58' 16.79"	Tuaran	Mixed Dipterocarp Forest (Riparian Forest)	High	Early Secondary Forest: Previously Lowland MDF (Riparian)
2	1	650	N.5° 26' 24.74"; E.117° 54' 58.93"	Tuaran	Mixed Dipterocarp Forest (Riparian Forest)	High	Early Secondary Forest: Previously Lowland MDF (Riparian)
2	2	650	N.5° 26' 19.35"; E.117° 54' 52.69"	Tuaran	Mixed Dipterocarp Forest (Riparian Forest)	High	Early Secondary Forest: Previously Lowland MDF (Riparian)
2	3	650	N.5° 26' 09.42"; E.117° 54' 39.56"	Tuaran	Mixed Dipterocarp Forest (Riparian Forest)	High	Late Secondary Forest: Previously Lowland MDF (Riparian)
2	4	750	N.5° 28' 30.23"; E.117° 55' 00.57"	Gomantong	Mixed Dipterocarp Forest & limestone vegetation	High	Secondary Forest: Previously Lowland MDF - Limestone vegetation
2	5	760	N.5° 28' 30.16"; E.117° 55' 08.67"	Gomantong	Mixed Dipterocarp Forest & limestone vegetation	High	Secondary Forest: Previously Lowland MDF - Limestone vegetation
2	6	750	N.5° 28' 56.03"; E.117° 55' 31.95"	Silabukan	Mixed Dipterocarp Forest (Lowland MDF Type B)	High	Early Secondary Forest: Previously Lowland MDF Type B
2	7	750	N.5° 28' 55.87"; E.117° 55' 40.16"	Silabukan	Mixed Dipterocarp Forest (Lowland MDF Type B)	High	Early Secondary Forest: Previously Lowland MDF Type B

APPENDIX III Floristic Composition

Table A. Familial composition of trees ≥10 cm recorded in Pin Supu SFM area (Nilus *et al*, 2007).

Forest type/Soil Asso.	Block	Line	Family	Density / ha	Basal Area / ha	Relative Dominance (%)	Diameter Cla (cm)									
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.059.9	60.069.9	70.0-79.9	80.0-89.9	90.0-99.9	>100.0
Early Secondary Forest: Lowland MDF Type B	2	6	Sterculiaceae	20.7	1.32	23.53	7.3	6.7	3.3	2.0	0.7	0.7				
			Euphorbiaceae	29.3	0.66	20.59	22.7	6.0	0.7							
			Lauraceae	8.7	0.77	12.12	4.0	2.7		0.7		0.7	0.7			
			Moraceae	9.3	0.26	7.02	8.0	0.7	0.7							
			Meliaceae	7.3	0.25	6.08	5.3	0.7	0.7	0.7						
			Dipterocarpaceae	4.7	0.32	5.54	1.3	0.7	2.7							
Silabukan			Datiscaceae	1.3	0.35	4.28			0.7				0.7			
			Alangiaceae	1.3	0.13	2.01	0.7			0.7						
			Magnoliaceae	2.7	0.03	1.55	2.7									
			Vernonia arborea	2.0	0.05	1.49	1.3	0.7								
			Rutaceae	2.0	0.05	1.45	1.3	0.7								
			Urticaceae	2.0	0.05	1.43	1.3	0.7								
			Leguminosae	2.0	0.03	1.25	2.0									
			Sapotaceae	2.0	0.03	1.20	2.0									
			Sabiaceae	0.7	0.08	1.19				0.7						

	Sapindaceae	1.3	0.05	1.19		1.3					
	Polygalaceae	1.3	0.05	1.14		1.3					
	Burseraceae	1.3	0.03	0.90	1.3						
	Tiliaceae	1.3	0.02	0.88	1.3						
	Rubiaceae	0.7	0.05	0.86			0.7				
	Verbenaceae	1.3	0.02	0.79	1.3						
	Rhamnaceae	0.7	0.04	0.72		0.7					
	Ulmaceae	0.7	0.02	0.56		0.7					
	Ebenaceae	0.7	0.02	0.50	0.7						
	Apocynaceae	0.7	0.02	0.48	0.7						
	Annonaceae	0.7	0.01	0.45	0.7						
	Myrtaceae	0.7	0.01	0.43	0.7						
	Lecythidaceae	0.7	0.01	0.37	0.7						
	Total	108.0	4.74	100.00	67.3	23.3	9.3	4.7	0.7	1.3	1.3

Forest type/Soil Asso.	Block	Line	Family	Density / ha	Basal Area / ha	Relative Dominance (%)	Diameter Cla (cm)									
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.059.9	60.069.9	70.0-79.9	80.0-89.9	90.0-99.9	>100.0
Early Secondary Forest: Lowland MDF Type B	2	7	Sterculiaceae	39.3	1.93	28.09	22.7	8.0	4.0	3.3	1.3					
			Euphorbiaceae	32.7	1.12	19.35	18.7	11.3	2.0	0.7						
			Dipterocarpaceae	11.3	0.40	6.83	6.7	3.3	0.7	0.7						
			Moraceae	11.3	0.24	5.47	10.0	1.3								
			Datiscaceae	2.0	0.49	4.66					1.3	0.7				
			Alangiaceae	6.7	0.21	3.77	4.7	1.3	0.7							
Silabukan			Burseraceae	7.3	0.13	3.36	6.7	0.7								
			Lauraceae	4.0	0.24	3.18	2.7	0.7			0.7					
			Sapindaceae	6.0	0.16	3.14	4.0	2.0								
			Sapotaceae	6.0	0.15	3.12	5.3		0.7							
			Fagaceae	2.7	0.24	2.77		1.3	0.7	0.7						
			Rubiaceae	4.7	0.11	2.33	4.0		0.7							
			Leguminosae	2.0	0.14	1.75		1.3	0.7							
			Rutaceae	3.3	0.07	1.63	2.7	0.7								
			Verbenaceae	3.3	0.07	1.61	2.7	0.7								
			Meliaceae	2.7	0.05	1.27	2.0	0.7								
			Unknown	1.3	0.06	0.94		1.3								

	Anacardiaceae	2.0	0.03	0.89	2.0					
	Annonaceae	2.0	0.03	0.86	2.0					
	Ebenaceae	1.3	0.05	0.83	0.7	0.7				
	Tiliaceae	1.3	0.05	0.83	0.7	0.7				
	Myristicaceae	1.3	0.03	0.69	0.7	0.7				
	Vernonia arborea	0.7	0.04	0.50		0.7				
	Elaeocarpaceae	0.7	0.02	0.39		0.7				
	Oleaceae	0.7	0.02	0.38		0.7				
	Lecythidaceae	0.7	0.01	0.32	0.7					
	Dracaenaceae	0.7	0.01	0.28	0.7					
	Bombacaceae	0.7	0.01	0.27	0.7					
	Indet	0.7	0.01	0.25	0.7					
	Magnoliaceae	0.7	0.01	0.25	0.7					
	Total	160.0	6.12	100.00	102.0	38.7	10.0	5.3	3.3	0.7

Forest type/Soil Asso.	Block	Line	Family	Density / ha	Basal Area / ha	Relative Dominance (%)	Diameter Cla (cm)									
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.059.9	60.069.9	70.0-79.9	80.0-89.9	90.0-99.9	>100.0
Early Secondary Forest: Lowland MDF (Riparian)	1	19	Tiliaceae	38.0	2.43	17.34	9.0	12.0	13.0	4.0						
			Sterculiaceae	30.0	2.64	16.59	8.0	3.0	12.0	4.0	3.0					
			Euphorbiaceae	38.0	1.03	11.72	30.0	5.0	1.0	2.0						
			Verbenaceae	15.0	1.14	7.55	3.0	3.0	6.0	2.0	1.0					
			Lauraceae	23.0	0.58	6.93	16.0	6.0	1.0							
			Rubiaceae	17.0	0.77	6.50	7.0	7.0	2.0	1.0						
Tuaran			Dilleniaceae	15.0	0.23	3.91	13.0	2.0								
			Moraceae	11.0	0.37	3.68	8.0	2.0		1.0						
			Dipterocarpaceae	2.0	0.52	2.49					1.0	1.0				
			Erythroxylaceae	3.0	0.44	2.37		1.0		1.0	1.0					
			Chrysobalanaceae	2.0	0.48	2.32					1.0	1.0				
			Myrtaceae	8.0	0.11	2.04	8.0									
			Apocynaceae	4.0	0.24	1.77	3.0				1.0					
			Flacourtiaceae	5.0	0.10	1.39	4.0	1.0								
			Hypericaceae	3.0	0.18	1.30	2.0			1.0						
			Sapindaceae	3.0	0.16	1.23	2.0			1.0						
			Oleaceae	4.0	0.08	1.13	3.0	1.0								

	Elaeocarpaceae	2.0	0.18	1.13			2.0			
	Leguminosae	3.0	0.12	1.07	2.0		1.0			
	Myristicaceae	3.0	0.11	1.04	2.0		1.0			
	Combretaceae	4.0	0.05	1.02	4.0					
	Ebenaceae	3.0	0.09	0.98	1.0	2.0				
	Sapotaceae	1.0	0.17	0.87				1.0		
	Anacardiaceae	3.0	0.04	0.75	3.0					
	Larauceae	2.0	0.04	0.56	1.0	1.0				
	Guttiferae	2.0	0.03	0.53	2.0					
	Melastomataceae	2.0	0.02	0.48	2.0					
	Monimiaceae	2.0	0.02	0.48	2.0					
	Unknown	1.0	0.03	0.31	1.0					
	Rutaceae	1.0	0.01	0.25	1.0					
	Symplocaceae	1.0	0.01	0.25	1.0					
	Leeaceae	1.0	0.01	0.24	1.0					
	Total	252.0	12.44	100.20	139.0	46.0	39.0	18.0	8.0	2.0

Forest type/Soil Asso.	Block	Line	Family	Density / ha	Basal Area / ha	Relative Dominance (%)	Diameter Cl (cm)									
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.059.9	60.069.9	70.0-79.9	80.0-89.9	90.0-99.9	>100.0
Early Secondary Forest: Lowland MDF (Riparian)	1	20	Euphorbiaceae	38.0	1.73	15.15	24.0	9.0	2.0		3.0					
			Tiliaceae	24.0	0.91	8.79	11.0	9.0	4.0							
			Rubiaceae	11.0	1.25	7.59	4.0		2.0	3.0	1.0	1.0				
			Lauraceae	17.0	0.88	7.23	10.0	3.0	1.0	2.0	1.0					
			Verbenaceae	13.0	1.04	7.09	3.0	2.0	5.0	3.0						
			Erythroxylaceae	9.0	0.97	5.99		4.0	1.0	3.0	1.0					
Tuaran			Sterculiaceae	16.0	0.62	5.93	7.0	6.0	3.0							
			Dilleniaceae	19.0	0.40	5.59	15.0	4.0								
			Myrtaceae	13.0	0.48	4.71	10.0	1.0		2.0						
			Flacourtiaceae	13.0	0.26	3.79	11.0	2.0								
			Leguminosae	7.0	0.44	3.30	3.0	3.0			1.0					
			Ebenaceae	7.0	0.29	2.68	4.0	1.0	2.0							
			Elaeocarpaceae	4.0	0.44	2.68	1.0	1.0	1.0		1.0					
			Sapindaceae	6.0	0.23	2.22	2.0	3.0	1.0							
			Dipterocarpaceae	7.0	0.18	2.22	6.0		1.0							
			Anacardiaceae	4.0	0.27	1.97	2.0	1.0		1.0						
			Annonaceae	4.0	0.23	1.78	3.0			1.0						

	Rutaceae	5.0	0.17	1.75	2.0	3.0				
	Oleaceae	4.0	0.20	1.69	1.0	2.0	1.0			
	Moraceae	5.0	0.07	1.30	5.0					
	Melastomataceae	2.0	0.20	1.28	1.0				1.0	
	Combretaceae	3.0	0.07	0.93	2.0	1.0				
	Sapotaceae	2.0	0.11	0.87	1.0		1.0			
	Unknown	1.0	0.11	0.66			1.0			
	Guttiferae	2.0	0.03	0.55	2.0					
	Polygalaceae	2.0	0.03	0.54	2.0					
	Alangiaceae	2.0	0.03	0.54	2.0					
	Lythraceae	1.0	0.04	0.38		1.0				
	Lecythidaceae	1.0	0.02	0.27	1.0					
	Burseraceae	1.0	0.01	0.26	1.0					
	Loganiaceae	1.0	0.01	0.24	1.0					
	Meliaceae	1.0	0.01	0.24	1.0					
	Total	245.0	11.74	100.20	138.0	56.0	26.0	15.0	9.0	1.0

Forest type/Soil Asso.	Block	Line	Family	Density / ha	Basal Area / ha	Relative Dominance (%)	Diameter Cla (cm)									
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.059.9	60.069.9	70.0-79.9	80.0-89.9	90.0-99.9	>100.0
Early Secondary Forest: Lowland MDF (Riparian)	1	21	Tiliaceae	93.0	4.04	33.68	47.0	29.0	13.0	2.0	1.0	1.0				
			Sterculiaceae	23.0	1.68	11.11	9.0	5.0	5.0	3.0		1.0				
			Verbenaceae	18.0	1.78	10.62	2.0	4.0	6.0	5.0	1.0					
			Rubiaceae	18.0	1.03	7.54	8.0	3.0	5.0	2.0						
			Euphorbiaceae	23.0	0.61	6.73	18.0	4.0		1.0						
			Dilleniaceae	23.0	0.39	5.83	22.0	1.0								
Tuaran			Leguminosae	10.0	0.27	2.96	8.0	1.0	1.0							
			Lauraceae	10.0	0.23	2.79	7.0	3.0								
			Guttiferae	7.0	0.36	2.74	3.0	2.0	2.0							
			Meliaceae	7.0	0.30	2.54	3.0	2.0	2.0							
			Apocynaceae	2.0	0.42	2.08		1.0					1.0			
			Flacourtiaceae	2.0	0.37	1.88				1.0	1.0					
			Ebenaceae	7.0	0.09	1.68	7.0									
			Myrtaceae	6.0	0.13	1.63	5.0	1.0								
			Anacardiaceae	5.0	0.16	1.56	3.0	2.0								
			Oleaceae	3.0	0.13	1.08	1.0	2.0								
			Moraceae	3.0	0.07	0.85	2.0	1.0								

	Sapindaceae	3.0	0.04	0.73	3.0						
	Sapotaceae	2.0	0.03	0.50	2.0						
	Polygalaceae	2.0	0.02	0.44	2.0						
	Annonaceae	1.0	0.03	0.33		1.0					
	Burseraceae	1.0	0.01	0.24	1.0						
	Myristicaceae	1.0	0.01	0.24	1.0						
	Dipterocarpaceae	1.0	0.01	0.23	1.0						
	Total	271.0	12.22	100.00	155.0	62.0	34.0	14.0	3.0	2.0	1.0

Forest type/Soil Asso.	Block	Line	Family	Density / ha	Basal Area / ha	Relative Dominance (%)	Diameter Cl (cm) 10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.059.9	60.069.9	70.0-79.9	80.0-89.9	90.0-99.9	>100.0
Early Secondary Forest: Lowland MDF (Riparian)	1	22	Sterculiaceae	56.7	3.37	25.94	23.3	8.3	16.7	8.3						
			Euphorbiaceae	68.3	2.45	23.83	31.7	30.0	6.7							
			Tiliaceae	23.3	1.33	10.43	8.3	5.0	8.3	1.7						
			Dilleniaceae	20.0	0.36	5.31	18.3	1.7								
			Moraceae	15.0	0.49	5.02	10.0	3.3	1.7							
			Rubiaceae	18.3	0.34	4.93	16.7	1.7								
Tuaran			Verbenaceae	10.0	0.65	4.83	1.7	3.3	5.0							
			Lauraceae	15.0	0.38	4.52	11.7	3.3								
			Oleaceae	10.0	0.39	3.63	6.7	1.7	1.7							
			Anacardiaceae	8.3	0.20	2.47	6.7	1.7								
			Rutaceae	3.3	0.38	2.38			1.7	1.7						
			Myrtaceae	8.3	0.16	2.25	8.3									
			Ebenaceae	5.0	0.12	1.45	3.3	1.7								
			Myristicaceae	3.3	0.04	0.77	3.3									
			Hypericaceae	1.7	0.06	0.57		1.7								
			Annonaceae	1.7	0.03	0.46	1.7									
			Fagaceae	1.7	0.03	0.43	1.7									

	Guttiferae	1.7	0.02	0.40	1.7									
	Meliaceae	1.7	0.02	0.38	1.7									
	Total	273.3	10.81	100.00	156.7	63.3	41.7	11.7						

Forest type/Soil Asso.	**Block**	**Line**	**Family**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**Diameter Cl (cm)**									
							10.0-19.9	**20.0-29.9**	**30.0-39.9**	**40.0-49.9**	**50.059.9**	**60.069.9**	**70.0-79.9**	**80.0-89.9**	**90.0-99.9**	**>100.0**
Early Secondary Forest: Lowland MDF (Riparian)	2	1	Euphorbiaceae	15.4	0.72	12.59	6.2	5.4	3.8							
			Sapindaceae	6.2	0.91	10.60		3.8				1.5	0.8			
			Tiliaceae	12.3	0.50	9.45	6.9	3.1	2.3							
			Rubiaceae	6.9	0.37	6.08	4.6	0.8	0.8		0.8					
			Flacourtiaceae	8.5	0.28	5.88	4.6	3.1	0.8							
			Myrtaceae	7.7	0.28	5.57	4.6	2.3	0.8							
Tuaran			Sterculiaceae	6.2	0.31	5.23	1.5	3.1	1.5							
			Lauraceae	5.4	0.33	5.10	2.3	1.5	0.8	0.8						
			Alangiaceae	8.5	0.12	4.46	8.5									
			Verbenaceae	3.8	0.31	4.33	0.8	0.8	1.5	0.8						
			Oleaceae	4.6	0.24	3.98	3.1		1.5							
			Dilleniaceae	5.4	0.12	3.27	4.6		0.8							
			Leguminosae	4.6	0.14	3.07	3.8		0.8							

	Sapotaceae	3.8	0.08	2.30	3.1	0.8	
	Ebenaceae	3.8	0.07	2.21	3.8		
	Ulmaceae	3.1	0.07	1.86	1.5	1.5	
	Polygalaceae	2.3	0.10	1.84	0.8	1.5	
	Meliaceae	2.3	0.10	1.83	0.8	0.8	0.8
	Moraceae	2.3	0.08	1.63	0.8	1.5	
	Dipterocarpaceae	1.5	0.10	1.49		0.8	0.8
	Apocynaceae	1.5	0.07	1.29		1.5	
	Annonaceae	1.5	0.07	1.28	0.8		0.8
	Magnoliaceae	0.8	0.05	0.76		0.8	
	Rhamnaceae	0.8	0.03	0.61		0.8	
	Olacaceae	0.8	0.03	0.58		0.8	
	Monimiaceae	0.8	0.03	0.56		0.8	
	Burseraceae	0.8	0.02	0.48	0.8		
	Myristicaceae	0.8	0.02	0.48	0.8		
	Lecythidaceae	0.8	0.02	0.47	0.8		
	Guttiferae	0.8	0.01	0.37	0.8		
	Proteaceae	0.8	0.01	0.37	0.8		

	Total	124.6	5.59	100.00	66.9	35.4	17.7	1.5	0.8	1.5	0.8

Forest type/Soil Asso.	Block	Line	Family	Density / ha	Basal Area / ha	Relative Dominance (%)	Diameter Cl (cm) 10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.059.9	60.069.9	70.0-79.9	80.0-89.9	90.0-99.9	>100.0
Early Secondary Forest: Lowland MDF (Riparian)	2	2	Dilleniaceae	45.4	1.05	20.53	41.5	1.5	2.3							
			Euphorbiaceae	38.5	1.26	19.95	29.2	3.8	3.8	1.5						
			Verbenaceae	16.9	1.58	15.82	2.3	3.8	6.2	3.8	0.8					
			Flacourtiaceae	13.1	0.90	10.06	3.8	3.1	4.6	0.8	0.8					
			Sterculiaceae	6.9	0.44	5.09	2.3	2.3	0.8	0.8	0.8					
			Rubiaceae	3.1	0.36	3.41		0.8	1.5		0.8					
Tuaran			Lythraceae	4.6	0.21	2.83	2.3	0.8	1.5							
			Tiliaceae	5.4	0.17	2.75	3.8	0.8	0.8							
			Leguminosae	2.3	0.29	2.70	0.8		0.8			0.8				
			Meliaceae	3.8	0.17	2.30	1.5	0.8	1.5							
			Myrtaceae	4.6	0.12	2.20	3.1	1.5								
			Sapotaceae	3.8	0.07	1.63	3.1	0.8								
			Oleaceae	3.1	0.10	1.60	2.3		0.8							
			Lauraceae	2.3	0.09	1.28	0.8	1.5								
			Hypericaceae	1.5	0.11	1.19		0.8	0.8							
			Guttiferae	2.3	0.04	0.97	2.3									

	Polygalaceae	2.3	0.03	0.91	2.3					
	Dipterocarpaceae	1.5	0.05	0.81	0.8	0.8				
	Apocynaceae	1.5	0.04	0.72	1.5					
	Myristicaceae	0.8	0.07	0.71			0.8			
	Unknown	0.8	0.02	0.40		0.8				
	Proteaceae	0.8	0.02	0.35	0.8					
	Burseraceae	0.8	0.01	0.32	0.8					
	Melastomataceae	0.8	0.01	0.31	0.8					
	Sapindaceae	0.8	0.01	0.31	0.8					
	Ebenaceae	0.8	0.01	0.30	0.8					
	Erythroxylaceae	0.8	0.01	0.29	0.8					
	Moraceae	0.8	0.01	0.28	0.8					
	Total	170.0	7.27	100.00	109.2	23.8	26.2	6.9	3.1	0.8

Forest type/Soil Asso.	Block	Line	Family	Density / ha	Basal Area / ha	Relative Dominance (%)	Diameter Cla (cm)									
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.059.9	60.069.9	70.0-79.9	80.0-89.9	90.0-99.9	>100.0
Late Secondary Forest: Lowland MDF (Riparian)	2	3	Euphorbiaceae	50.0	2.95	21.05	22.3	13.1	6.2	7.7	0.8					
			Rubiaceae	37.7	2.67	17.45	12.3	11.5	5.4	6.9	1.5					
			Dilleniaceae	52.3	1.49	16.44	37.7	10.0	3.8	0.8						
			Verbenaceae	17.7	2.09	11.11	0.8	1.5	9.2	5.4	0.8					
			Sterculiaceae	15.4	1.92	10.03	2.3	3.1	3.8	4.6		0.8		0.8		
			Tiliaceae	15.4	0.72	5.83	5.4	5.4	4.6							
Tuaran			Moraceae	6.9	0.35	2.72	3.8	1.5	0.8	0.8						
			Anacardiaceae	3.1	0.48	2.34	0.8			1.5	0.8					
			Leguminosae	6.2	0.22	2.07	3.8	2.3								
			Annonaceae	5.4	0.25	2.02	3.1	0.8	0.8	0.8						
			Lauraceae	4.6	0.15	1.51	3.1	1.5								
			Capparaceae	3.8	0.19	1.50	1.5	1.5	0.8							
			Flacourtiaceae	2.3	0.20	1.19		1.5		0.8						
			Myrtaceae	2.3	0.09	0.82		2.3								
			Lythraceae	2.3	0.08	0.78	1.5	0.8								
			Guttiferae	1.5	0.12	0.76		0.8	0.8							
			Ebenaceae	2.3	0.06	0.70	1.5	0.8								

	Apocynaceae	1.5	0.07	0.59		1.5						
	Melastomataceae	1.5	0.03	0.43	1.5							
	Rhizophoraceae	0.8	0.06	0.39			0.8					
	Polygalaceae	0.8	0.02	0.22	0.8							
	Unknown	0.8	0.01	0.20	0.8							
	Total	234.6	14.23	100.16	103.1	60.0	36.9	29.2	3.8	0.8	0.8	

Forest type/Soil Asso.	**Block**	**Line**	**Family**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**Diameter Cla (cm)**									
							10.0-19.9	**20.0-29.9**	**30.0-39.9**	**40.0-49.9**	**50.059.9**	**60.069.9**	**70.0-79.9**	**80.0-89.9**	**90.0-99.9**	**>100.0**
Secondary Forest: Lowland MDF – Limestone vegetation	2	4	Sterculiaceae	26.0	1.94	24.06	12.7	4.0	4.0	3.3	1.3			0.7		
			Euphorbiaceae	16.7	0.56	10.77	9.3	6.0	1.3							
			Rubiaceae	12.0	0.84	10.74	4.0	2.7	2.7	2.7						
			Tiliaceae	7.3	0.63	7.36	1.3	2.0	1.3	2.7						
			Meliaceae	7.3	0.49	6.39	1.3	3.3	2.0	0.7						
			Sapindaceae	4.7	0.33	4.21	1.3	2.0	0.7		0.7					
Gomantong			Apocynaceae	2.7	0.41	3.93		1.3			0.7	0.7				
			Larauceae	4.0	0.21	3.10	2.0	0.7	1.3							
			Magnoliaceae	4.0	0.15	2.70	2.0	1.3	0.7							
			Moraceae	4.7	0.10	2.66	3.3	1.3								
			Dipterocarpaceae	2.7	0.20	2.45	1.3	0.7			0.7					

	Ebenaceae	3.3	0.15	2.40	1.3	1.3	0.7		
	Annonaceae	2.0	0.18	2.07		1.3			0.7
	Myristicaceae	1.3	0.21	1.99		0.7			0.7
	Oleaceae	2.7	0.09	1.73	1.3	1.3			
	Leguminosae	2.0	0.11	1.56	0.7	0.7	0.7		
	Urticaceae	2.7	0.06	1.55	2.0	0.7			
	Anacardiaceae	1.3	0.14	1.53	0.7				0.7
	Sonneratiaceae	0.7	0.16	1.40					0.7
	Datiscaceae	1.3	0.12	1.38			1.3		
	Polygalaceae	1.3	0.07	1.01	0.7		0.7		
	Verbenaceae	2.0	0.02	0.98	2.0				
	Lauraceae	1.3	0.06	0.95		1.3			
	Sapotaceae	1.3	0.05	0.90	0.7	0.7			
	Violaceae	1.3	0.01	0.66	1.3				
	Nyctaginaceae	0.7	0.04	0.55		0.7			
	Unknown	0.7	0.01	0.36	0.7				
	Flacourtiaceae	0.7	0.01	0.33	0.7				
	Dilleniaceae	0.7	0.01	0.32	0.7				

	Total	119.3	7.35	100.00	51.3	34.0	17.3	9.3	6.0	0.7	0.7	

Forest type/Soil Asso.	Block	Line	Family	Density / ha	Basal Area / ha	Relative Dominance (%)	Diameter Cl (cm) 10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.059.9	60.069.9	70.0-79.9	80.0-89.9	90.0-99.9	>100.0
Secondary Forest: Lowland MDF - Limestone vegetation	2	5	Euphorbiaceae	60.5	1.71	20.72	38.8	19.1	2.6							
			Sterculiaceae	21.1	1.33	10.50	8.6	7.2	1.3	2.6	0.7	0.7				
			Dipterocarpaceae	13.2	1.43	9.26	2.6	0.7	5.9	1.3	1.3	1.3				
			Moraceae	16.4	0.71	6.73	12.5	2.0	0.7		0.7	0.7				
			Meliaceae	14.5	0.67	6.12	7.9	2.6	2.6	0.7	0.7					
			Ebenaceae	9.9	0.53	4.51	6.6	1.3	1.3				0.7			
Gomantong			Larauceae	6.6	0.63	4.23	1.3	2.0	1.3	1.3	0.7					
			Rubiaceae	9.9	0.42	4.03	5.3	2.0	2.0	0.7						
			Sapindaceae	8.6	0.43	3.79	5.3	0.7	2.0	0.7						
			Datiscaceae	5.3	0.49	3.35	0.7	2.0	0.7	1.3	0.7					
			Tiliaceae	8.6	0.29	3.15	3.9	3.9		0.7						
			Burseraceae	5.9	0.36	2.92	3.3	1.3	0.7			0.7				
			Leguminosae	6.6	0.30	2.76	3.3	2.0	0.7	0.7						
			Annonaceae	8.6	0.20	2.75	6.6	2.0								
			Oleaceae	3.3	0.32	2.17		2.0		0.7	0.7					

	Rutaceae	5.3	0.08	1.51	5.3					
	Lauraceae	3.3	0.18	1.50	2.0	0.7		0.7		
	Myristicaceae	2.0	0.22	1.41	0.7			1.3		
	Magnoliaceae	1.3	0.21	1.21	0.7					0.7
	Alangiaceae	3.3	0.07	1.01	3.3					
	Sapotaceae	3.3	0.06	0.99	3.3					
	Verbenaceae	2.6	0.08	0.94	1.3	1.3				
	Guttiferae	1.3	0.13	0.89	0.7				0.7	
	Myrtaceae	2.0	0.08	0.79	1.3		0.7			
	Anacardiaceae	2.0	0.02	0.51	2.0					
	Urticaceae	1.3	0.04	0.44	0.7	0.7				
	Olacaceae	1.3	0.02	0.37	1.3					
	Leeaceae	1.3	0.02	0.35	1.3					
	Fagaceae	0.7	0.05	0.35			0.7			
	Unknown	0.7	0.01	0.20	0.7					
	Vernonia arborea	0.7	0.01	0.20	0.7					
	Polygalaceae	0.7	0.01	0.18	0.7					
	Apocynaceae	0.7	0.01	0.17	0.7					

			Total	232.2	11.12	100.00	132.9	53.3	23.0	12.5	5.9	3.9	0.7			
Forest type/Soil Asso.	**Block**	**Line**	**Family**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**Diameter Cla (cm)**									
							10.0-19.9	**20.0-29.9**	**30.0-39.9**	**40.0-49.9**	**50.059.9**	**60.069.9**	**70.0-79.9**	**80.0-89.9**	**90.0-99.9**	**>100.0**
Peatswamp Forest Seasonal Freshwater Swamp Forest	--	1	13	Verbenaceae	60.5	3.21	31.09	24.0	19.0	13.5	2.5	1.5				
				Euphorbiaceae	20.0	0.55	7.94	17.5	1.0	1.0			0.5			
				Rubiaceae	8.5	1.03	7.03	0.5	1.5	3.0	1.5	1.5	0.5			
				Apocynaceae	3.5	1.27	6.79		0.5		0.5	0.5	1.0	0.5		0.5
				Anacardiaceae	9.5	0.85	6.49	3.5	2.0	1.5	0.5	1.5	0.5			
				Dipterocarpaceae	10.5	0.68	5.95	5.5	2.0	1.5		1.0	0.5			
				Myrtaceae	11.5	0.52	5.47	7.5	2.0	0.5	1.0		0.5			
Klias				Melastomataceae	9.0	0.29	3.78	6.5	1.0	1.5						
				Aquifoliaceae	9.0	0.24	3.55	6.0	2.5	0.5						
				Annonaceae	7.0	0.26	3.08	4.0	2.0	0.5	0.5					
				Lecythidaceae	2.5	0.47	2.84		1.0			0.5	0.5	0.5		
				Elaeocarpaceae	7.5	0.18	2.84	6.0	1.5							
				Myristicaceae	2.0	0.23	1.57	0.5		1.0		0.5				
				Dilleniaceae	4.0	0.07	1.38	4.0								
				Flacourtiaceae	2.5	0.14	1.30	2.0				0.5				
				Sterculiaceae	2.0	0.11	1.03	0.5	0.5	1.0						
				Datiscaceae	0.5	0.18	0.97						0.5			

	Celastraceae	2.0	0.08	0.90	0.5	1.5						
	Ebenaceae	2.5	0.05	0.89	2.0	0.5						
	Lauraceae	1.5	0.09	0.84	1.0			0.5				
	Moraceae	2.0	0.06	0.82	1.5		0.5					
	Unknown	0.5	0.14	0.78						0.5		
	Leguminosae	1.5	0.05	0.62	1.0	0.5						
	Tiliaceae	1.5	0.03	0.54	1.5							
	Guttiferae	1.0	0.03	0.41	0.5	0.5						
	Sapindaceae	1.0	0.03	0.39	0.5	0.5						
	Rhizophoraceae	0.5	0.02	0.24		0.5						
	Ochnaceae	0.5	0.02	0.22		0.5						
	Meliaceae	0.5	0.01	0.20	0.5							
	Total	185.0	10.89	100.00	97.0	41.0	26.0	7.0	7.5	5.0	1.0	0.5

Table B. Species composition of trees ≥10 cm recorded in Pin Supu SFM area (Nilus *et al*, 2007).

Forest type/Soil Asso.	Block	Line	Species	Density / ha	Basal Area / ha	Relative Dominance (%)	Diameter Class (cm) 10.0 - 19.9	20.0 - 29.9	30.0 - 39.9	40.0 - 49.9	50.0 - 59.9	60.0 - 69.9	70.0 - 79.9	80.0 - 89.9	90.0 - 99.9	>100.0
Early Secondary Forest on previously Lowland Mixed Dipterocarp Forest Type B	2	6	*Pterospermum elongatum*	20.0	1.29	22.89	7.3	6.0	3.3	2.0	0.7	0.7				
			Croton	9.3	0.22	6.69	6.7	2.7								
			Eusideroxylon zwageri	3.3	0.45	6.33		2.0		0.7			0.7			
			Litsea	5.3	0.32	5.79	4.0	0.7				0.7				
			Aglaia	6.7	0.25	5.70	4.7	0.7	0.7	0.7						
			Ficus treubii	6.7	0.19	5.06	6.0		0.7							
Silabukan			*Octomeles sumatrana*	1.3	0.35	4.28			0.7				0.7			
			Parashorea tomentella	3.3	0.25	4.22	0.7	0.7	2.0							
			Cleistanthus	5.3	0.09	3.46	4.7	0.7								
			Mallotus mollissimus	4.0	0.06	2.53	4.0									
			Spathiostemon javensis	3.3	0.06	2.22	3.3									
			Alangium griffithii	0.7	0.13	1.63				0.7						
			Magnolia	2.7	0.03	1.55	2.7									
			Vernonia arborea	2.0	0.05	1.49	1.3	0.7								
			Endospermum	1.3	0.06	1.23		1.3								
			Meliosma	0.7	0.08	1.19				0.7						
			Xanthophyllum	1.3	0.05	1.14		1.3								

	Drypetes	2.0	0.02	1.14	2.0		
	Urticaceae	1.3	0.04	1.03	0.7	0.7	
	Melicope	1.3	0.04	1.03	0.7	0.7	
	Macaranga hypoleuca	0.7	0.06	0.95			0.7
	Canarium	1.3	0.03	0.90	1.3		
	Dipterocarpus caudiferus	0.7	0.05	0.86			0.7
	Hymenodictyon orixense	0.7	0.05	0.86			0.7
	Ficus	1.3	0.02	0.84	1.3		
	Sapotaceae	1.3	0.02	0.82	1.3		
	Teijsmanniodendron	1.3	0.02	0.79	1.3		
	Artocarpus anisophyllus	0.7	0.04	0.75		0.7	
	Ziziphus angustifolius	0.7	0.04	0.72		0.7	
	Pterocymbium javanicum	0.7	0.03	0.64		0.7	
	Nephelium lappaceum	0.7	0.03	0.61		0.7	
	Mallotus	0.7	0.03	0.59		0.7	
	Paranephelium joannis	0.7	0.03	0.58		0.7	
	Gironniera nervosa	0.7	0.02	0.56		0.7	
	Macaranga tanarius	0.7	0.02	0.55		0.7	

	Microcos	0.7	0.02	0.51	0.7
	Diospyros	0.7	0.02	0.50	0.7
	Alstonia	0.7	0.02	0.48	0.7
	Shorea macrophylla	0.7	0.01	0.46	0.7
	Crudia reticulata	0.7	0.01	0.46	0.7
	Polyalthia	0.7	0.01	0.45	0.7
	Bridelia	0.7	0.01	0.43	0.7
	Syzygium	0.7	0.01	0.43	0.7
	Murraya paniculata	0.7	0.01	0.42	0.7
	Glochidion	0.7	0.01	0.42	0.7
	Cynometra	0.7	0.01	0.42	0.7
	Leucosyke capitellata	0.7	0.01	0.39	0.7
	Adenanthera pavonina	0.7	0.01	0.38	0.7
	Madhuca	0.7	0.01	0.38	0.7
	Azadirachta excelsa	0.7	0.01	0.38	0.7
	Alangium	0.7	0.01	0.38	0.7
	Planchonia valida	0.7	0.01	0.37	0.7
	Ficus racemosa	0.7	0.01	0.37	0.7

	Ptychopyxis arborea	0.7	0.01	0.37	0.7							
	Brownlowia	0.7	0.01	0.36	0.7							
	Total	108.0	4.74	100.00	67.3	23.3	9.3	4.7	0.7	1.3	1.3	

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**Diameter Class (cm)**									
							10.0 - 19.9	**20.0 - 29.9**	**30.0 - 39.9**		**50.0-59.9**	**60.0-69.9**	**70.0-79.9**	**80.0-89.9**	**90.0 - 99.9**	**>100.0**
Early Secondary Forest on previously Lowland Mixed Dipterocarp Forest Type B	2	7	*Pterospermum elongatum*	38.7	1.92	27.77	22.0	8.0	4.0	3.3	1.3					
			Parashorea tomentella	9.3	0.37	5.96	4.7	3.3	0.7	0.7						
			Croton argyratus	8.7	0.30	5.18	4.7	3.3	0.7							
			Octomeles sumatrana	2.0	0.49	4.66					1.3	0.7				
			Ficus treubii	7.3	0.14	3.41	7.3									
			Macaranga hypoleuca	3.3	0.28	3.30	0.7	1.3	0.7	0.7						
Silabukan			*Alangium*	5.3	0.17	3.05	4.0	0.7	0.7							
			Chrysophyllum	5.3	0.14	2.84	4.7		0.7							
			Lithocarpus	2.7	0.24	2.77		1.3	0.7	0.7						
			Eusideroxylon zwageri	2.7	0.22	2.62	1.3	0.7			0.7					
			Macaranga tanarius	4.7	0.13	2.54	2.0	2.7								
			Spathiostemon javensis	3.3	0.07	1.63	2.7	0.7								
			Paranephelium xestophyllum	3.3	0.07	1.61	2.7	0.7								
			Sumbaviopsis albicans	2.7	0.07	1.39	1.3	1.3								

	Peltophorum racemosum	1.3	0.11	1.33		0.7	0.7
	Drypetes	2.7	0.06	1.32	1.3	1.3	

Canarium 2.7		0.05	
		1.22 2.7	
Glochidion 2.0		0.06	1.10 1.3
		0.7	
Verbenaceae 2.0		0.04	
		0.94 2.0	
Unknown 1.3		0.06	
		0.94 1.3	
Dracontomelon dao 2.0		0.03	
		0.89 2.0	
Macaranga gigantea 0.7		0.08	0.88 0.7
Dipterocarpus 2.0		0.03	
		0.87 2.0	
Canarium denticulatum 2.0		0.03	
		0.87 2.0	
Polyalthia 2.0		0.03	
		0.86 2.0	
Diospyros 1.3		0.05	0.83 0.7
		0.7	
Melicope 1.3		0.05	0.82 0.7
		0.7	
Alangium griffithii 1.3		0.04	0.71 0.7
		0.7	
Ficus 1.3		0.03	0.69 0.7
		0.7	
Knema 1.3		0.03	0.69 0.7
		0.7	
Vitex pinnata 1.3		0.03	0.67 0.7
		0.7	
Ficus nota 1.3		0.03	
		0.65 1.3	
Ptychopyxis 1.3		0.02	
		0.61 1.3	
Dacryodes 1.3		0.02	
		0.61 1.3	
Neolamarckia cadamba 0.7		0.05	0.59 0.7
Nauclea subdita 1.3		0.02	
		0.57 1.3	
Aglaia 1.3		0.02	
		0.54 1.3	
Mallotus phillippensis 1.3		0.01	
		0.54 1.3	
Clausena excavata 1.3		0.01	
		0.53 1.3	

Diplodiscus parviflorus 0.7			0.04	0.53	0.7
Vernonia arborea 0.7			0.04	0.50	0.7
Nephelium 0.7			0.03	0.45	0.7
Artocarpus 0.7			0.03	0.44	0.7
Aglaia grandis 0.7			0.03	0.43	0.7
Ormosia 0.7			0.03	0.43	0.7
Dimocarpus dentatus 0.7			0.03	0.41	0.7
Elaeocarpus stipularis 0.7			0.02	0.39	0.7
Canarium odontophyllum 0.7			0.02	0.38	0.7
Chionanthus 0.7			0.02	0.38	0.7
Dimocarpus longan 0.7			0.02	0.36	0.7
Tarenna 0.7			0.02	0.36	0.7
Barringtonia curranii 0.7			0.01	0.32	0.7
Mallotus 0.7			0.01	0.32	0.7
Pterocymbium javanicum 0.7			0.01	0.32	0.7
Cubilia cubili 0.7			0.01	0.31	0.7
Litsea 0.7			0.01	0.31	0.7
Brownlowia stipulata 0.7			0.01	0.30	0.7
Sandoricum maingayi 0.7			0.01	0.29	0.7
Ptychopyxis motleyii 0.7			0.01	0.29	0.7
	Canarium decumanum	0.7	0.01	0.28	0.7
	Dracaena angustifolia	0.7	0.01	0.28	0.7
	Rubiaceae	0.7	0.01	0.28	0.7
	Madhuca dubardii	0.7	0.01	0.28	0.7
	Citrus	0.7	0.01	0.27	0.7
	Ficus variegata	0.7	0.01	0.27	0.7
	Neesia	0.7	0.01	0.27	0.7
	Diplospora	0.7	0.01	0.27	0.7
	Macaranga	0.7	0.01	0.27	0.7

	Ludekia borneensis	0.7	0.01	0.26	0.7					
	Cryptocarya	0.7	0.01	0.26	0.7					
	Indet	0.7	0.01	0.25	0.7					
	Magnolia	0.7	0.01	0.25	0.7					
	Total	160.0	6.12	100.00	102.0	38.7	10.0	5.3	3.3	0.7

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**10.0 19.9 -**	**20.0 29.9 -**	**30.0 39.9 -**	**Diameter Class (cm) 50.0- 59.9**	**60.0- 69.9**	**70.0- 79.9**	**80.0- 89.9**	**90.0 99.9**	**- >100.0**
Early Secondary Forest: Lowland Mixed Dipterocarp Forest (Riparian)	1	19	*Colona serratifolia*	35.0	2.38	16.53	6.0	12.0	13.0	4.0					
			Pterospermum elongatum	25.0	1.82	12.31	8.0	3.0	10.0	4.0					
			Vitex pinnata	15.0	1.14	7.55	3.0	3.0	6.0	2.0	1.0				
			Nauclea subdita	15.0	0.70	5.80	6.0	6.0	2.0	1.0					
			Pterospermum macrocarpum	5.0	0.81	4.27			2.0		3.0				
			Dillenia excelsa	15.0	0.23	3.91	13.0	2.0							
Tuaran			*Antidesma thwaitesianum*	8.0	0.45	3.38	4.0	2.0	1.0	1.0					
			Baccaurea stipulata	11.0	0.13	2.71	11.0								
			Endiandra	9.0	0.17	2.48	7.0	2.0							
			Ficus nota	9.0	0.17	2.46	8.0	1.0							
			Erythroxylum cuneatum	3.0	0.44	2.37		1.0		1.0	1.0				

	Atuna nannodes	2.0	0.48	2.32				1.0	1.0	
	Syzygium	8.0	0.11	2.04	8.0					
	Cleistanthus myrianthus	7.0	0.13	1.93	6.0	1.0				
	Dehaasia	6.0	0.18	1.90	4.0	2.0				
	Glochidion	6.0	0.11	1.65	5.0	1.0				
	Vatica venulosa	1.0	0.28	1.34					1.0	
	Cratoxylum sumatranum	3.0	0.18	1.30	2.0		1.0			
	Anisoptera costata	1.0	0.24	1.15				1.0		
	Chionanthus	4.0	0.08	1.13	3.0	1.0				

Elaeocarpus stipularis 2.0		0.18	1.13 2.0	
Mallotus muticus 2.0		0.17		1.09 1.0
		1.0		
Actinodaphne 4.0		0.07	1.07 3.0	
		1.0		
Terminalia citrina 4.0		0.05		
		1.02 4.0		
Alstonia angustiloba 1.0		0.20	0.99 1.0	
Diospyros 3.0		0.09	0.98 1.0	
		2.0		
Dimocarpus longan 2.0		0.14		0.95 1.0
		1.0		
Madhuca 1.0		0.17	0.87 1.0	
Microcos crassifolia 3.0		0.05		
		0.81 3.0		
Ficus variegata 1.0		0.15	0.78 1.0	
Myristica 1.0		0.09	0.56 1.0	
Cryodophnopsis tokenensis 2.0		0.04	0.56 1.0	
		1.0		
Xylosma sumatrana 2.0		0.04	0.56 1.0	
		1.0		
Hydnocarpus 2.0		0.04		
		0.54 2.0		
Parkia speciosa 1.0		0.08	0.52 1.0	
Litsea 2.0		0.03		
		0.52 2.0		
Cryptocarya 1.0		0.08	0.50 1.0	
Dracontomelon dao 2.0		0.03		
		0.50 2.0		
Rauvolfia sumatrana 2.0		0.02		
		0.50 2.0		
Knema 2.0		0.02		
		0.48 2.0		
Kibara coriacea 2.0		0.02		
		0.48 2.0		
Litsea cauliflora 1.0		0.07		
		0.46 1.0		
Ludekia borneensis 1.0		0.07		
		0.46 1.0		
Prainea limpato 1.0		0.06		
		0.43 1.0		
Sindora 1.0		0.03		
		0.30 1.0		

Cubilia cubili 1.0			0.02	0.28 1.0						
Hydnocarpus polypetalus 1.0			0.02	0.28 1.0						
Rauvolfia 1.0			0.02	0.28 1.0						
Garcinia parvifolia 1.0			0.02	0.27 1.0						
Garcinia 1.0			0.02	0.26 1.0						
Aporosa nigricans 1.0			0.01	0.25 1.0						
Melicope 1.0			0.01	0.25 1.0						
Symplocos 1.0			0.01	0.25 1.0						
Memecylon paniculatum 1.0			0.01	0.25 1.0						
Baccaurea 1.0			0.01	0.25 1.0						
Cynometra 1.0			0.01	0.24 1.0						
Semecarpus bumburyanus 1.0			0.01	0.24 1.0						
Leea indica 1.0			0.01	0.24 1.0						
Memecylon 1.0			0.01	0.23 1.0						
Mallotus 1.0			0.01	0.23 1.0						
Bridelia 1.0			0.01	0.23 1.0						
Gardenia tubifera 1.0			0.01	0.23 1.0						
Unknown 0.0			0.03	0.11 1.0						
	Total	251.0	12.44	100.00	139.0	46.0	39.0	18.0	8.0	2.0

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**10.0 19.9 -**	**20.0 29.9 -**	**30.0 39.9 -**	**40.0-49.9**	**50.0-59.9**	**ıeter Cla (cr 60.069.9**	**70.079.9**	**80.0-89.9**	**90.0-99.9**	**>100.0**
Early Secondary Forest: Lowland Mixed Dipterocarp Forest (Riparian)	1	20	*Colona serratifolia*	20.0	0.83	7.65 7.09	8.0	8.0	4.0							
			Vitex pinnata	13.0	1.04	5.99	3.0	2.0	5.0	3.0						
			Erythroxylum cuneatum	9.0	0.97			4.0	1.0	3.0	1.0					
			Dillenia excelsa	19.0	0.40	5.59	15.0	4.0								
			Nauclea subdita	6.0	0.92	5.15			2.0	3.0	1.0					
			Syzygium	13.0	0.48	4.71	10.0	1.0		2.0						
Tuaran			*Mallotus muticus*	5.0	0.81	4.49	2.0				3.0					

	Pterospermum elongatum	12.0	0.46	4.41	5.0	5.0	2.0			
	Cleistanthus myrianthus	13.0	0.34	4.09	8.0	5.0				
	Antidesma thwaitesianum	9.0	0.24	2.86	7.0	1.0	1.0			
	Diospyros	7.0	0.29	2.68	4.0	1.0	2.0			
	Parkia speciosa	3.0	0.34	2.05		2.0			1.0	
	Dehaasia	5.0	0.23	2.02	3.0	1.0		1.0		
	Dracontomelon dao	4.0	0.27	1.97	2.0	1.0		1.0		
	Elaeocarpus	2.0	0.36	1.95			1.0		1.0	
	Hydnocarpus polypetalus	7.0	0.12	1.95	7.0					
	Endiandra	3.0	0.31	1.92	1.0	1.0			1.0	
	Cryptocarya	4.0	0.24	1.83	2.0		1.0	1.0		
	Melicope	5.0	0.17	1.75	2.0	3.0				
	Chionanthus	4.0	0.20	1.69	1.0	2.0	1.0			
	Cubilia cubili	4.0	0.18	1.61	1.0	2.0	1.0			
	Pterospermum macrocarpum	4.0	0.17	1.52	2.0	1.0	1.0			
	Neolamarckia cadamba	1.0	0.28	1.41						1.0
	Ficus nota	5.0	0.07	1.30	5.0					
	Cananga odorata	2.0	0.19	1.24	1.0			1.0		

	Litsea	4.0	0.08	1.17	3.0	1.0			
	Dipterocarpus validus	4.0	0.08	1.17	4.0				
	Pternandra galeata	1.0	0.20	1.04				1.0	
	Terminalia citrina	3.0	0.07	0.93	2.0	1.0			
	Crudia	3.0	0.06	0.89	3.0				
	Microcos crassifolia	3.0	0.06	0.86	2.0	1.0			
	Pleiocarpidia sandakanica	3.0	0.04	0.79	3.0				
	Xylosma sumatrana	3.0	0.03	0.75	3.0				
	Elaeocarpus stipularis	2.0	0.07	0.73	1.0	1.0			
	Mallotus penangensis	2.0	0.07	0.70	1.0	1.0			
	Margaritaria indica	1.0	0.10	0.61			1.0		
	Madhuca	1.0	0.08	0.55			1.0		
	Vatica venulosa	1.0	0.08	0.55			1.0		
	Polyalthia obliqua	2.0	0.03	0.55	2.0				
	Xanthophyllum flavescens	2.0	0.03	0.54	2.0				
	Drypetes	2.0	0.03	0.52	2.0				
	Aporosa nigricans	2.0	0.02	0.51	2.0				
	Vatica rassak	2.0	0.02	0.50	2.0				

	Unknown	0.0	0.11	0.46			1.0
	Cleistanthus	1.0	0.06	0.45		1.0	
	Hydnocarpus kunstleri	1.0	0.05	0.43		1.0	
	Hydnocarpus	1.0	0.04	0.38		1.0	
	Lagerstroemia speciosa	1.0	0.04	0.38		1.0	
	Croton oblongus	1.0	0.04	0.37		1.0	
	Cynometra	1.0	0.04	0.37		1.0	
	Pometia pinnata	1.0	0.03	0.35		1.0	
	Madhuca dubardii	1.0	0.03	0.33	1.0		
	Glochidion	1.0	0.02	0.30	1.0		
	Actinodaphne	1.0	0.02	0.29	1.0		
	Alangium	1.0	0.02	0.29	1.0		
	Garcinia parvifolia	1.0	0.02	0.29	1.0		
	Xylosma	1.0	0.02	0.28	1.0		
	Planchonia valida	1.0	0.02	0.27	1.0		
	Microcos	1.0	0.02	0.27	1.0		
	Baccaurea stipulata	1.0	0.01	0.27	1.0		
	Canarium denticulatum	1.0	0.01	0.26	1.0		

	Dimocarpus longan	1.0	0.01	0.26	1.0						
	Garcinia	1.0	0.01	0.26	1.0						
	Gardenia tubifera	1.0	0.01	0.25	1.0						
	Alangium javanicum	1.0	0.01	0.24	1.0						
	Fagraea spicata	1.0	0.01	0.24	1.0						
	Memecylon paniculatum	1.0	0.01	0.24	1.0						
	Aphanamixis	1.0	0.01	0.24	1.0						
	Total	244.0	11.74	100.00	138.0	56.0	26.0	15.0	9.0	1.0	

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**Diameter Class (cm)**								
							10.0-19.9	**20.0-29.9**	**30.0-39.9**	**40.0-49.9**	**50.0-69.9**	**60.0-79.9**	**70.059.9**	**80.0-89.9**	**90.0-99.9**	**>100.0**
Early Secondary Forest: Lowland Mixed Dipterocarp Forest (Riparian)	1	21	*Colona serratifolia*	82.0	3.50	29.44	38.0	28.0	13.0	2.0	1.0					
			Pterospermum macrocarpum	23.0	1.68	11.11	9.0	5.0	5.0	3.0		1.0				
			Vitex pinnata	17.0	1.74	10.26	2.0	3.0	6.0	5.0	1.0					
			Dillenia excelsa	23.0	0.39	5.83	22.0	1.0								
			Nauclea subdita	8.0	0.52	3.61	1.0	3.0	4.0							
			Mallotus muticus	10.0	0.22	2.75	8.0	2.0								
Tuaran			*Mesua*	7.0	0.36	2.74	3.0	2.0	2.0							
			Aglaia	7.0	0.30	2.54	3.0	2.0	2.0							

	Pentace	4.0	0.39	2.35	2.0	1.0				1.0	
	Litsea	8.0	0.20	2.30	5.0	3.0					
	Bridelia	6.0	0.25	2.13	4.0	1.0		1.0			
	Kibatalia	2.0	0.42	2.08		1.0					1.0
	Microcos	7.0	0.15	1.90	7.0						
	Hydnocarpus woodii	2.0	0.37	1.88				1.0	1.0		
	Fordia	6.0	0.15	1.74	5.0		1.0				
	Diospyros	7.0	0.09	1.68	7.0						
	Syzygium	6.0	0.13	1.63	5.0	1.0					
	Nauclea orientalis	3.0	0.25	1.59	1.0		1.0	1.0			
	Ixora	6.0	0.12	1.58	6.0						
	Dracontomelon dao	5.0	0.16	1.56	3.0	2.0					
	Chionanthus	3.0	0.13	1.08	1.0	2.0					
	Sindora	3.0	0.10	0.97	2.0	1.0					
	Spathiostemon javensis	3.0	0.07	0.86	2.0	1.0					
	Ficus	3.0	0.07	0.85	2.0	1.0					
	Mitragyna speciosa	1.0	0.14	0.75				1.0			
	Dimocarpus longan	3.0	0.04	0.73	3.0						

	Madhuca	2.0	0.03	0.50	2.0						
	Litsea resinosa	2.0	0.03	0.49	2.0						
	Xanthophyllum	2.0	0.02	0.44	2.0						
	Teijsmanniodendron	1.0	0.04	0.36		1.0					
	Polyalthia	1.0	0.03	0.33		1.0					
	Mallotus penangensis	1.0	0.03	0.30	1.0						
	Saraca declinata	1.0	0.02	0.25	1.0						
	Croton	1.0	0.02	0.25	1.0						
	Canarium	1.0	0.01	0.24	1.0						
	Myristica	1.0	0.01	0.24	1.0						
	Vatica	1.0	0.01	0.23	1.0						
	Baccaurea	1.0	0.01	0.23	1.0						
	Glochidion	1.0	0.01	0.22	1.0						
	Total	271.0	12.22	100.00	155.0	62.0	34.0	14.0	3.0	2.0	1.0

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**Diameter Class (cm)**								
							10.0-19.9	**20.0-29.9**	**30.0-39.9**	**40.0-69.9**	**50.0-79.9**	**60.0-69.9**	**70.0-79.9**	**80.0-89.9**	**90.0-99.9**	**>100.0**	**59.9**
Early Secondary Forest: Lowland Mixed Dipterocarp Forest (Riparian)	1	22	*Pterospermum macrocarpum*	56.7	3.37	25.94	23.3	8.3	16.7	8.3							
			Mallotus muticus	55.0	1.93	19.01	26.7	23.3	5.0								

	Colona serratifolia	18.3	1.26	9.19	3.3	5.0	8.3	1.7
	Vitex pinnata	10.0	0.65	4.83	1.7	3.3	5.0	
	Dillenia excelsa	16.7	0.33	4.56	15.0	1.7		
	Chionanthus	10.0	0.39	3.63	6.7	1.7	1.7	
Tuaran	*Ixora*	10.0	0.20	2.74	8.3	1.7		
	Melicope	3.3	0.38	2.38			1.7	1.7
	Litsea resinosa	8.3	0.18	2.38	6.7	1.7		
	Syzygium	8.3	0.16	2.25	8.3			
	Litsea	6.7	0.20	2.14	5.0	1.7		
	Bridelia	6.7	0.18	2.07	3.3	3.3		
	Ficus	6.7	0.18	2.05	5.0	1.7		
	Spathiostemon javensis	3.3	0.25	1.77		1.7	1.7	
	Diospyros	5.0	0.12	1.45	3.3	1.7		
	Buchanania	5.0	0.09	1.34	5.0			
	Pleiocarpidia	5.0	0.09	1.32	5.0			
	Artocarpus	3.3	0.12	1.16	1.7	1.7		
	Dracontomelon dao	3.3	0.11	1.13	1.7	1.7		
	Croton	3.3	0.08	0.98	1.7	1.7		

	Ficus treubii	3.3	0.07	0.92	3.3				
	Ficus racemosa	1.7	0.13	0.89			1.7		
	Pentace	3.3	0.05	0.83	3.3				
	Myristica	3.3	0.04	0.77	3.3				
	Dillenia	3.3	0.03	0.76	3.3				
	Cratoxylum	1.7	0.06	0.57		1.7			
	Ludekia borneensis	1.7	0.04	0.49	1.7				
	Polyalthia	1.7	0.03	0.46	1.7				
	Lithocarpus	1.7	0.03	0.43	1.7				
	Microcos	1.7	0.02	0.41	1.7				
	Garcinia	1.7	0.02	0.40	1.7				
	Gardenia tubifera	1.7	0.02	0.39	1.7				
	Aglaia	1.7	0.02	0.38	1.7				
	Total	273.3	10.81	100.00	156.7	63.3	41.7	11.7	

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**Diameter Class (cm)**								
							10.0 19.9	**20.0 29.9**	**30.0 39.9**	**40.0- 69.9**	**50.0- 79.9**	**60.0- 70.049.9**	**59.9**	**80.0- 89.9**	**90.0- 99.9**	**>100.0**
Early Secondary Forest: Lowland Mixed Dipterocarp Forest (Riparian)	2	1	*Colona serratifolia*	10.8	0.46	8.45 6.82	6.2	2.3	2.3							
			Mallotus muticus	7.7	0.42	6.33	1.5	3.8	2.3							
			Pometia pinnata	3.1	0.57			1.5								
												0.8	0.8			

	Hydnocarpus	8.5	0.28	5.88	4.6	3.1	0.8			
	Syzygium	7.7	0.28	5.57	4.6	2.3	0.8			
	Pterospermum macrocarpum	6.2	0.31	5.23	1.5	3.1	1.5			
Tuaran	*Alangium*	8.5	0.12	4.46	8.5					
	Chionanthus	4.6	0.24	3.98	3.1		1.5			
	Litsea	3.1	0.29	3.81		1.5	0.8	0.8		
	Vitex pinnata	3.1	0.28	3.74	0.8		1.5	0.8		
	Cleistanthus	5.4	0.14	3.42	3.8	1.5				
	Dimocarpus longan	1.5	0.27	3.00		0.8				0.8
	Dillenia excelsa	4.6	0.11	2.80	3.8		0.8			
	Nauclea orientalis	1.5	0.24	2.80			0.8		0.8	
	Diospyros	3.8	0.07	2.21	3.8					
	Baccaurea	1.5	0.15	1.96			1.5			
	Nauclea subdita	3.1	0.07	1.88	2.3	0.8				
	Gironniera nervosa	3.1	0.07	1.86	1.5	1.5				
	Xanthophyllum	2.3	0.10	1.84	0.8	1.5				
	Aglaia	2.3	0.10	1.83	0.8	0.8	0.8			
	Dryobalanops lanceolata	1.5	0.10	1.49		0.8	0.8			

	Sapotaceae	2.3	0.05	1.40	1.5	0.8	
	Eusideroxylon zwageri	2.3	0.04	1.29	2.3		
	Alstonia macrophylla	1.5	0.07	1.29		1.5	
	Nephelium	1.5	0.07	1.27		1.5	
	Ficus	1.5	0.07	1.23		1.5	
	Sindora	0.8	0.07	0.95			0.8
	Madhuca	1.5	0.03	0.90	1.5		
	Gardenia tubifera	1.5	0.03	0.89	1.5		
	Fordia	1.5	0.03	0.89	1.5		
	Polyalthia	0.8	0.06	0.87			0.8
	Sympetalandra borneensis	1.5	0.03	0.86	1.5		
	Magnolia	0.8	0.05	0.76		0.8	
	Ziziphus angustifolius	0.8	0.03	0.61		0.8	
	Teijsmanniodendron	0.8	0.03	0.59		0.8	
	Pentace	0.8	0.03	0.59		0.8	
	Ochanostachys amentacea	0.8	0.03	0.58		0.8	
	Kibara coriacea	0.8	0.03	0.56		0.8	
	Ludekia borneensis	0.8	0.02	0.51	0.8		

	Canarium	0.8	0.02	0.48	0.8						
	Myristica	0.8	0.02	0.48	0.8						
	Planchonia valida	0.8	0.02	0.47	0.8						
	Dillenia indica	0.8	0.02	0.47	0.8						
	Cananga odorata	0.8	0.01	0.41	0.8						
	Microcos	0.8	0.01	0.41	0.8						
	Ficus septica	0.8	0.01	0.39	0.8						
	Aporosa	0.8	0.01	0.39	0.8						
	Garcinia	0.8	0.01	0.37	0.8						
	Intsia palembanica	0.8	0.01	0.37	0.8						
	Helicia	0.8	0.01	0.37	0.8						
	Total	124.6	5.59	100.00	66.9	35.4	17.7	1.5	0.8	1.5	0.8

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**10.0 19.9 -**	**20.0 29.9 -**	**30.0 39.9 -**	**40.0-49.9**	**50.0-59.9**	**ıeter Cla (cr 60.069.9**	**70.079.9**	**80.0-89.9**	**90.0-99.9**	**>100.0**
Early Secondary Forest: Lowland Mixed Dipterocarp Forest (Riparian)	2	2	*Dillenia excelsa*	43.8	1.01	19.84	40.0	1.5	2.3							
			Mallotus muticus	28.5	1.05	15.59	21.5	1.5	3.8							
			Vitex pinnata	16.2	1.57	15.52	1.5	3.8	6.2	1.5 3.8	0.8					
			Hydnocarpus	13.1	0.90	10.06	3.8	3.1	4.6	0.8	0.8					
			Pterospermum macrocarpum	6.9	0.44	5.09	2.3	2.3	0.8	0.8	0.8					

	Lagerstroemia speciosa	4.6	0.21	2.83	2.3	0.8	1.5			
Tuaran	*Aglaia*	3.8	0.17	2.30	1.5	0.8	1.5			
	Syzygium	4.6	0.12	2.20	3.1	1.5				
	Nauclea orientalis	1.5	0.25	2.14			0.8	0.8		
	Colona serratifolia	3.8	0.15	2.14	2.3	0.8	0.8			
	Baccaurea stipulata	4.6	0.06	1.77	4.6					
	Dialium	0.8	0.22	1.72					0.8	
	Chionanthus	3.1	0.10	1.60	2.3		0.8			
	Madhuca	3.1	0.07	1.35	2.3	0.8				
	Nauclea subdita	1.5	0.12	1.26		0.8	0.8			
	Cratoxylum	1.5	0.11	1.19		0.8	0.8			
	Cleistanthus	2.3	0.04	0.98	2.3					
	Fordia	1.5	0.08	0.98	0.8		0.8			
	Garcinia	2.3	0.04	0.97	2.3					
	Xanthophyllum	2.3	0.03	0.91	2.3					
	Vatica rassak	1.5	0.05	0.81	0.8	0.8				
	Litsea	1.5	0.05	0.78	0.8	0.8				
	Alstonia macrophylla	1.5	0.04	0.72	1.5					

	Myristica	0.8	0.07	0.71			0.8
	Dillenia	1.5	0.04	0.69	1.5		
	Microcos	1.5	0.02	0.61	1.5		
	Actinodaphne	0.8	0.04	0.50		0.8	
	Ptychopyxis arborea	0.8	0.04	0.49		0.8	
	Glochidion	0.8	0.03	0.41		0.8	
	Mallotus floribundus	0.8	0.02	0.40		0.8	
	Unknown	0.8	0.02	0.40		0.8	
	Helicia	0.8	0.02	0.35	0.8		
	Dacryodes	0.8	0.01	0.32	0.8		
	Croton	0.8	0.01	0.31	0.8		
	Memecylon	0.8	0.01	0.31	0.8		
	Pometia pinnata	0.8	0.01	0.31	0.8		
	Teijsmanniodendron	0.8	0.01	0.30	0.8		
	Diospyros	0.8	0.01	0.30	0.8		
	Erythroxylum cuneatum	0.8	0.01	0.29	0.8		
	Artocarpus	0.8	0.01	0.28	0.8		
	Sapotaceae	0.8	0.01	0.28	0.8		

	Total	170.0	7.27	100.00	109.2	23.8	26.2	6.9	3.1	0.8

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**10.0 19.9 -**	**20.0 29.9 -**	**30.0 39.9 -**	**Diameter Class (cm) 50.0- 59.9**	**60.0- 69.9**	**70.0- 79.9**	**80.0- 89.9**	**90.0 99.9**	**- >100.0**
Late Secondary Forest: Lowland Mixed Dipterocarp Forest (Riparian)	2	3	*Mallotus muticus*	36.9	2.63	17.14	12.3	10.8	5.4	7.7	0.8				
			Nauclea orientalis	32.3	2.49	15.66	9.2	9.2	5.4	6.9	1.5				
			Dillenia excelsa	48.5	1.16	14.43	37.7	9.2	1.5						
			Vitex pinnata	17.7	2.09	11.11	0.8	1.5	9.2	5.4	0.8				
			Pterospermum macrocarpum	14.6	1.84	9.60	2.3	3.1	3.1	4.6			0.8		0.8
			Colona serratifolia	10.8	0.58	4.33	3.1	3.8	3.8						
Tuaran			*Dracontomelon dao*	3.1	0.48	2.34	0.8			1.5	0.8				
			Polyalthia obliqua	5.4	0.25	2.02	3.1	0.8	0.8	0.8					
			Dillenia indica	3.8	0.34	2.00		0.8	2.3	0.8					
			Antidesma thwaitesianum	5.4	0.19	1.81	3.1	1.5	0.8						
			Ficus nota	4.6	0.16	1.54	3.1	1.5							
			Crateva	3.8	0.19	1.50	1.5	1.5	0.8						
			Microcos crassifolia	4.6	0.14	1.49	2.3	1.5	0.8						
			Xylosma	2.3	0.20	1.19		1.5		0.8					
			Mitragyna speciosa	3.1	0.14	1.14	0.8	2.3							

	Cryptocarya griffithiana	3.1	0.09	0.99	2.3	0.8		
	Ficus racemosa	1.5	0.18	0.96			0.8	0.8
	Milletia pinnata	2.3	0.12	0.93	0.8	1.5		
	Syzygium	2.3	0.09	0.82		2.3		
	Lagerstroemia speciosa	2.3	0.08	0.78	1.5	0.8		
	Garcinia parvifolia	1.5	0.12	0.76		0.8	0.8	
	Diospyros	2.3	0.06	0.70	1.5	0.8		
	Crudia reticulata	2.3	0.06	0.69	1.5	0.8		
	Baccaurea stipulata	2.3	0.03	0.60	2.3			
	Rauvolfia sumatrana	1.5	0.07	0.59		1.5		
	Litsea	1.5	0.06	0.52	0.8	0.8		
	Drypetes	1.5	0.05	0.49	0.8	0.8		
	Ludekia borneensis	1.5	0.04	0.46	1.5			
	Cynometra	1.5	0.04	0.46	1.5			
	Kleinhovia hospita	0.8	0.08	0.43			0.8	
	Cleistanthus myrianthus	1.5	0.02	0.41	1.5			
	Mallotus floribundus	1.5	0.02	0.40	1.5			
	Carallia brachiata	0.8	0.06	0.39			0.8	

	Memecylon paniculatum	0.8	0.02	0.23	0.8							
	Xanthophyllum	0.8	0.02	0.22	0.8							
	Artocarpus	0.8	0.02	0.22	0.8							
	Memecylon	0.8	0.01	0.20	0.8							
	Margaritaria indica	0.8	0.01	0.20	0.8							
	Cericoides perakensis	0.8	0.01	0.19	0.8							
	Unknown	0.0	0.01	0.03	0.8							
	Total	233.8	14.23	100.00	103.1	60.0	36.9	29.2	3.8	0.8	0.8	

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**Diameter Class (cm) 10.0 - 19.9**	**20.0 - 29.9**	**30.0 - 39.9**	**40.0 - 49.9**	**50.0-59.9**	**60.0-69.9**	**70.0-79.9**	**80.0-89.9**	**90.0 - 99.9**	**>100.0**
Secondary Forest: Lowland Mixed Dipterocarp - Limestone vegetation	2	4	*Pterospermum elongatum*	24.0	1.52	20.41	11.3	4.0	4.0	3.3	1.3					
			Nauclea orientalis	7.3	0.52	6.59	2.0	2.0	2.0	1.3						
			Colona serratifolia	5.3	0.55	6.00	0.7	0.7	1.3	2.7						
			Aglaia	5.3	0.42	5.09	0.7	2.0	2.0	0.7						
			Croton	4.7	0.27	3.82	0.7	2.7	1.3							
			Pterospermum javanicum	2.0	0.41	3.65	1.3								0.7	
Gomantong			*Dimocarpus longan*	3.3	0.30	3.42	0.7	1.3	0.7		0.7					
			Cryodophnopsis tokenensis	4.0	0.21	3.10	2.0	0.7	1.3							
			Magnolia	4.0	0.15	2.70	2.0	1.3	0.7							

	Diospyros	3.3	0.15	2.40	1.3	1.3	0.7				
	Ficus	4.0	0.09	2.28	2.7	1.3					
	Mitragyna speciosa	2.0	0.21	2.27	0.7			1.3			
	Polyalthia	2.0	0.18	2.07		1.3			0.7		
	Cleistanthus	3.3	0.09	2.02	2.0	1.3					
	Alstonia angustiloba	1.3	0.20	1.94		0.7			0.7		
	Chionanthus	2.7	0.09	1.73	1.3	1.3					
	Alstonia	0.7	0.19	1.56						0.7	
	Dracontomelon dao	1.3	0.14	1.53	0.7				0.7		
	Spathiostemon javensis	2.7	0.06	1.49	2.0	0.7					
	Myristica	0.7	0.18	1.48					0.7		
	Duabanga mollucana	0.7	0.16	1.40					0.7		
	Octomeles sumatrana	1.3	0.12	1.38			1.3				
	Microcos	2.0	0.08	1.36	0.7	1.3					
	Shorea johorensis	0.7	0.14	1.24					0.7		
	Neolamarckia cadamba	1.3	0.09	1.15		0.7	0.7				
	Xanthophyllum	1.3	0.07	1.01	0.7		0.7				
	Vitex pinnata	2.0	0.02	0.98	2.0						

	Chisocheton	1.3	0.06	0.96		1.3	
	Litsea	1.3	0.06	0.95		1.3	
	Dendrocnide elliptica	1.3	0.04	0.84	0.7	0.7	
	Saraca declinata	0.7	0.07	0.77			0.7
	Ludekia borneensis	1.3	0.03	0.74	1.3		
	Urticaceae	1.3	0.02	0.71	1.3		
	Mallotus muticus	1.3	0.02	0.70	1.3		
	Hopea nervosa	1.3	0.01	0.66	1.3		
	Rinorea	1.3	0.01	0.66	1.3		
	Pisonia umbellifera	0.7	0.04	0.55		0.7	
	Shorea agami	0.7	0.04	0.55		0.7	
	Myristicaceae	0.7	0.03	0.51		0.7	
	Sapotaceae	0.7	0.03	0.51		0.7	
	Mallotus floribundus	0.7	0.03	0.47		0.7	
	Sindora	0.7	0.02	0.45		0.7	
	Pometia pinnata	0.7	0.02	0.44		0.7	
	Mallotus	0.7	0.02	0.43		0.7	
	Kibatalia	0.7	0.02	0.42		0.7	

	Mallotus penangensis	0.7	0.02	0.41	0.7							
	Aporosa acuminatissima	0.7	0.02	0.40	0.7							
	Madhuca	0.7	0.02	0.39	0.7							
	Artocarpus	0.7	0.01	0.38	0.7							
	Drypetes	0.7	0.01	0.36	0.7							
	Unknown	0.7	0.01	0.36	0.7							
	Adenanthera pavonina	0.7	0.01	0.35	0.7							
	Nephelium lappaceum	0.7	0.01	0.35	0.7							
	Glochidion	0.7	0.01	0.35	0.7							
	Aglaia oligophylla	0.7	0.01	0.34	0.7							
	Hydnocarpus	0.7	0.01	0.33	0.7							
	Baccaurea	0.7	0.01	0.33	0.7							
	Dillenia excelsa	0.7	0.01	0.32	0.7							
	Total	119.3	7.35	100.00	51.3	34.0	17.3	9.3	6.0	0.7	0.7	

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**Diameter Class (cm)**								
							10.0 - 19.9	**20.0 - 29.9**	**30.0 - 39.9**	**50.0-59.9**	**60.0-69.9**	**70.0-79.9**	**80.0-89.9**	**90.0 - 99.9**	**>100.0**
Secondary Forest: Lowland Mixed Dipterocarp - Limestone vegetation	2	5	*Pterospermum elongatum*	20.4	1.32	10.32	7.9	7.2	1.3	2.6	0.7	0.7			
			Spathiostemon javensis	27.6	0.73	9.21	19.7	6.6	1.3						
			Diospyros	9.9	0.53	4.51	6.6	1.3	1.3					0.7	

	Cryodophnopsis tokenensis	6.6	0.63	4.23	1.3	2.0	1.3	1.3	0.7
	Sumbaviopsis albicans	11.2	0.36	4.02	5.9	4.6	0.7		
	Chisocheton	6.6	0.48	3.57	2.0	1.3	2.0	0.7	0.7
Gomantong	*Octomeles sumatrana*	5.3	0.49	3.35	0.7	2.0	0.7	1.3	0.7
	Drypetes	8.6	0.29	3.14	3.9	3.9	0.7		
	Colona serratifolia	6.6	0.26	2.56	2.6	3.3		0.7	
	Cleistanthus myrianthus	7.9	0.18	2.50	6.6	1.3			
	Dryobalanops lanceolata	4.6	0.31	2.39	1.3	0.7	2.0	0.7	
	Chionanthus	3.3	0.32	2.17		2.0		0.7	0.7
	Aglaia	6.6	0.13	1.99	5.3	1.3			
	Ficus variegata	4.6	0.21	1.93	3.3	0.7			0.7

Canarium odontophyllum 2.6		0.29	1.87 0.7 0.7 0.7
		0.7	
Neonauclea artocarpioides 5.9		0.12	1.81 4.6
		1.3	
Parashorea malaanonan 1.3		0.32	1.70 0.7 0.7
Dimocarpus dentatus 3.3		0.21	1.65 2.0 0.7
		0.7	
Shorea guiso 2.0		0.26	1.60 1.3 0.7
Polyalthia 4.6		0.10	1.44 3.9
		0.7	
Hopea beccariana 1.3		0.24	1.36 0.7 0.7
Cynometra 2.6		0.16	1.30 1.3 0.7
		0.7	
Saraca declinata 3.3		0.13	1.29 1.3 1.3
		0.7	
Magnolia 1.3		0.21	1.21 0.7
		0.7	
Ficus treubii 3.9		0.07	1.18 3.3
		0.7	
Artocarpus anisophyllus 0.7		0.22	1.12 0.7
Enicosanthum 3.3		0.09	1.09 2.0
		1.3	
Ficus 2.6		0.11	1.08 2.0
		0.7	
Paranephelium joannis 2.0		0.14	1.05 0.7
		1.3	
Neolamarckia cadamba 1.3		0.16	1.02 0.7 0.7
Alangium 3.3		0.07	
		1.01 3.3	
Ficus nota 3.3		0.07	
		1.00 3.3	
Garcinia 1.3		0.13	0.89 0.7
		0.7	
Canarium 2.6		0.06	0.86 2.0
		0.7	
Syzygium 2.0		0.08	0.79 1.3
		0.7	
Croton argyratus 2.0		0.08	
		0.76 2.0	
Knema 1.3		0.10	0.74 0.7
		0.7	
Shorea gibbosa 0.7		0.13	0.72 0.7
Myristica malaccensis 0.7		0.12	0.68 0.7
Dehaasia 0.7		0.11	0.65 0.7

Murraya paniculata 2.0			0.04	0.60	2.0		
Melicope 2.0			0.03	0.57	2.0		
Dracontomelon dao 2.0			0.02	0.51	2.0		
Mischocarpus 1.3			0.05	0.50	0.7	0.7	
Endiandra maingayi 1.3			0.05	0.49	0.7	0.7	
Leucosyke capitellata 1.3			0.04	0.44	0.7	0.7	
Shorea pauciflora 0.7			0.07		0.44	0.7	
Teijsmanniodendron 1.3			0.03	0.41	0.7	0.7	
Chrysophyllum 1.3			0.03	0.41	1.3		
Neonauclea 0.7			0.06		0.41	0.7	
Madhuca kingiana 1.3			0.02	0.39	1.3		
Sapindaceae 1.3			0.02	0.38	1.3		
Azadirachta excelsa 0.7			0.05		0.38	0.7	
Anacolosa frutescens 1.3			0.02	0.37	1.3		
Parashorea tomentella 0.7			0.05		0.36	0.7	
Leea indica 1.3			0.02	0.35	1.3		
Castanopsis 0.7			0.05		0.35	0.7	
	Shorea leptoderma	0.7	0.05	0.35			0.7
	Timonius villamilii	0.7	0.05	0.35			0.7
	Microcos	1.3	0.01	0.35	1.3		
	Callicarpa pentandra	0.7	0.04	0.32		0.7	
	Ptychopyxis	0.7	0.04	0.31		0.7	
	Nauclea artocarpoides	0.7	0.03	0.27		0.7	
	Microcos crassifolia	0.7	0.02	0.24		0.7	
	Artocarpus elasticus	0.7	0.02	0.23		0.7	
	Macaranga tanarius	0.7	0.02	0.22	0.7		
	Cananga odorata	0.7	0.02	0.21	0.7		

	Pometia pinnata	0.7	0.01	0.21	0.7
	Verbenaceae	0.7	0.01	0.21	0.7
	Unknown	0.7	0.01	0.20	0.7
	Vernonia arborea	0.7	0.01	0.20	0.7
	Eusideroxylon zwageri	0.7	0.01	0.20	0.7
	Acalypha caturus	0.7	0.01	0.20	0.7
	Dacryodes	0.7	0.01	0.19	0.7
	Madhuca	0.7	0.01	0.19	0.7
	Xanthophyllum flavescens	0.7	0.01	0.18	0.7
	Ficus lepicarpa	0.7	0.01	0.18	0.7
	Aglaia odoratissima	0.7	0.01	0.18	0.7
	Hopea	0.7	0.01	0.18	0.7
	Cleistanthus	0.7	0.01	0.18	0.7
	Clausena excavata	0.7	0.01	0.17	0.7
	Pterospermum javanicum	0.7	0.01	0.17	0.7
	Ormosia bancana	0.7	0.01	0.17	0.7
	Bridelia penangiana	0.7	0.01	0.17	0.7
	Actinodaphne	0.7	0.01	0.17	0.7

	Citrus	0.7	0.01	0.17	0.7						
	Alstonia	0.7	0.01	0.17	0.7						
	Dipterocarpus	0.7	0.01	0.16	0.7						
	Ludekia borneensis	0.7	0.01	0.16	0.7						
	Total	232.2	11.12	100.00	132.9	53.3	23.0	12.5	5.9	3.9	0.7

Forest type/Soil Asso.	**Block**	**Line**	**Species**	**Density / ha**	**Basal Area / ha**	**Relative Dominance (%)**	**Diameter Class (cm) 10.0 - 19.9**	**20.0 - 29.9**	**30.0 - 39.9**	**40.0 - 49.9**	**50.0-59.9**	**60.0-69.9**	**70.0-79.9**	**80.0-89.9**	**90.0 - 99.9**	**>100.0**
Peatswamp Forest Seasonal Freshwater Swamp Forest	--	1	13	*Vitex pinnata*	60.5	3.21	31.09	24.0	19.0	13.5	2.5	1.5				
				Alstonia	3.5	1.27	6.79		0.5		0.5	0.5	1.0	0.5		0.5
				Dracontomelon dao	9.0	0.84	6.30	3.0	2.0	1.5	0.5	1.5	0.5			
				Syzygium	11.5	0.52	5.47	7.5	2.0	0.5	1.0		0.5			
				Pternandra galeata	8.5	0.29	3.62	6.0	1.0	1.5						
				Shorea leprosula	4.5	0.52	3.58	1.0	1.0	1.0		1.0	0.5			
				Ilex cymosa	9.0	0.24	3.55	6.0	2.5	0.5						
Klias				*Nauclea subdita*	4.0	0.46	3.19	0.5	1.0	0.5	1.0	1.0				
				Planchonia valida	2.5	0.47	2.84		1.0			0.5	0.5	0.5		
				Elaeocarpus nitidum	7.0	0.17	2.67	5.5	1.5							
				Glochidion	5.0	0.25	2.52	3.5	1.0				0.5			

Cananga odorata	5.5	0.17	2.28	3.5	1.5	0.5				
Baccaurea bracteata	5.5	0.17	2.27	4.5		1.0				
Vatica rassak	5.5	0.16	2.22	4.0	1.0	0.5				
Neolamarckia cadamba	3.0	0.29	2.13		0.5	2.0	0.5			
Myristica	2.0	0.23	1.57	0.5		1.0		0.5		
Dillenia excelsa	4.0	0.07	1.38	4.0						
Xylosma	2.5	0.14	1.30	2.0				0.5		
Drypetes	3.5	0.04	1.14	3.5						
Octomeles sumatrana	0.5	0.18	0.97						0.5	
Ludekia borneensis	1.0	0.14	0.93			0.5		0.5		
Nauclea	0.5	0.14	0.78						0.5	
Unknown	0.5	0.14	0.78						0.5	
Lophopetalum multinervium	1.5	0.06	0.70		1.5					
Bridelia penangiana	2.0	0.03	0.69	2.0						
Polyalthia	1.0	0.08	0.65		0.5		0.5			
Macaranga conifera	2.0	0.02	0.65	2.0						
Sterculia	1.0	0.07	0.60			1.0				
Diospyros	1.5	0.03	0.55	1.0	0.5					

	Microcos crassifolia	1.5	0.03	0.54	1.5			
	Notaphobe	0.5	0.08	0.52				0.5
	Pterospermum elongatum	1.0	0.04	0.44	0.5	0.5		
	Archidendron	1.0	0.02	0.37	1.0			
	Bridelia	1.0	0.02	0.36	1.0			
	Diospyros wallichii	1.0	0.02	0.34	1.0			
	Ficus nota	0.5	0.04	0.32			0.5	
	Sindora	0.5	0.03	0.25		0.5		
	Carallia brachiata	0.5	0.02	0.24		0.5		
	Calophyllum	0.5	0.02	0.23		0.5		
	Gomphia serrata	0.5	0.02	0.22		0.5		
	Mischocarpus	0.5	0.02	0.22		0.5		
	Aphanamixis	0.5	0.01	0.20	0.5			
	Lophopetalum	0.5	0.01	0.20	0.5			
	Ficus variegata	0.5	0.01	0.19	0.5			
	Garcinia	0.5	0.01	0.19	0.5			
	Mangifera	0.5	0.01	0.19	0.5			
	Baccaurea stipulata	0.5	0.01	0.17	0.5			

	Elaeocarpus	0.5	0.01	0.17	0.5							
	Nephelium	0.5	0.01	0.17	0.5							
	Cryptocarya	0.5	0.01	0.16	0.5							
	Actinodaphne	0.5	0.01	0.16	0.5							
	Polyalthia obliqua	0.5	0.00	0.16	0.5							
	Ficus	0.5	0.00	0.16	0.5							
	Memecylon paniculatum	0.5	0.00	0.16	0.5							
	Artocarpus kemando	0.5	0.00	0.15	0.5							
	Vatica umbonata	0.5	0.00	0.15	0.5							
	Antidesma thwaitesianum	0.5	0.00	0.15	0.5							
	Total	185.0	10.89	100.00	97.0	41.0	26.0	7.0	7.5	5.0	1.0	0.5

APPENDIX IV List of Plants

List of Flora Recorded in Pin-Supu Forest Reserve

Species	Family	Endemism	IUCN Red List	Group	H	SFD Prohibited	SWCE	CITES
Acacia pennata	Fabaceae	Not	NE	Ad	c	No	No	No
Acalypha caturus	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Actinodaphne glomerata	Lauraceae	Not	NE	Ad	t	No	No	No
Adenanthera pavonina	Fabaceae	intro	NE	Ad	t	No	No	No
Adinandra myrioneura	Pentaphylacaceae	Borneo	NE	Ad	t	No	No	No
Aeschynanthus tricolor	Gesneriaceae	Borneo	NE	Ad	c	No	No	No
Agelaea borneensis	Connaraceae	Not	NE	Ad	c	No	No	No
Aglaia beccarii	Meliaceae	Not	NE	Ad	t	No	No	No
Aglaia borneensis	Meliaceae	Not	NE	Ad	t	No	No	No
Aglaia grandis	Meliaceae	Not	NT	Ad	t	No	No	No
Aglaia odoratissima [Syn: *A. affinis*]	Meliaceae	Not	LC	Ad	t	No	No	No
Aglaia oligophylla	Meliaceae	Not	NT	Ad	t	No	No	No
Alangium griffithii	Cornaceae	Not	NE	Ad	t	No	No	No
Alangium javanicum	Cornaceae	Not	LC	Ad	t	No	No	No
Allophylus cobbe	Sapindaceae	Not	NE	Ad	t	No	No	No
Alocasia denudata	Araceae	Not	NE	Am	h	No	No	No
Alocasia heterophylla	Araceae	Not	NE	Am	h	No	No	No
Alocasia regia (reginae?)	Araceae	Borneo	NE	Am	h	No	No	No
Alstonia angustiloba	Apocynaceae	Not	LC	Ad	t	No	No	No
Alstonia macrophylla	Apocynaceae	Not	LC	Ad	t	No	No	No
Anacolosa frutescens	Olacaceae	Not	NE	Ad	t	No	No	No
Antidesma thwaitesianum	Phyllanthaceae	Not	NE	Ad	t	No	No	No
Antidesma tomentosum var. *tomentosum*	Phyllanthaceae	Not	NE	Ad	t	No	No	No
Aporosa acuminatissima	Phyllanthaceae	Not	NE	Ad	t	No	No	No
Aporosa nitida	Phyllanthaceae	Borneo	NE	Ad	t	No	No	No
Aquillaria malaccensis	Thymelaeaceae	Not	VU	Ad	t	Yes	No	Yes
Archidendron clypearia	Fabaceae	Not	NE	Ad	c	No	No	No
Aristolochia minutiflora	Aristolochiaceae	Not	NE	Ad	c	No	No	No
Artocarpus anisophyllus	Moraceae	Not	NE	Ad	t	No	No	No
Artocarpus elasticus	Moraceae	Not	NE	Ad	t	No	No	No
Azadirachta excelsa	Meliaceae	Not	NE	Ad	t	No	No	No
Baccaurea tetrandra	Phyllanthaceae	Not	NE	Ad	t	Yes	No	No
Barringtonia curranii	Lecythidaceae	Not	NE	Ad	t	No	No	No
Barringtonia lanceolata	Lecythidaceae	Borneo	NE	Ad	t	No	No	No
Barringtonia pterita	Lecythidaceae	Not	NE	Ad	t	No	No	No
Barringtonia sarcostachys	Lecythidaceae	Not	NE	Ad	t	No	No	No
Bauhinia diptera	Fabaceae	Borneo	NE	Ad	c	No	No	No
Bauhinia semibifida	Fabaceae	Not	NE	Ad	c	No	No	No
Beilschmiedia assamica	Lauraceae	Not	NE	Ad	t	No	No	No
Beilschmiedia micrantha	Lauraceae	Borneo	NE	Ad	t	No	No	No
Beilschmiedia quadrae	Lauraceae	Not	NE	Ad	t	No	No	No

Bridelia minutiflora	Phyllanthaceae	Not	NE	Ad	t	No	No	No
Bridelia penangiana	Phyllanthaceae	Not	NE	Ad	t	No	No	No
Bridelia stipularis	Phyllanthaceae	Not	NE	Ad	c	No	No	No
Brownlowia stipulata	Malvaceae	Not	NE	Ad	t	No	No	No
Buchanania arborescens	Anacardiaceae	Not	NE	Ad	t	No	No	No
Buchanania sessifolia	Anacardiaceae	Not	NE	Ad	t	No	No	No
Calamus acuminatus	Arecaceae	Sabah	NE	Am	c	No	No	No
Calamus caesius	Arecaceae	Not	NE	Am	c	No	No	No
Calamus javensis	Arecaceae	Not	NE	Am	c	No	No	No
Calamus praetermissus	Arecaceae	Borneo	NE	Am	c	No	No	No
Callicarpa pentandra	Lamiaceae	Not	NE	Ad	t	No	No	No
Calophyllum blancoi	Calophyllaceae	Not	NE	Ad	t	No	No	No
Cananga odorata	Annonaceae	Not	NE	Ad	t	No	No	No
Canarium decumanum	Burseraceae	Not	NE	Ad	t	No	No	No
Canarium denticulatum	Burseraceae	Not	NE	Ad	t	No	No	No
Canarium hirsutum	Burseraceae	Not	NE	Ad	t	No	No	No
Canarium odontophyllum	Burseraceae	Not	NE	Ad	t	No	No	No
Carallia brachiata	Rhizopharaceae	Not	NE	Ad	t	No	No	No
Caryodaphnopsis tonkinensis	Lauraceae	Not	NE	Ad	t	No	No	No
Casaeria grewiaefolia	Salicaceae	Not	NE	Ad	t	No	No	No
Cassia javanica	Fabaceae	Not	NE	Ad	t	No	No	No
Cericoides perakensis	Rubiaceae	Not	NE	Ad	c	No	No	No
Chassalia chartacea	Rubiaceae	Not	NE	Ad	s	No	No	No
Chionanthus oliganthus	Oleaceae	Not	NE	Ad	t	No	No	No
Chromolaena odoratum	Asteraceae	Not	NE	Ad	s	No	No	No
Cinnamomum griffithii	Lauraceae	Not	NE	Ad	t	No	No	No
Claoxylon praetermissum	Euphorbiaceae	Sabah	NE	Ad	t	No	No	No
Clausena excavata	Rutaceae	Not	NE	Ad	t	No	No	No
Cleistanthus myrianthus	Phyllanthaceae	Not	NE	Ad	t	No	No	No
Clidemia hirta	Melastomataceae	intro	NE	Ad	s	No	No	No
Colona serratifolia	Malvaceae	Not	NE	Ad	t	No	No	No
Connarus winkleri subsp. winkleri	Connaraceae	Not	NE	Ad	c	No	No	No
Coscinum fenestriatum	Menispermaceae	Not	NE	Ad	c	No	No	No
Cratoxylum arborescens	Hypericaceae	Not	LC	Ad	t	No	No	No
Croton argyratus	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Croton oblongifolius	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Crudia reticulata	Fabaceae	Borneo	NE	Ad	t	No	No	No
Cryptocarya griffithiana	Lauraceae	Not	NE	Ad	t	No	No	No
Cubilia cubili	Sapindaceae	Not	LC	Ad	t	No	No	No
Cyathostemma excelsum	Annonaceae	Not	NE	Ad	c	No	No	No
Cynometra inaequifolia	Fabaceae	Not	VU	Ad	t	No	No	No
Cyrtandra angularis	Gesneriaceae	Not	NE	Ad	c	No	No	No
Daemonorops fissa	Arecaceae	Borneo	NE	Am	c	No	No	No
Daemonorops longipas	Arecaceae	Not	NE	Am	c	No	No	No
Daemonorops sabut	Arecaceae	Not	NE	Am	c	No	No	No
Daemonorops sparsiflora	Arecaceae	Borneo	NE	Am	c	No	No	No
Deheasia cuneata	Lauraceae	Not	NE	Ad	t	No	No	No

Dendrocnide elliptica	Urticaceae	Not	NE	Ad	t	No	No	No

Dialium indum	Fabaceae	Not	NE	Ad	t	No	No	No
Dillenia excelsa	Dilleniaceae	Not	NE	Ad	t	No	No	No
Dillenia indica	Dilleniaceae	Not	NE	Ad	t	No	No	No
Dimocarpus dentatus	Sapindaceae	Borneo	NE	Ad	t	No	No	No
Dimocarpus longan	Sapindaceae	intro	NT	Ad	t	No	No	No
Dinochloa scabrida	Poaceae	Borneo	NE	Am	c	No	No	No
Diospyros borneensis	Ebenaceae	Not	NE	Ad	t	No	No	No
Diospyros elliptifolia	Ebenaceae	Not	NE	Ad	t	No	No	No
Diospyros euphlebia	Ebenaceae	Borneo	NE	Ad	t	No	No	No
Diospyros macrophylla	Ebenaceae	Not	NE	Ad	t	No	No	No
Diospyros polyalthoides	Ebenaceae	Not	NE	Ad	t	No	No	No
Diospyros squmaefolia	Ebenaceae	Sabah	NE	Ad	t	No	No	No
Diospyros toposioides	Ebenaceae	Not	NE	Ad	t	No	No	No
Diospyros tuberculata	Ebenaceae	Borneo	NE	Ad	t	No	No	No
Diplodiscus parviflorus	Malvaceae	Not	NE	Ad	t	No	No	No
Dipterocarpus acutangulus	Dipterocarpaceae	Not	NE	Ad	t	No	No	No
Dipterocarpus caudiferus	Dipterocarpaceae	Borneo	NE	Ad	t	No	No	No
Dipterocarpus kerrii	Dipterocarpaceae	Not	CR	Ad	t	No	No	No
Dipterocarpus validus	Dipterocarpaceae	Not	CR	Ad	t	No	No	No
Dischidia benghalensis	Apocynaceae	Not	NE	Ad	c	No	No	No
Dissochaeta cf. *annulata*	Melastomataceae			Ad	c	No	No	No
Donax canniformis	Marantaceae	Not	NE	Am	s	No	No	No
Dracaena angustifolia	Asaparagaceae	Not	NE	Am	s	No	No	No
Dracontomelon dao	Anacardiaceae	Not	NE	Ad	t	Yes	No	No
Drynaria sparsisora	Polypodiaceae	Not	NE	F	f	No	No	No
Dryobalanops lanceolata	Dipterocarpaceae	Borneo	EN	Ad	t	No	No	No
Drypetes caesia	Putranjivaceae	Borneo	NE	Ad	t	No	No	No
Drypetes crassipes	Putranjivaceae	Not	NE	Ad	t	No	No	No
Drypetes kikir	Putranjivaceae	Not	NE	Ad	t	No	No	No
Duabanga mollucana	Lythraceae	Not	NE	Ad	t	No	No	No
Durio zibethinus	Malvaceae	Not	NE	Ad	t	Yes	No	No
Elaeocarpus stipularis	Elaeocarpaceae	Not	NE	Ad	t	No	No	No
Ellipanthus beccarii var. peltatus	Connaraceae	Borneo	NE	Ad	c	No	No	No
Endiandra maingayi	Lauraceae	Not	LC	Ad	t	No	No	No
Ensideroxylon zwageri	Lauraceae	Not	VU	Ad	t	No	No	No
Eria javanica	Orchidaceae	Not	NE	Am	h	No	Yes	Yes
Erycibe borneensis	Convolvulaceae	Borneo	NE	Ad	t	No	No	No
Erythroxylum cuneatum	Erythroxylaceae	Not	NE	Ad	t	No	No	No
Fagraea cf. cuspidata	Gentianaceae			Ad	t	No	No	No
Fagraea cuspidata	Gentianaceae	Not	NE	Ad	t	No	No	No
Fagraea elliptica	Gentianaceae	Not	NE	Ad	t	No	No	No
Ficus annulata	Moraceae	Not	NE	Ad	t	No	No	No
Ficus endospermifolia	Moraceae	Borneo	NE	Ad	t	No	No	No
Ficus lepicarpa	Moraceae	Not	NE	Ad	t	No	No	No
Ficus nota	Moraceae	Not	NE	Ad	t	No	No	No

Ficus racemosa	Moraceae	Not	NE	Ad	t	No	No	No
Ficus septica	Moraceae	Not	NE	Ad	t	No	No	No

Ficus treubii	Moraceae	Borneo	NE	Ad	t	No	No	No
Ficus variegata	Moraceae	Not	NE	Ad	t	No	No	No
Friesodielsia glauca	Annonaceae	Not	NE	Ad	c	No	No	No
Garcinia forbesi	Clusiaceae	Not	NE	Ad	t	No	No	No
Garcinia parvifolia	Clusiaceae	Not	NE	Ad	t	No	No	No
Gardenia tubifera	Rubiaceae	Not	NE	Ad	t	No	No	No
Gironniera nervosa	Cannabaceae	Not	NE	Ad	t	No	No	No
Globba franciscii	Zingiberaceae	Borneo	NE	Am	h	No	Yes	No
Glochidion obscurum	Phyllanthaceae	Not	NE	Ad	t	No	No	No
Glochidion rubrum	Phyllanthaceae	Not	NE	Ad	t	No	No	No
Gluta sabahana	Anacardiaceae	Sabah	NE	Ad	t	No	No	No
Gluta wallichii	Anacardiaceae	Not	NE	Ad	t	No	No	No
Gnetum leptostachyum	Gnetaceae	Not	LC	G	t	No	No	No
Gonocaryum macrophyllum	Cardiopteridaceae	Not	NE	Ad	t	No	No	No
Grewia acuminata	Malvaceae	Not	NE	Ad	t	No	No	No
Guioa pleuropteris	Sapindaceae	Not	NE	Ad	t	No	No	No
Hedyotis rigida	Rubiaceae	Not	NE	Ad	s	No	No	No
Helminthostaclys zeylanica	Ophioglossaceae	Not	NE	F	f	No	No	No
Homalium caryophyllaceum	Salicaceae	Not	NE	Ad	t	No	No	No
Homalium foetidum	Salicaceae	Not	LC	Ad	t	No	No	No
Hopea sangal	Dipterocarpaceae	Not	CR/NT*	Ad	t	No	No	No
Hopea beccariana	Dipterocarpaceae	Not	CR/LC*	Ad	t	No	No	No
Hopea nervosa	Dipterocarpaceae	Not	CR/LC*	Ad	t	No	No	No
Hopea nutans	Dipterocarpaceae	Not	CR	Ad	t	No	No	No
Hydnocarpus anomalus	Achariaceae	Borneo	NE	Ad	t	No	No	No
Hydnocarpus borneensis	Achariaceae	Borneo	NE	Ad	t	No	No	No
Hydnocarpus polypetalus	Achariaceae	Not	NE	Ad	t	No	No	No
Hydnocarpus subfalcata	Achariaceae	Not	NE	Ad	t	No	No	No
Hydnocarpus woodii	Achariaceae	Not	NE	Ad	t	No	No	No
Hymenodictyon orixense	Rubiaceae	Not	NE	Ad	t	No	No	No
Intsia palembanica	Fabaceae	Not	NE	Ad	t	Yes	No	No
Irvingia malayana	Irvingiaceae	Not	LC	Ad	t	No	No	No
Ixora elliptica	Rubiaceae	Not	NE	Ad	t	No	No	No
Ixora grandifolia	Rubiaceae	Not	NE	Ad	t	No	No	No
Jasminum melastomifolium	Oleaceae	Borneo	NE	Ad	c	No	No	No
Kibara coriacea	Monimiaceae	Not	LC	Ad	c	No	No	No
Kleinhovia hospita	Malvaceae	Not	NE	Ad	t	No	No	No
Knema cinerea	Myristicaceae	Not	NE	Ad	t	No	No	No
Knema laurina	Myristicaceae	Not	NE	Ad	t	No	No	No
Koompassia malaccensis	Fabaceae	Not	LC	Ad	t	Yes	No	No
Koordersiodendron pinnatum	Anacardiaceae	Not	NE	Ad	t	No	No	No
Korthalsia concolor	Arecaceae	Borneo	NE	Am	c	No	No	No
Korthalsia furtadoana	Arecaceae	Borneo	NE	Am	c	No	No	No
Korthalsia jala	Arecaceae	Borneo	NE	Am	c	No	No	No

Korthalsia rigida	Arecaceae	Not	NE	Am	c	No	No	No
Korthalsia robusta	Arecaceae	Not	NE	Am	c	No	No	No
Lagerstroemia speciosa	Lythraceae	intro	NE	Ad	t	No	No	No
Leea indica	Vitaceae	Not	NE	Ad	t	No	No	No

Lepisanthes rubiginosa	Sapindaceae	Not	NE	Ad	t	No	No	No
Leucosyke capitellata	Urticaceae	Not	NE	Ad	t	No	No	No
Linostoma pauciflorum	Thymelaeaceae	Not	NE	Ad	t	No	No	No
Litsea cf. oppositifolia	Lauraceae			Ad	t	No	No	No
Litsea citrata	Lauraceae	Not	NE	Ad	t	No	No	No
Litsea lancifolia var. *lancifolia*	Lauraceae	Not	NE	Ad	t	No	No	No
Litsea oppositifolia	Lauraceae	Borneo	NE	Ad	t	No	No	No
Lophopetalum beccarianum	Celestraceae	Not	NE	Ad	t	No	No	No
Lophopetalum multinervium	Celastraceae	Not	NE	Ad	t	No	No	No
Ludekia borneensis	Rubiaceae	Borneo	NE	Ad	t	No	No	No
Lygodium circinatum	Lygodiaceae	Not	NE	F	f	No	No	No
Macaranga conifera	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Macaranga gigantea	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Macaranga gigantea	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Macaranga hypoleuca	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Macaranga pearsonii	Euphorbiaceae	Borneo	NE	Ad	t	No	No	No
Macaranga tanarius	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Macaranga triloba	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Macrosolen macrophyllus	Loranthaceae	Not	NE	Ad	t	No	No	No
Madhuca dubardii	Sapotaceae	Not	NE	Ad	t	No	No	No
Madhuca kingiana	Sapotaceae	Not	NE	Ad	t	No	No	No
Mallotus floribundus	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Mallotus miquellianus	Euphorbiaceae	Not	NE	Ad	s	No	No	No
Mallotus mollissimus	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Mallotus muticus	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Mallotus peltatus	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Mallotus penangensis	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Mallotus philippensis	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Mammea calciphila	Calophyllaceae	Not	NE	Ad	t	No	No	No
Mangifera foetida	Anacardiaceae	Not	LC	Ad	t	Yes	No	No
Margaritaria indica	Phyllanthaceae	Not	NE	Ad	t	No	No	No
Melastoma malabatricum	Melastomataceae	Not	NE	Ad	s	No	No	No
Melicope confusa	Rutaceae	Not	NE	Ad	t	No	No	No
Melicope incana	Rutaceae	Not	NE	Ad	t	No	No	No
Melicope lunu-ankenda	Rutaceae	Not	NE	Ad	t	No	No	No
Memecylon beccarianum	Melastamataceae	Borneo	NE	Ad	t	No	No	No
Memecylon paniculatum	Melastomataceae	Not	NE	Ad	t	No	No	No
Mesua elmeri	Calophyllaceae	Not	NE	Ad	t	No	No	No
Mesua hexapetala	Calophyllaceae	Not	NE	Ad	t	No	No	No
Mesua macrantha	Calophyllaceae	Not	NE	Ad	t	No	No	No
Microcos crassifolia	Malvaceae	Borneo	NE	Ad	t	No	No	No
Microcos elmeri	Malvaceae	Borneo	NE	Ad	t	No	No	No

Microcos reticulata	Malvaceae	Not	NE	Ad	t	No	No	No
Milletia pinnata	Fabaceae	Not	NE	Ad	t	No	No	No
Mischocarpus sundaicus	Sapindaceae	Not	NE	Ad	t	No	No	No
Mitragyna speciosa	Rubiaceae	Not	NE	Ad	t	No	No	No
Murraya paniculata	Rutaceae	Not	NE	Ad	t	No	No	No

Myristica malaccensis	Myristicaceae	Not	NE	Ad	t	No	No	No
Myristica villosa	Myristicaceae	Borneo	NE	Ad	t	No	No	No
Nageia wallichiana	Podocarpaceae	Not	LC	G	t	No	No	No
Nauclea orientalis	Rubiaceae	Not	NE	Ad	t	No	No	No
Nauclea subdita	Rubiaceae	Not	NE	Ad	t	No	No	No
Neolamarckia cadamba	Rubiaceae	Not	NE	Ad	t	No	No	No
Neonauclea artocarpioides	Rubiaceae	Borneo	NE	Ad	t	No	No	No
Neonauclea gigantea	Rubiaceae	Borneo	NE	Ad	t	No	No	No
Neoscortechinia sumatrensis var. *angustifolia*	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Nephelium lappaceum	Sapindaceae	Not	LC	Ad	t	Yes	No	No
Nephelium ramboutan-ake	Sapindaceae	Not	NE	Ad	t	Yes	No	No
Nothaphoebe malabonga	Lauraceae	Not	NE	Ad	t	No	No	No
Ochanostachys amentacea	Olacaceae	Not	DD	Ad	t	No	No	No
Octomeles sumatrana	Datiscaceae	Not	LC	Ad	t	No	No	No
Ormosia bancana	Fabaceae	Not	NE	Ad	t	No	No	No
Oryza meyeriana	Poaceae	Not	NE	Am	g	No	No	No
Palaquium calophyllum	Sapotaceae	Not	NE	Ad	t	No	No	No
Pandanus pachyphyllus	Pandanaceae	Borneo	NE	Am	s	No	No	No
Paranephelium joannis	Sapindaceae	Borneo	NE	Ad	t	Yes	No	No
Paranephelium xestophyllum	Sapindaceae	Not	NE	Ad	t	Yes	No	No
Parashorea malaanonan	Dipterocarpaceae	Not	CR	Ad	t	No	No	No
Parashorea tomentella	Dipterocarpaceae	Borneo	NE	Ad	t	No	No	No
Passiflora foetida	Passifloraceae	intro	NE	Ad	c	No	No	No
Peltophorum racemosum	Fabaceae	Borneo	NE	Ad	t	No	No	No
Pentace adenophora	Malvaceae	Not	NE	Ad	t	No	No	No
Phrynium capitatum	Marantaceae	Not	NE	Am	s	No	No	No
Piper caninum	Piperaceae	Not	NE	Ad	c	No	No	No
Pipturus argenteus	Urticaceae	Not	NE	Ad	t	No	No	No
Pisonia umbellifera	Nyctaginaceae	Not	NE	Ad	t	No	No	No
Planchonia valida	Lecythidaceae	Not	NE	Ad	t	No	No	No
Plectocomiopsis mira	Arecaceae	Not	NE	Am	c	No	No	No
Pleiocarpidia sandakanica	Rubiaceae	Borneo	NE	Ad	t	No	No	No
Poikilospermum suaveolens	Urticaceae	NOt	NE	Ad	c	No	No	No
Polyalthia cauliflora	Annonaceae	Not	NE	Ad	t	No	No	No
Polyalthia obliqua	Annonaceae	Not	NE	Ad	t	No	No	No
Pometia pinnata	Sapindaceae	Not	NE	Ad	t	No	No	No
Pothos berbarianus	Araceae	Not	NE	Am	h	No	No	No
Pothos brevistylis	Araceae	Borneo	NE	Am	h	No	No	No
Prainea limpato	Moraceae	Not	NE	Ad	t	No	No	No
Procris frutescens	Urticaceae	Not	NE	Ad	t	No	No	No
Pternandra coerulescens	Melastomataceae	Not	NE	Ad	t	No	No	No

Pternandra crassicalyx	Melastomataceae	Borneo	NE	Ad	t	No	No	No
Pterocymbium javanicum	Malvaceae	Not	NE	Ad	t	No	No	No
Pterospermum diversifolium	Malvaceae	Not	NE	Ad	t	No	No	No
Pterospermum elongatum	Malvaceae	Not	NE	Ad	t	No	No	No
Pterospermum javanicum	Malvaceae	Not	NE	Ad	t	No	No	No
Ptychopyxis arborea	Euphorbiaceae	Borneo	NE	Ad	t	No	No	No

Pyrenaria parviflora	Theaceae	Not	NE	Ad	t	No	No	No
Rauvolfia sumatrana	Apocynaceae	Not	NE	Ad	t	No	No	No
Sandoricum maingayi	Meliaceae	Not	NE	Ad	t	No	No	No
Saraca declinata	Fabaceae	Not	NE	Ad	t	No	No	No
Scaphium longipetiolatum	Malvaceae	Borneo	NE	Ad	t	No	No	No
Semecarpus bunburyanus	Anacardiaceae	Not	NE	Ad	t	No	No	No
Shorea agamii	Dipterocarpaceae	Borneo	EN	Ad	t	No	No	No
Shorea argentifolia	Dipterocarpaceae	Borneo	EN	Ad	t	No	No	No
Shorea falciferoides	Dipterocarpaceae	Borneo	EN	Ad	t	No	No	No
Shorea foxworthii	Dipterocarpaceae	Not	CR	Ad	t	No	No	No
Shorea gibbosa	Dipterocarpaceae	Not	CR/LC*	Ad	t	No	No	No
Shorea guiso	Dipterocarpaceae	Not	CR/NT*	Ad	t	No	No	No
Shorea johorensis	Dipterocarpaceae	Not	CR/NT*	Ad	t	No	No	No
Shorea macrophylla	Dipterocarpaceae	Borneo	VU	Ad	t	Yes	No	No
Shorea macroptera	Dipterocarpaceae	Borneo	NE	Ad	t	No	No	No
Shorea mecisopterix	Dipterocarpaceae	Borneo	NE	Ad	t	Yes	No	No
Shorea multiflora	Dipterocarpaceae	Not	LC	Ad	t	No	No	No
Shorea pauciflora	Dipterocarpaceae	Not	EN/LC*	Ad	t	No	No	No
Shorea scrobiculata	Dipterocarpaceae	Not	NE/LC*	Ad	t	No	No	No
Shorea smithiana	Dipterocarpaceae	Borneo	CR	Ad	t	No	No	No
Shorea xanthophylla	Dipterocarpaceae	Borneo	CR	Ad	t	No	No	No
Sindora beccariana	Fabaceae	Borneo	DD	Ad	t	No	No	No
Spathiostemon javensis	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Stachyphrynium latifolium	Marantaceae	Not	NE	Am	s	No	No	No
Stenochlaena palustris	Blechnaceae	Not	NE	F	f	No	No	No
Sterculia rubiginosa var. *setistipula*	Malvaceae	Not	NE	Ad	t	No	No	No
Sterculia stipulata	Malvaceae	Borneo	NE	Ad	t	No	No	No
Sumbaviopsis albicans	Euphorbiaceae	Not	NE	Ad	t	No	No	No
Sympetalandra unijuga	Fabaceae	Not	NE	Ad	t	Yes	No	No
Symplocos cerasifolia	Symplocaceae	Not	NE	Ad	t	No	No	No
Symplocos fasciculata	Symplocaceae	Not	NE	Ad	t	No	No	No
Symplocos odoratissima var. *odoratissima*	Symplocaceae	Not	NE	Ad	t	No	No	No
Syzygium fastigiatum	Myrtaceae	Not	NE	Ad	t	No	No	No
Syzygium heterocladum	Myrtaceae	Not	NE	Ad	t	No	No	No
Syzygium kingii	Myrtaceae	Not	NE	Ad	t	No	No	No
Teijsmanniodendron holophyllum	Lamiaceae	Not	NE	Ad	t	No	No	No
Tetracera scandens	Dilleniaceae	Not	NE	Ad	c	No	No	No
Tetrastigma trifoliolatum	Vitaceae	Not	NE	Ad	c	No	Yes	No
Timonius villamilii	Rubiaceae	Borneo	NE	Ad	t	No	No	No

Trichosanthes quinquangulata	Cucurbitaceae	Not	NE	Ad	c	No	No	No
Trigoniastrum hypoleucum	Trigoniaceae	Not	NE	Ad	t	No	No	No
Uncaria cordata	Rubiaceae	Not	NE	Ad	c	No	No	No
Urophyllum griffithianum	Rubiaceae	Not	NE	Ad	t	No	No	No
Uvaria cauliflora	Annonaceae	Not	NE	Ad	c	No	No	No
Uvaria polyantha	Annonaceae	Not	NE	Ad	c	No	No	No
Vatica rassak	Dipterocarpaceae	Not	LC	Ad	t	No	No	No
Ventilago malaccensis	Rhamnaceae	Not	NE	Ad	c	No	No	No
Vernonia arborea	Asteraceae	Not	NE	Ad	t	No	No	No
Vitex pinnata	Lamiaceae	Not	NE	Ad	t	No	No	No
Walsura pinnata	Meliaceae	Not	NE	Ad	t	No	No	No
Xanthophyllum adenotus	Polygalaceae	Not	NE	Ad	t	No	No	No
Xanthophyllum adenotus var. *adenotus*	Polygalaceae	Not	NE	Ad	t	No	No	No
Xanthophyllum flavescens	Polygalaceae	Not	NE	Ad	t	No	No	No
Xanthyphyllum becarianum	Polygalaceae	Borneo	NE	Ad	t	No	No	No
Xylopia ferruginea	Annonaceae	Not	NE	Ad	t	No	No	No
Ziziphus angustifolius	Rhamnaceae	Not	NE	Ad	t	No	No	No
Ziziphus borneensis	Rhamnaceae	Borneo	NE	Ad	c	No	No	No

APPENDIX V List of Wildlife

Table A. List of mammal species in Pin Supu Forest Reserve. (Notes: IUCN Code, EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; & DD = Data Deficient.)

No.	Scientific name	Common name	Family	WCE Schedule (SWD)	Endemic	CITES Appendix	IUCN
1	*Bos javanicus*	Banteng, Tembadau	Bovidae	1	EN		
2	*Macaca nemestrina*	Pig-tailed Macaque	Cercopithecidae	2		VU	
3	*Nasalis larvatus*	Proboscis Monkey	Cercopithecidae	1		EN I	X
4	*Presbytis hosei*	Hose's Langur	Cercopithecidae	2	VU	X	
5	*Presbytis rubicunda*	Maroon Langur	Cercopithecidae	2	LC	X	
6	*Cervus unicolor*	Sambar Deer	Cervidae	3	VU		
7	*Elephas maximus borneensis*	Bornean Pygmy Elephant	Elephantidae	1	EN	I	X
8	*Neofelis diardi*	Clouded Leopard	Felidae	2	VU		
9	*Pardofelis badia*	Bay Cat	Felidae	2	EN	X	
10	*Pardofelis marmorata*	Marbled Cat	Felidae	2		VU I	
11	*Prionailurus planiceps*	Flat-headed Cat	Felidae	2	EN	I	
12	*Hylobates muelleri*	Bornean Gibbon	Hylobatidae	2	EN	X	
13	*Trichys fasciculata*	Long-tailed Porcupine	Hystricidae	2		LC	
14	*Nycticebus coucang*	Slow Loris	Lorisidae	2		VU I	
15	*Lutra perspicillata*	Smooth Otter	Mustelidae	2		VU II	
16	*Martes flavigula*	Yellow-throated Marten	Mustelidae	2		LC III	
17	*Mustela nudipes*	Malay Weasel	Mustelidae	2	LC		
18	*Mydaus javanensis*	Malay Badger	Mustelidae	2	LC		
19	*Pongo pygmaeus morio*	Orang-utan	Pongidae	1	EN	I	X
20	*Petaurista elegans*	Spotted Giant Flying Squirrel	Sciuridae	2		LC	
21	*Petaurista petaurista*	Common Giant Flying Squirrel	Sciuridae	2		LC	
22	*Ratufa affinis*	Pale Giant Squirrel	Sciuridae	2	NT		
23	*Rheithrosciurus macrotis*	Tufted Ground Squirrel	Sciuridae	2	VU		X
24	*Sus barbatus*	Bearded Pig	Suidae	3	VU		
25	*Tarsius bancanus*	Western Tarsier	Tarsiidae	2	VU	II	
26	*Tragulus javanicus*	Lesser Mouse Deer	Tragulidae	3		DD	
27	*Tragulus napu*	Greater Mousedeer	Tragulidae	3		LC	
28	*Helarctos malayanus*	Sun Bear	Ursidae	1	VU	I	

29	*Arctictis binturong*	Binturong	Viverridae	Schedule 2	Appendix III	VU		
30	*Arctogalidia trivirgata*	Small-toothed Palm Civet	Viverridae	Schedule 2		LC		
31	*Hemigalus derbyanus*	Banded Palm Civet	Viverridae	Schedule 2	Appendix II	VU		
32	*Herpestes semitorquatus*	Collared Mongoose	Viverridae	Schedule 2		DD		
33	*Paradoxurus hermaphroditus*	Common Palm Civet	Viverridae	Schedule 2		LC		
34	*Prionodon linsang*	Banded Linsang	Viverridae	Schedule 2	Appendix II	LC		
35	*Viverra tangalunga*	Malay Civet	Viverridae	Schedule 2		LC		
36	*Paguma larvata*	Masked Palm Civet	Viverridae	Schedule 2	Appendix III	L C		

Table B. List of terrestrial bird species in Pin Supu Forest Reserve. (Notes: IUCN Code, EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; & DD = Data Deficient.)

No.	Scientific name	Common name	Family	WCE (SWD)	CITES	IUCN	Endemic
1	*Accipiter trivirgatus*	Crested Goshawk	Accipitridae	Schedule 2		LC	
2	*Aviceda jerdoni*	Jerdon's Baza	Accipitridae	Schedule 2		LC	
3	*Haliaeetus leucogaster*	White-bellied Sea Eagle	Accipitridae		LC		
4	*Haliastur indus*	Brahminy Kite	Accipitridae	Schedule 2		LC	
5	*Ichthyophaga humilis*	Lesser Fish Eagle	Accipitridae	Schedule 2		NT	
6	*Spilornis cheela*	Crested Serpent Eagle	Accipitridae	Schedule 2			LC
7	*Spilornis kinabaluensis*	Mountain Serpent-eagle	Accipitridae	Schedule 2		VU	X
8	*Spizaetus cirrhatus*	Changeable Hawk Eagle	Accipitridae		LC		
9	*Spizaetus nanus*	Wallace's Hawk-eagle	Accipitridae	Schedule 2			VU
10	*Alcedo euryzona*	Blue-banded Kingfisher	Alcedinidae		VU		
11	*Alcedo meninting*	Blue-eared Kingfisher	Alcedinidae			LC	
12	*Lacedo melanops*	Bornean Banded Kingfisher	Alcedinidae		LC	X	
13	*Pelargopsis capensis*	Stork-billed Kingfisher	Alcedinidae		LC		
14	*Anhinga melanogaster*	Oriental Darter	Anhingidae	Schedule 2		NT	
15	*Ardea alba*	Great Egret	Ardeidae	LC			
16	*Ardea purpurea*	Purple Heron	Ardeidae	Schedule 2	LC		
17	*Bubulcus ibis*	Cattle Egret	Ardeidae	LC			
18	*Butorides striata*	Striated Heron	Ardeidae	LC			
19	*Egretta eulophotes*	Chinese Egret	Ardeidae	Schedule 2	VU		
20	*Egretta garzetta*	Little Egret	Ardeidae	Schedule 2	LC		
21	*Nycticorax caledonicus*	Black-crowned Night-Heron	Ardeidae	Schedule 2	LC		
22	*Aceros comatus*	White-crowned Hornbill	Bucerotidae	Schedule 2		NT	
23	*Aceros corrugatus*	Wrinkled Hornbill	Bucerotidae	Schedule 2		NT	
24	*Anorrhinus galeritus*	Bushy-crested Hornbill	Bucerotidae	Schedule 2		LC	
25	*Anthracoceros albirostris*	Oriental Pied Hornbill	Bucerotidae				LC
26	*Anthracoceros malayanus*	Black Hornbill	Bucerotidae	Schedule 2			NT
27	*Caprimulgus concretus*	Sunda Nightjar	Caprimulgidae	Schedule 2		VU	
28	*Ciconia stormi*	Storm's Stork	Ciconiidae	Schedule 2		EN	
29	*Leptoptilos javanicus*	Lesser Adjutant	Ciconiidae		VU		
30	*Orthotomus atrogularis*	Dark-necked Tailorbird	Cisticolidae		LC		
31	*Orthotomus ruficeps*	Ashy Tailorbird	Cisticolidae		LC		
32	*Chalcophaps indica*	Emerald Dove	Columbidae	Schedule 2		LC	
33	*Ducula aenea*	Green Imperial Pigeon	Columbidae			LC	
34	*Ducula pickeringii*	Grey Imperial Pigeon	Columbidae	Schedule 2		VU	

35	*Treron capellei*	Large Green Pigeon	Columbidae	Schedule 2			VU	
36	*Treron olax*	Little Green Pigeon	Columbidae		LC			
37	*Eurystomus orientalis*	Dollarbird	Coracidae	LC				
38	*Corvus enca*	Slender-billed Crow	Corvidae	LC				
39	*Corvus macrorhynchos*	Thick-billed Crow	Corvidae		LC			
40	*Cacomantis merulinus*	Plaintive Cuckoo	Cuculidae		LC			
41	*Centropus rectunguis*	Short-toed Coucal	Cuculidae	Schedule 2		VU		
42	*Centropus sinensis*	Greater Coucal	Cuculidae		LC			
43	*Phaenicophaeus chlorophaeus*	Raffle's Malkoha	Cuculidae		LC			
44	*Dicaeum trigonostigma*	Orange-bellied Flowerpecker	Dicaeidae		LC			
45	*Cymbirhynchus*	Black-and-red Broadbill	Eurylaimidae			LC	*macrorhynchos*	
46	*Eurylaimus ochromalus*	Black-and-yellow Broadbill	Eurylaimidae			NT		
47	*Hirundo rustica*	Barn Swallow	Hirundinidae			LC		
48	*Hirundo tahitica*	Pacific Swallow	Hirundinidae			LC		
49	*Chloropsis sonnerati*	Lesser Green Leafbird	Irenidae			LC		
50	*Chlidonias leucopterus*	White-wing Tern	Laridae		LC			
51	*Merops viridis*	Blue-throated Bee-Eater	Meropidae			LC		
52	*Hypothymis azurea*	Black-naped Monarch	Monarchidae				LC	
53	*Terpsiphone paradisi*	Asian Paradise Flycatcher	Monarchidae	Schedule 2			LC	
54	*Motacilla flava*	Yellow Wagtail	Motacillidae			LC		
55	*Cyornis caerulatus*	Large-billed Blue-flycatcher	Muscicapidae			VU		
56	*Rhinomyias brunneatus*	Brown-chested Jungle-flycatcher	Muscicapidae				VU	
57	*Arachnothera longirostra*	Little Spiderhunter	Nectariniidae				LC	
58	*Amaurornis phoenicurus*	White-breasted Waterhen	Phasianidae				LC	
59	*Arborophilla charltonii*	Chestnut Necklaced Partridge	Phasianidae	Schedule 2			VU	
60	*Argusianus argus*	Great Argus	Phasianidae	Schedule 2		Appendix II	NT	
61	*Lophura bulweri*	Wattled Pheasant	Phasianidae	Schedule 2			VU	X
62	*Lophura erythrophthalma*	Crestless Fireback	Phasianidae	Schedule 2				VU
63	*Lophura ignita*	Bornean Crested Fireback	Phasianidae	Schedule 2			NT	X
64	*Melanoperdix nigra*	Black Partridge	Phasianidae	Schedule 2			VU	
65	*Polyplectron*	Bornean Peacock-pheasant	Phasianidae	Schedule 2	Appendix II	EN	X	*schleiermacheri*
66	*Dryocopus javensis*	White-bellied Woodpecker	Picidae	Schedule 2	Appendix I	LC		
67	*Meiglyptes grammithorax*	Buff-rumped Woodpecker	Picidae			LC		
68	*Pitta baudii*	Blue-headed Pitta	Pittidae	Schedule 2		VU	X	
69	*Pitta nympha*	Fairy Pitta	Pittidae	Schedule 2	Appendix II	VU		
70	*Pitta sordida cucullata*	Hooded Pitta	Pittidae	Schedule 2		LC		
71	*Pitta ussheri*	Black and Crimson Pitta	Pittidae		NT	X		
72	*Criniger bres*	Grey-cheeked Bulbul	Pycnonotidae			LC		
73	*Pycnonotus brunneus*	Red-eyed Bulbul	Pycnonotidae			LC		
74	*Pycnonotus goiavier*	Yellow-vented Bulbul	Pycnonotidae				LC	
75	*Pycnonotus zeylanicus*	Straw-headed Bulbul	Pycnonotidae	Schedule 2		Appendix II	VU	
76	*Setornis criniger*	Hook-billed Bulbul	Pycnonotidae	Schedule 2			VU	
77	*Tricholestes criniger*	Hairy-backed Bulbul	Pycnonotidae			LC		

78	*Calorhamphus fuliginoses*	Bornean Brown Barbet	Ramphastidae								LC
	X										
79	*Megalaima australis*	Blue-eared Barbet	Ramphastidae					LC			
80	*Megalaima mystacophanos*	Red-throated Barbet	Ramphastidae				NT				
81	*Rhipidura javanica*	Pied Fantail	Rhipiduridae					LC			
82	*Actitis hypoleucos*	Common Sandpiper	Scolopacidae					LC			
83	*Kenopia striata*	Stripe Wren-Babbler	Timaliidae					NT	84		
	Macronous ptilosus	Fluffy-backed Tit Babbler	Timaliidae					NT			
85	*Malacopteron affine*	Sooty-capped Babbler	Timaliidae						NT		
86	*Malacopteron cinereum*	Scaly-crowned Babbler	Timaliidae					LC			
87	*Pellorneum capistratum*	Black-capped Babbler	Timaliidae						LC		
88	*Ptilocichla leucogrammica*	Bornean Wren-babbler	Timaliidae		Schedule 2				VU		X
89	*Stachyris erythroptera*	Chestnut-winged Babbler	Timaliidae					LC			
90	*Stachyris maculata*	Chestnut-rumped Babbler	Timaliidae					NT			
91	*Trichastoma abbotti*	Abott's Babbler	Timaliidae					LC			
92	*Trichastoma bicolor*	Ferruginous Babbler	Timaliidae		Schedule 2				LC		
93	*Trichastoma rostratum*	White-chested Babbler	Timaliidae			Schedule 2					NT
94	*Harpactes duvaucelii*	Scarlet-rumped Trogon	Trogonidae					NT			
95	*Copsychus saularis*	Magpie Robin	Turdidae	Schedule 2				LC			
96	*Copsychus stricklandi*	White-crowned Shama	Turdidae					Not	X		
										Recognized	

APPENDIX VI

Letter of Approval from Sabah Wildlife Department

Below is the sample letter of approval from Sabah Wildlife Department to allow KOPEL to manage Supu Caves.

Tel. : 089-561527
: 089-561581
Faks : 089-561523

PEJABAT HIDUPAN LIAR
DAERAH KINABATANGAN
W.D.T. 169
90200 Kota Kinabatangan

(Sila catatkan Rujukan Fail kami apabila menjawab)
Ruj.Kami.JHL.KKTN.600-7/8 (55)
Tarikh:23hb.Feb 2012

Pengurus Eksekutif
Koperasi Pelancongan Mukim Batu Putih
Kinabatangan Berhad (KOPEL BERHAD).

Tuan,

KEBENARAN MENJAGA GUA SUPU

Dengan hormatnya,saya adalah diarah menyampaikan arahan Pengarah Jabatan Hidupan Liar berkenaan perkara di atas.

2 Sukacita dimaklumkan perkara di atas ada kaitan dengan permohonan pihak tuan untuk Kerjasama Usaha Konservasi Pemuliharaan Gua Supu dengan jabatan.

3 Adalah dengan ini pihak tuan dibenarkan menjalankan penjagaan ke atas Gua Supu sementara proses penyediaan MOU dibuat.

Sekian dan terima kasih.

"BERKHIDMAT UNTUK NEGARA DENGAN BERSIH,CEKAP DAN AMANAH"

"LINDUNGILAH HIDUPAN LIAR KITA"

Saya yang menurut perintah

[JON BIN TARAN]
b.p Pegawai Penguasa
Pejabat Hidupan Liar
KINABATANGAN

s.k Pengarah
Jabatan Hidupan Liar
KOTA KINABALU

APPENDIX VII

Methods in Monitoring Forest Landscape and Keystone Species

Methodologies for monitoring programme for landscape and keystone species conservation targets in the Pin-Supu Forest Reservc management plan.

1. Ecosystem Conservation Targets

1.1 Guideline for Monitoring Forest Change Using Permanent Sample Plots

Permanent Sample Plots (PSPs) are advocated as an approach that is robust in documenting detailed changes in forest structure and composition. These plots also provide baseline distribution data for species and also information on the habitats of a particular site. The continual long-term monitoring of these plots would provide valuable information on changes or the lack of changes in plant diversity and richness, growth, mortality, regeneration and dynamics of the sampled forest. Monitoring of permanent plots by measuring these characteristics of the vegetation is likely to remain relevant in the face of changing or evolving environmental issues. Often, it is commonplace for such plot data to be used to address issues beyond the original enquiries at time of establishment and are usually developed as new lines of enquiries or research avenues (i.e. measuring carbon storage, etc.).

In PSFR management plan, permanent sample plots are used for monitoring programme for landscape and keystone species conservation targets in the forest management unit.

Plot Layout

The permanent sample plot layout consists of circular design with 20 m radius (Figure 1). The center of the plot should be clearly marked by erecting permanent post (i.e. PVC pipe, ironwood or concrete-metal post). All trees ≥10 cm diameter at breast height or 1.3 m above ground level should be enumerated by measuring the stem diameter, determine the species identity, and tree location parameters, such as distance, slope angle and also the azimuth from the center of the plot. Five (5) large and healthy trees should be selected and labelled on the ground using aluminum tags as reference trees and will be used to reestablish the center point of the plot for future enumeration if the center post are missing. Tree number and point of measurement of all enumerated trees should be labelled with yellow paint (signal yellow).

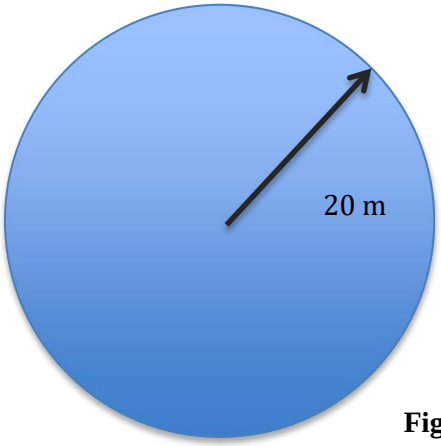

Figure 1: A circular plot with 20m radius.

Maintenance of Permanent Plots

Permanent plots require ongoing maintenance and when left unattended for long periods of time, they become increasingly difficult to relocate, re-establish, and to undertake accurate remeasurements. The maintenance of permanent plots consist of determining the presence of center post and tree labels with minimal disturbance to the vegetation within the plot, including look out for severe damage to the plots, and investigate its cause.

Remeasurement of Permanent Plots

Experience across a range of forest types suggests a **5 to 10 year** interval is generally suitable for monitoring demography of tree populations, and changes in the forest structure and composition. However, the remeasurement interval could be shortened if the management would like to investigate the respond of local weather pattern that influence forest dynamic in the region. Where possible, plots should be remeasured in the same order and over the same months as the historical measurements. Re-locating and remeasuring all the permanent plots in an existing vegetation dataset, with the same field season make analysis of vegetation change over time easy. Before embarking on plot remeasurement, it is critical to understand and employ the methods used in the original survey design. These include following the arrangement, maintaining the size and shape of the sample plots, locality and access points of the plot, and protocols for measuring and labelling the trees. Pre-fieldwork planning is essential to ensure that the fieldwork proceeds as smoothly and efficiently as possible.

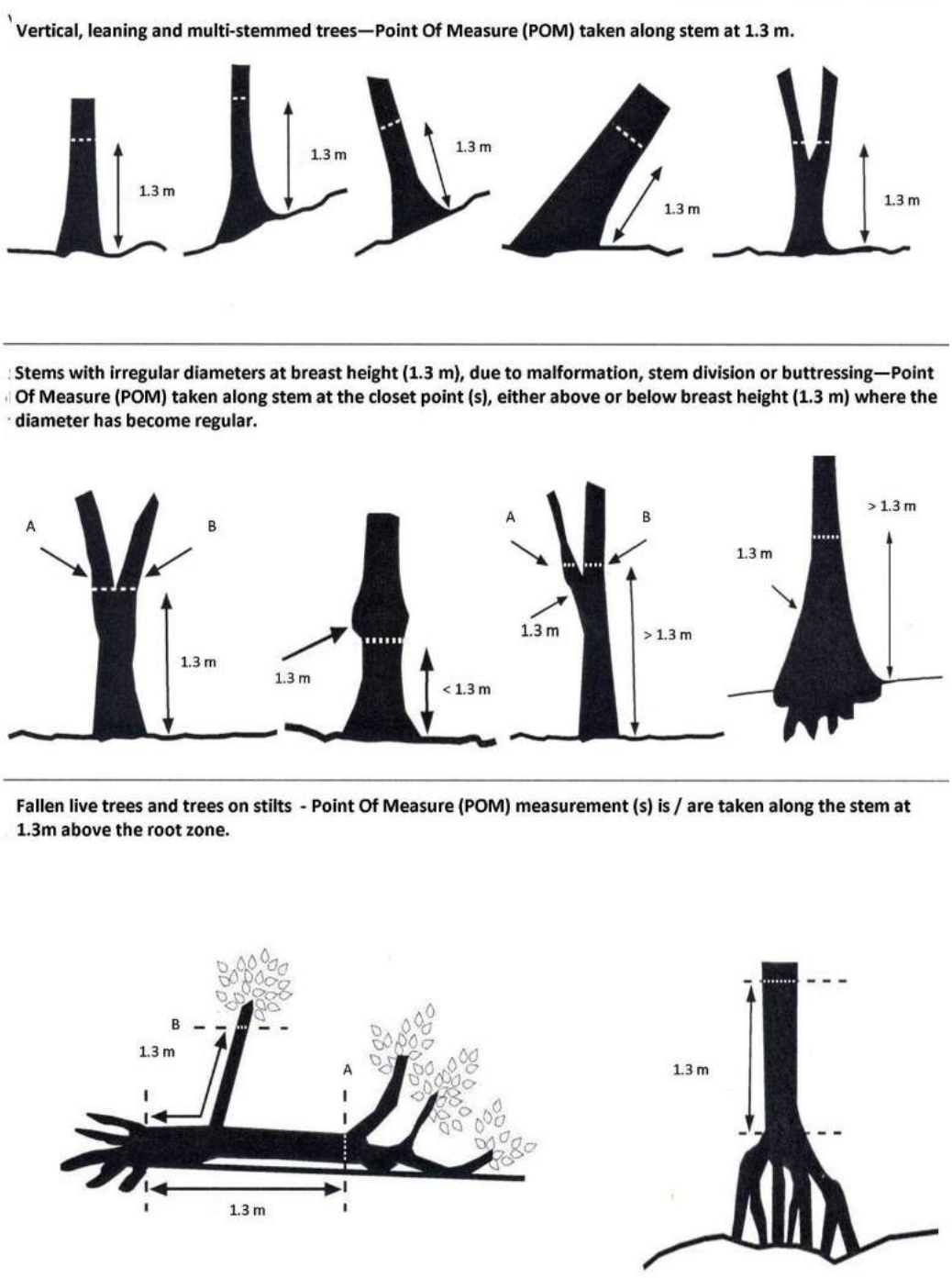

Figure 2: Diagram for standardized procedures for the measurement of tree stem diameter at breast height.

1.2 Establishment of Forest Restoration Plot (based on Nilus & Hastie, 2008)

Species Selection

The choice of species for planting is the main determinant of success in any restoration project (Lamb & Tomlinson, 1994). Presently, native species are used based on their ecological preferences to the underlying edaphic and climatic conditions. Ultilizing

native species has another advantage of preserving the genetic diversity and integrity, as well as the ecological balance of the site.

Prior to listing species for restoration, botanical information (species composition) from reference sites of old growth forest with similar edaphic conditions can provide a useful checklist of potential species. Reference sites can also act as donor sites, especially when used to identify areas for seed and wildling collection. Reference books such as the Tree Flora of Sabah and Sarawak and the Plant Resource of South-east Asia, could also provide important secondary information on species characteristics and habitat types.

Planting Material Procurement and Conditioning

The successful implementation of any planting programme, be it forest restoration or forest plantation is dependent on the continuous availability of planting material. Initially, locating and marking potential seed production stands prior to regular phenological observations could be conducted for selected tree species in order to determine patterns of flowering and fruiting. Unfortunately, fruiting of many forests trees is irregular in the Bornean dipterocarp forest. The occurrence of synchronized supra-annual fruiting or 'masting' events of many climax species is believed to be associated with the climatic event known as El Niño – Southern Oscillation phenomenon (ENSO), which triggers widespread flowering of the Sunda Shelf region in Southeast Asia (Janzen, 1974; Whitmore, 1984; Curran *et al.,* 1999).

Seeds of many tropical species, especially climax and mid-seral species, are also known to have short periods of viability (Shmidt, 2000). The recalcitrant nature of seeds of many forest trees has meant extended storage of such seeds is not feasible. Therefore, the supply of seeds for any restoration project is inconsistent. In some temperate countries, restoring native plant communities is conducted through direct seeding, and also promoting the germination of seeds stored in soil seedbanks by ripping the soils. However, these techniques are not applicable in tropical systems due to high seed predation and the lack of seed bank in the soils. Due to the inconsistencies in acquiring fresh seeds of selected species, other measures have been implemented to provide planting material, such as, vegetative propagation, tissue culture and wilding collections from donor seedling banks. The latter option has been widely adopted, initially involving the up-rooting of seedlings from the forest floor, the immediate potting in polyethylene bags to minimize seedling stress from desiccation, and storage under low light and humid environments to recuperate from the initial stress. Two techniques are commonly used to increase wilding translocation survival, and are described as follows:

i. In a nursery environment, potted wildings are kept in high-humidity retention enclosures using plastic sheets under a low light regime
ii. Temporary nursery underneath thick forest canopy, is built adjacent to a stream in order to maintain low light and air temperature, and high humidity.

However, translocation survival of seedlings is very much dependent on, and varies between species, and among individuals, due to age-sized factors (smaller or freshly germinated seedlings have high rejuvenation capabilities). The collection of wildings should also be regulated as it might reduce the regeneration capacity of a donor site. The nursery stage and the techniques applied in raising healthy seedlings is crucial in ensuring success during transplanting in the field. Planting materials derived either from seeds or wildings are raised in polyethylene bags. This technique has proven effective for reintroducing tree seedlings where harsh mirco-environmental conditions may prevail at a restoration site. As it is important to prepare all seedlings for outplanting, preconditioning or acclimatization of the seedlings (hardening process) to higher light regimes and periods of water stress is necessary in improving seedling survival during field planting.

Site Preparation, Planting and Maintenance

A precondition in formulating a restoration design strategy is an evaluation of the potential stress of the site, both abiotic and biotic. This section covers the adopted, modified, silvicultural techniques commonly used in mixed dipterocarp forest rehabilitation projects in the context of creating greater species and structural diversity in a forest stand.

There are several types of liberation exercise that can be undertaken, depending on the vegetation cover and quality of the site. On degraded sites, weed species (climbers or vines, invasive trees) may predominate, limiting the colonization or establishment of tree species. The removal of this biotic stress is an important start in preparing the site for planting. Usually this is carried out manually through selective removal of the weeds by cutting them back or with herbicides. Light adjustment is another manipulative technique that involves the removal of competing cover (secondary species tree cover) depending on the light requirements of the planted seedling to facilitate growth. This manipulative measure is often practised over a series of stages in the development (incremental growth, stature and closing of canopy) of a forest stand. However, naturally harsh conditions found at ultramafic, kerangas and on peat soils, require minimal removal of above-ground cover in order to minimize water stress (excessive rates of evapotranspiration) of newly planted seedlings.

The planting design is a key aspect in creating a varied structured stand. Current practices similar to mixed dipterocarp forest (MDF), require a large variety of species (fruit trees, timber trees, mid-storey, upper-storey) to be planted consecutively, but selected based on their preferential light environment. Enrichment planting in MDF forests was initially designed to yield sufficient timber in the future. However the current restoration practices applied usually requires the planting of tree seedlings in a cluster, and at a higher density of seedlings (200–1,000 planted trees/ha) depending on the cover of the surrounding forest structure. The use of fertilizers is also encouraged to assist the initial establishment of planted seedlings.

It is advisable that field planting should be carried out in the early morning or late afternoon to reduce desiccation stress of the planted seedlings. Replacement planting should be conducted within months after planting. If considerable mortality of planted seedlings occurs, a thorough investigation is required to ascertain the cause of mortality, before replacing the seedlings. There are a number of causative possibilities, poor seedling handling (from nursery to field planting) or poor planting technique. Selective pressures on seedling survival due to site factors may only become evident later (second replacement mortality). Restoration projects require continual monitoring, which often allows for adjustments in the design of the project, from lessons learnt or through acquiring new knowledge.

Maintenance regimes for restoration exercises vary among site and depend on the type of secondary vegetation regrowth, soil fertility status of the site, and species planted. Weeding around planted seedlings is necessary to avoid seedlings from being suppressed by secondary vegetation. Secondary vegetation such as woody vines, shrubs and sedges usually have higher relative growth rates compared with many forest tree species. Therefore, the frequency and duration of many maintenance regimes is dependent on the growth of planted seedlings, to a point where the plant can competitively exclude or suppress weed species.

Evaluating Success

Restoration project of a particular site has to be evaluated continuously to identify problems that arise throughout the project period, and the problems usually varied among sites. In many experiences, this practice involves a dynamic and evolving learning process.

The success of the restoration project can be evaluated through a monitoring programme with a set of criteria and targets in different stages against the actual achievement on the ground. The criteria can be measured through a set of measurable indicators that can be scored quantitatively or qualitatively. Two indicators, i.e., silvicultural and environmental, which are proposed by Lamb & Tomlinson (1994) could be used as a standard in evaluating success in restoration activities (Table 8). Socioeconomics is not applied here because no economic return is expected but only enhancement of environmental services. One aspect that falls under the social indicators, which are intangible and difficult to quantify, is public awareness towards environmental sustainability.

The monitoring of silvicultural indicators provide a feedback mechanism allowing for future actions to be taken. Seedling survival, depending on the time scale of monitoring, for example from planted seedling to maturity, helps evaluate the suitability of the selected species. Growth measures are as important in determining the adaptiveness of the species to the management regime or the site conditions. For example, fast growth maybe a precondition of the restoration plan, to allow for rapid canopy closure.

Therefore, knowledge of the growth rate of a species could be useful when aiming diverse structure stands for restoration project. Although not usually incorporated into many monitoring programmes, information on potential pest or disease is vital for a forest manager to avoid possible pitfalls of the species. Knowledge may be severely lacking on potential pests (insect or mammals), or disease (fungal, bacterial or viral). Monitoring for pest and disease would strengthen knowledge leading to their control initially, but eventually allowing the manager to prescribe the necessary treatments or avoiding the species entirely in future restoration programmes. Evaluating the effectiveness of maintenance practices as a function of time, from vine tending to gap creation, provides a multitude of information including the cost effectiveness of the prescribed treatment.

Environmental indicators should include soil fertility, soil stability, water quality, structural diversity, and species assemblage (plant and animal) of the restored site. These measures are often recognizable, quantifiable indicators of restoration success, and indicators of the development of a plant community, and the effects on the abiotic system.

Table I. Two indicators, i.e., silvicultural and ecological, for evaluating success in restoration activities (based on Lamb & Tomlinson, 1994).

Indicator	Subject	Aim
Silvicultural	• Seedling survival • Seedling growth • Weeding/maintenance • Pest & disease	• Species-site preference • Tree health and development • Weeding and maintenance regime guideline
		□ Eradicating pest & disease
Ecological	• Surface soil stability • Soil fertility and organic matter • Tree structure • Inventory of native flora and fauna	• Improve surface soil stability • Increase soil fertility and organic matter • Diverse tree structure • Establishment of native plant species • Increased wildlife presence

2. Species Conservation Targets

2.1 Selected Plants

2.1.1 Methods in Quantifying Plant Population Density

Distribution

Record geographical reference point and mark all selected keystone plant species during field surveys in the remaining disturbed forest. All individuals encountered should be measured for their diameter and stand quality of the individuals. Subdivide individuals by demographic classes, such as, mature trees, pole, saplings and seedlings.

Dynamics

Population dynamics can be determined by a series of growth and turnover assessment for each selected species and this can be within the permanent sample plot (circular plot). Such trend can be an indicator of species integrity in the area. Other additional activities, such as phenological observation, are required to investigate fruiting and flowering of mature trees that would support recruitment assessment.

2.2 Selected animals

2.2.1 Methods in quantifying animal population density

2.2.1.1 Proboscis monkey

Based on Acrenaz (2013), river survey will be used to estimate proboscis monkey population density. The sampling length are fixed and direct counting on number, group size and demographic structure (sex: male and female; adult, juvenile and younglings), including geographic reference points, of all encountered will be recorded. Additional methods such as oppurtunistic sightings and interviews with surrounding communities may be also be carried out periodically.

2.2.1.1 Bornean Elephant

Based on Acrenaz (2013), transect or line survey will be used to estimate elephant population density. The transect length or size and distribution of sampling is fixed and direct counting on number, group size and demographic structure (sex: male and female; adult, juvenile and younglings), including geographic reference points, of all encountered will be recorded. Additional methods such as oppurtunistic sightings and interviews with surrounding communities may be also be carried out periodically.

SOCIAL ASSESSMENTS OF PIN-SUPU FOREST RESERVE KOTA KINABATANGAN

SABAH FORESTRY DEPARTMENT

JULY 2018

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LIST OF ABBREVIATIONS

FR	Forest Reserve
HCV	High Conservation Value
PSFR	Pin-Supu Forest Reserve
SBS	Social Baseline Survey
SIA	Social Impact Assessment
VJR	Virgin Jungle Reserve

1.0 INTRODUCTION

This is a social assessment report for the Pin Supu Forest Reserve. The social assessments involved are Social Baseline Study (SBS), Social Impact Assessment (SIA) and High Conservation Value No. 5 & 6 (HCV 5&6). This social assessment was undertaken by the combination of SFM Division and Kota Kinabatangan District Forest Office in January 2018 to fulfill part of the legal requirements consistence with the standard forest management practices of forest reserves in Sabah. This is required for the certification and continuous operation of forest sustainability as well as to integrate appropratiate mitigative measures that will foster socio-economic interest of the affected local communities living in close proximities to the PSFR.

1.1 Objectives

The social assessment on Pin-Supu Forest Reserve is aimed at establishing the present status and magnitude of social influence onto the forest reserve.

The objectives of the study are to:

i. identify villages who are influencing the forest reserve ecologically.
ii. know the demographic status, socio-economic aspect and socio-forestry conflicts that might exist.
iii. recommends necessary management and monitoring plan to mitigate the activities of the villagers to safeguard the forest reserve.

The information obtained will be used to support the review of the Pin-Supu Forest Reserve Management Plan which is currently being carried out by the Sabah Forestry Department.

1.2 Study Sites

Pin-Supu Forest Reserve (PSFR) is located about 20km from the Kota Kinabatangan District, 90km by road from Sandakan and 75km from Lahad Datu. The reserve is 4,696 ha and the Kinabatangan River forms the southern boundary of the reserve. PSFR was first gazetted in 1935 as a Class II Commercial Forest Reserve but was regazetted as a Class VI Virgin Jungle Reserve in 1984. Major concerns were for the protection of the edible birds nest, which are still present in the limestone caves on the western part of the reserve, which are protected and harvested by the surrounding local communities.

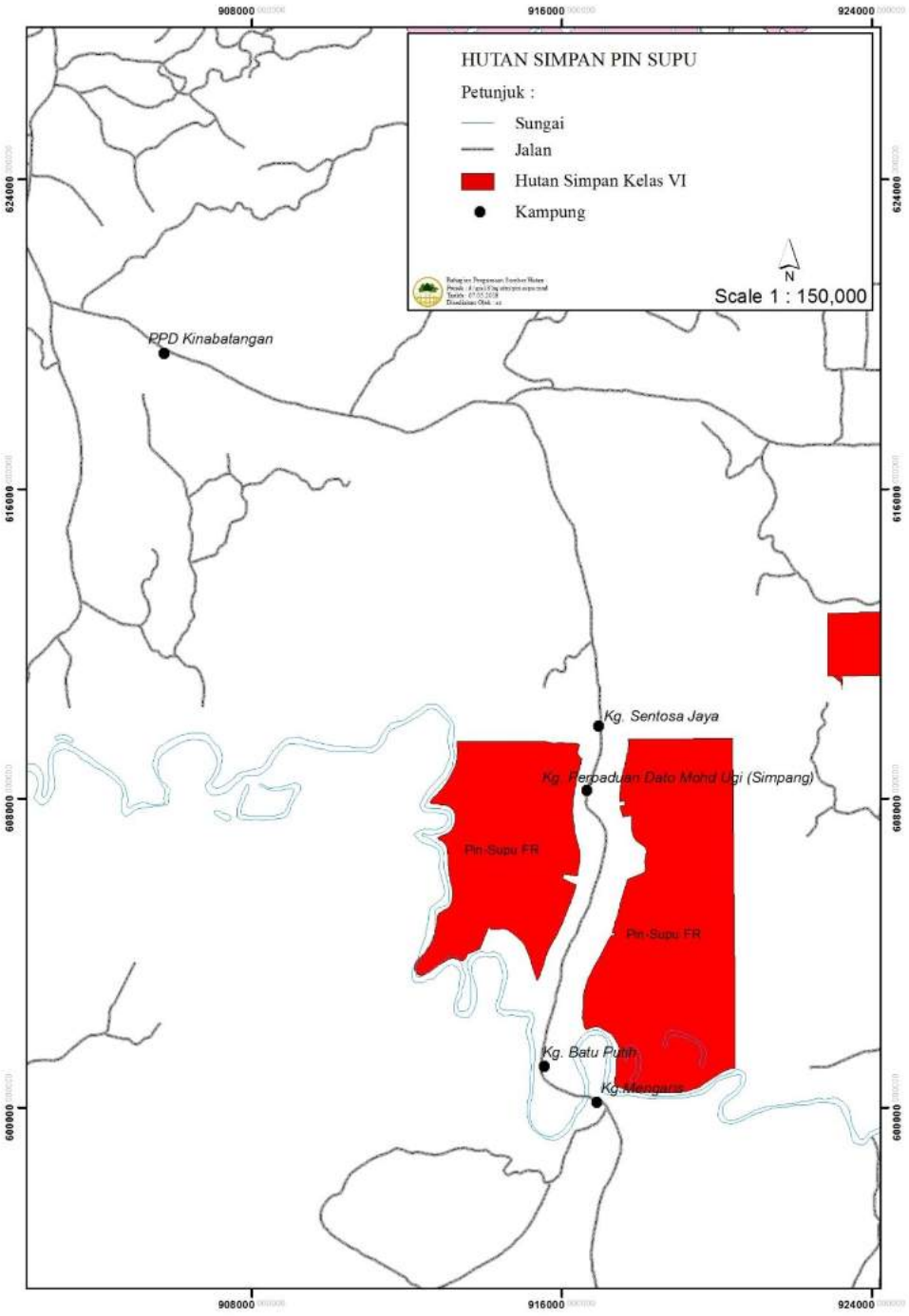

Figure 1: Location of villages nearby Pin Supu Forest Reserve.

2.0 METHODOLOGY

The social assessments are implemented in 4 stages, described as folows:

2.1 Phase I: Pre-SBS

- Collection of secondary information
- Operational Planning
- Location and Mapping Survey (GPS Observation)
- Briefing to communities involved
- Complete Forms
  - PreSBS 1 - Village Information
  - PreSBS 2 - Households List
- PreSBS data entry

2.2 Phase II: SBS Interview

- Random sampling of 30% of the number of household in a village.
- If the village is located inside a forest reserve, 100% SBS interview will be conducted.
- Sending appointment letter for interview (Selected Households List is included).
- Interviewing Operations
  - Community Questionnaire Form
  - Household Questionnaire Form

2.3 Phase III: Focus Group Discussion

- Focus Group Discusion members are consisted of the Village Head, Chairman of JKKK and 5 Elders/Keypersons who knows the history, present status and development of the village
- SIA Interview
- Interviewing Operations
  - SIA (Social Impact Assessment) Form
- HCV 5 & 6 Interview
- Interviewing Operations
  - HCV 5 & 6 Assessment Form

2.4 Phase IV: Post-SBS

- Data entry of all SBS, SIA & HCV5&6 data
- Data Analyzing (Standard Method)
- Report Writing
- Report Submission

3.0 RESULTS & DISCUSSION

3.1 SBS

3.1.1 Village Information

Mukim Batu Putih is the land adjacent to the Pin-Supu Forest Reserve (PSFR). There are 4 villages in the vicinity of PSFR namely Kg Batu Putih, Kg Mengaris, Kg Perpaduan and Kg Sentosa Jaya. All these villages are located along the Sandakan-Lahad Datu Highway. The most populous of these villages is Batu Puteh with Mengaris Village at the Kinabatangan Bridge being the next main concentration of dwellings. The villages of Perpaduan, Sentosa Jaya are spread along the Sandakan Lahad Datu Highway to the north through the centre of the reserve. Development in these villages is not concentrated, but spread-out along the 8km of highway, which runs through the centre of the reserve. The village of Batu Puteh was officially recognised in 1956. Kg Mengaris was founded in 1962 while Kg Perpaduan and Kg Sentosa Jaya was established in 1981.

3.1.2 Households Information

Kampung Batu Putih is the most populous village of 751 peoples consisting of 133 households and occupies 98 houses. Kg Mengaris has a population of 520 of 132 households with a total of 85 houses followed by Kg Perpaduan with a population of 452 from 87 households and living in 83 houses. The least populated is Kg Sentosa Jaya with only 422 peoples from 67 households and 53 houses (See **Table 1** and **Figure 2**).

Table 1: Number of House and Households of each Village

Village	**Kg Batu Putih**	**Kg Mengaris**	**Kg Perpaduan**	**Kg Sentosa Jaya**
No. of Houses	98	85	83	53
No. of Households	133	132	87	67
Population	751	520	452	422

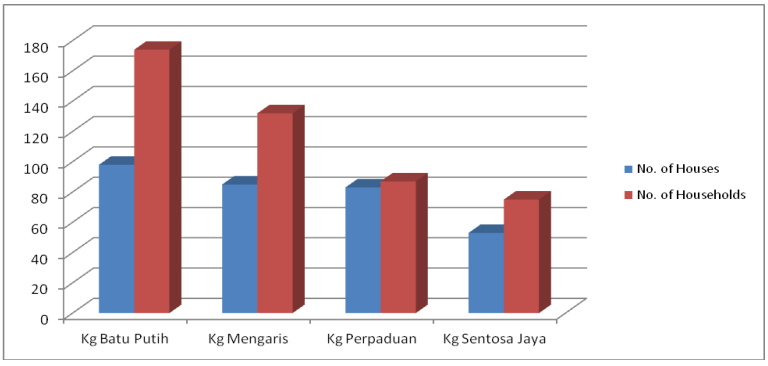

Figure 2: Number of House and Households of each village.

The majority of the ethnic group who inhabit all the villages near Pin Supu Forest Reserve are Orang Sungai. The highest percentage of the Orang Sungai occupies Kg Batu Putih with a percentage of 96% followed by Kg Perpaduan, Kg Mengaris and Kg Sentosa Jaya with 88%, 87% and 52% respectively.

Bugis and Bajau ethnics are the second most populous ethnic who occupy Kg Sentosa Jaya with 17% respectively. For other villages, ethnics such as Bajau, Suluk, Bugis and Kadazan are minority groups with a percentage of 1-6%. (**Table 2** and **Figure 3**)

Table 2: The percentage of ethnic groups within the village

Ethnic Group	Kg Batu Putih (%)	Kg Mengaris (%)	Kg Perpaduan (%)	Kg Sentosa Jaya (%)
Sungai	96.0	87.0	88.0	52.0
Bugis	1.0	2.0	7.0	17.0
Bajau	0.0	2.0	0.0	17.0
Suluk	0.0	2.0	0.0	4.0
Kadazan	2	3	2	4
Others	1	4	3	6

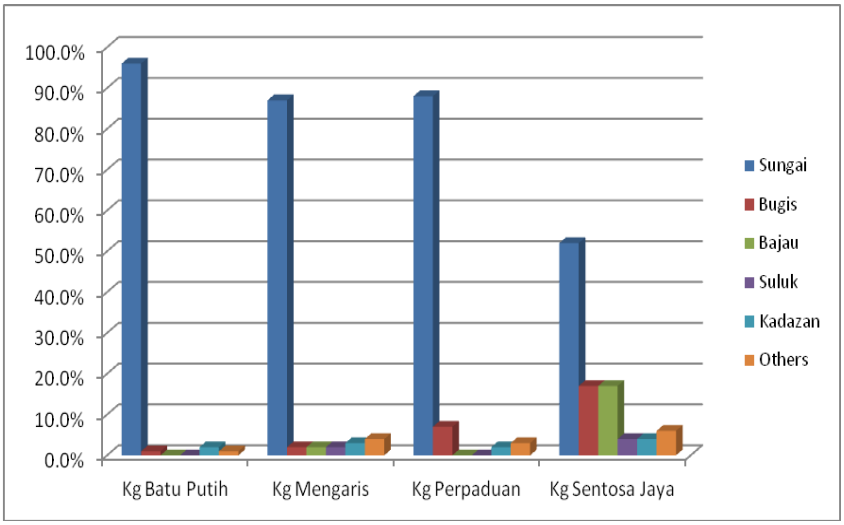

Figure 3: Percentage of ethnic groups within the village.

3.1.3 Socio-economic Activities

The main occupation of the villagers for all 4 villages is agriculture although there are also people who work in government agencies, private sectors and self-employed. Oil palm plantation

activities and working in oil palm estates become the main activity. Plantation activity for Kg Sentosa Jaya was the highest representing 71.7% of the total activity in the village followed by Kg Batu Putih with 64.3%, Kg Perpaduan 68.1% and Kg Mengaris 30.4%. Palm oil from all villages is marketed at nearby palm oil collection centres either at Hansur Maju Sdn Bhd or Global Sdn Bhd.

The second job activity is public sector employment. 71% of respondents in Kg Mengaris work in the public sectors whether as a government employees, teachers, nurses or policemen. Kg Sentosa Jaya occupies second spot with percentage of 30.2% followed by Kg Batu Putih with 29.6% while Kg Perpaduan has only 32.2% (**Figure 4**).

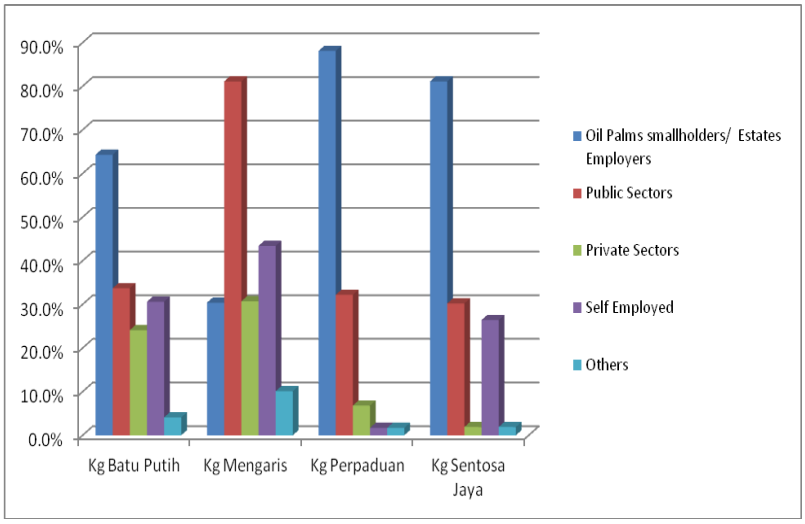

Figure 4: Percentage of jobs within the village

3.1.4 Agricultural Land Ownership Status

Kg Batu Putih had the highest land titled ownership of 32.0% followed by Kg Sentosa Jaya with 35.8% and Kg Perpaduan with 5.1% while for Kg Mengaris the entire households had no land titled (**Table 3**). Higher percentage of villagers who have land but without land title recorded by Kg Sentosa Jaya with 30.2%, Kg Mengaris with 20.3%, Kg Perpaduan with 18.6% and Kg Batu Putih with 14.0%.

In terms of land ownership, the highest numbers of villagers who have land with land title or still in the land application process is Kg Sentosa Jaya with a percentage of 66%. Land ownership for Kg Batu Putih is 46%, Kg Perpaduan is 23.7% and Kg Mengaris is 20.3%. For those who have no land, the highest percentage is from Kg Mengaris which is 79.7% followed by Kg Perpaduan (76.3%), Kg Batu Putih (54.0%) and Kg Sentosa Jaya (34.0%) (See **Figure 5**)

Table 3: Land ownership status

Village	Kg Batu Putih (%)	Kg Mengaris (%)	Kg Perpaduan (%)	Kg Sentosa Jaya (%)
Land with Land Title	32.0	0	5.1	35.8
Land without Land title	14.0	20.3	18.6	30.2
No Land Ownership	54.0	79.7	76.3	34.0

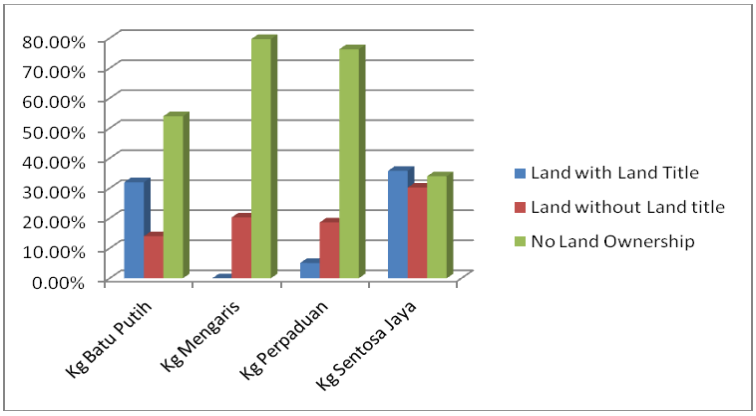

Figure 5: Land ownership status of each village.

3.1.5 Agriculture Land

Table 4: Agriculture Land Area within the village.

Land Area (acre)	Kg Batu Putih (%)	Kg Mengaris (%)	Kg Perpaduan (%)	Kg Sentosa Jaya (%)
0.1-5	23.5	0.0	10.4	0
5.1-10	12.2	13.0	50.0	18.9
10.1-15	6.1	5.8	35.4	41.5
15.1-20	0.0	1.4	4.2	1.9
20.1-25	0.0	0.0	0.0	1.9
25.1-30	1.0	0.0	0.0	1.9

From **Table 4** and **Figure 6**, it can be seen that for land area below 5 acres, Kg Batu Putih recorded the highest percentage of 23.5% while for 5.1-10 acres, Kg Perpaduan was the highest with a percentage of 50.0%. Kg Sentosa Jaya recorded a percentage of land ownership of 41.5% for land area of 10.1 to 15 acres. **Table 4** also shows that Kg Perpaduan has the highest percentage (85.4%) on the land area between 5-15 acres and followed by Kg Sentosa Jaya with a percentage of 60.4%.

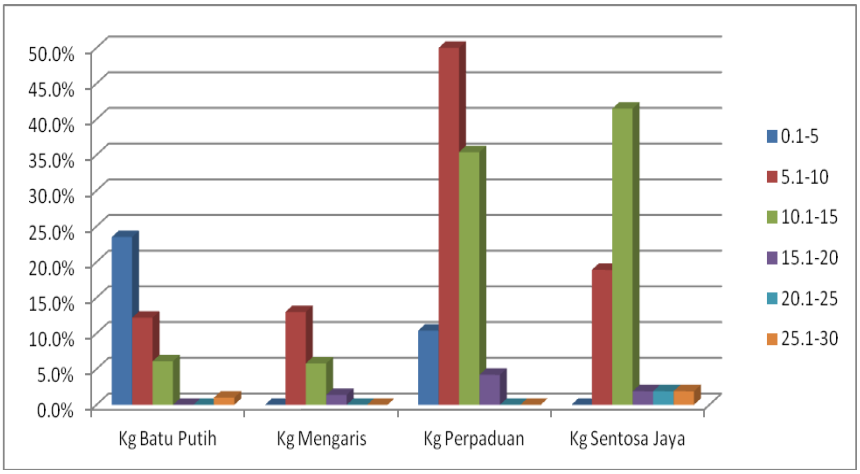

Figure 6: Percentage of land area of each village

3.1.6 Monthly Income Status

As seen from the **Table 5** below, Kg Batu Putih has the highest hardcore poor rate of 43% followed by Kg Mengaris with 37.7% and Kg Sentosa Jaya and Kg Perpaduan with 20.4% and 12.2% respectively.

Table 5: Households Income within the village

Income (RM)	Kg Batu Putih (%)	Kg Mengaris (%)	Kg Perpaduan (%)	Kg Sentosa Jaya (%)
0-1000	43.9	37.7	12.2	20.4
1001-2000	22.4	30.4	23.5	14.3
2001-3000	14.3	10.1	7.1	8.2
3001-4000	7.1	7.2	5.1	5.1
4001-5000	2.0	4.3	6.1	2.0
5001-6000	5.1	2.9	1.0	1.0
6001-7000	0.0	2.9	3.1	1.0
7001-8000	1.0	1.4	0.0	1.0
8001-9000	0.0	2.9	1.0	0.0
9001-10000	1.0	0.0	0.0	1.0
10001-15000	2.0	0.0	5.0	0.0
15001-20000	1.0	0.0	1.0	1.0

The highest earning income of RM1,001-RM5,000 was from Kg Mengaris with 52.0% followed by Kg Batu Putih, Kg Sentosa Jaya and Kg Perpaduan with 46%, 20.4% and 12.2% respectively. For income range of RM5,001-RM10,000, Kg Mengaris recorded the highest percentage with 10.1%, Kg Batu Putih with 7.1%, Kg Perpaduan with 5% and Kg Sentosa Jaya 4%.

Only 2 villages recorded income of RM 10,001-RM15,000, i.e. Kg Perpaduan (5%) and Kg Batu Putih (2%) whilst 3 villages namely Kg Batu Putih, Kg Perpaduan and Kg Sentosa Jaya all have 1% households earning income of RM15,001-RM20,000 (**Table 5, Figure 7**).

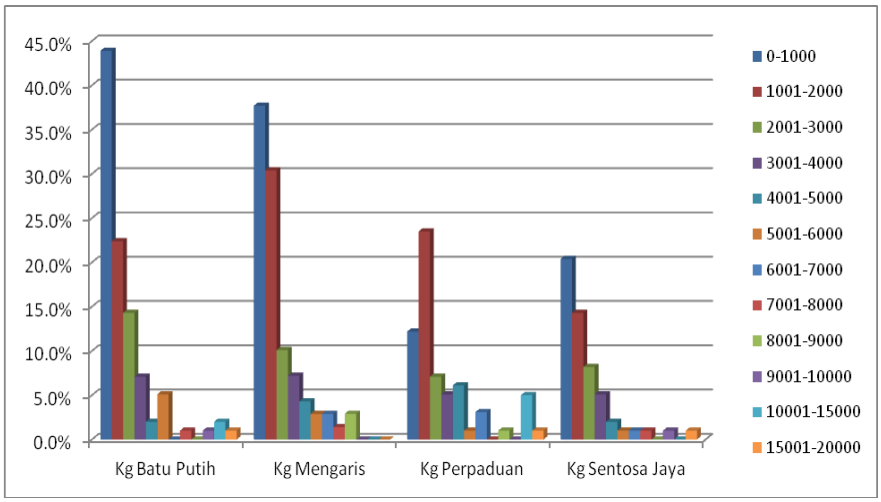

Figure 7: Percentage of income of the villages.

3.2 SIA

18.8% of the residents of Kg Mengaris were involved in fishing and shrimp activities conducted in Kinabatangan River. For Kg Batu Putih, 10.2% of the population is still involved in fishery activity. Kg Perpaduan and Kg Sentosa Jaya are not heavily involved with fishing activities because their village's location is quite far from Kinabatangan River**.**

3.3 HCVF 5&6

Water supply is mainly sourced from government water supply pipes. No villagers use a forest reserve as a water source for their daily necessities. The need for forest produce such as medicinal plants, building materials, forest fruits and rattan/ bamboo has declined due to availabilty of replacement –products. Handicrafting was also declined due to unavailability of supply. This is because all material required are no longer needed or have been replaced with other materials that are more readily available. Fishing is still a very important activity mainly for self consumption. Hunting activity has become seldom due to strict government monitoring and also a very much reduced quantity of wildlife available. Building materials are still sought by the villagers, particularly to repair their houses.

Kg Batu Putih has an old graveyard area which is also a historical site called Agop Batu Tulog located at N 05 ° 24'59.8" and E 117 ° 56 '21.7". This area is a popular historical site and has been used as one of the main exhibits at the Sabah State Museun.

3.4 Villagers' Issues

During the Focus Group Discussions held at each of the village, the following issues keep arising for the attention of the government:

1. Many villagers had already applied for Land Title long year back (1979-2000) but there is no land title up to now.
2. Villagers agreed for Forest Reserve to be maintained so that future generations can still see the existence of the forest reserve.
3. If there is any project carried out at Pin Supu Forest Reserve then the local residents who are adjacent to the forest reserve should be prioritized for participation.
4. The authorities to pay attention to the elephant and human conflict because this elephant damages the villagers' crops. It is recommended that the government install electrical fences to prevent these elephants from entering the village area.
5. Most villagers have no land. Hopefully the government can consider the villagers pledge to excise a small portion of the forest reserves for the community.

4.0 CONCLUSION

All four villages are located outside of the Pin Supu Forest Reserve and can be accessed by Sandakan-Lahad Datu main road. Majority of the households relies on agricultural activities particularly oil palm farming; however the majority of them also are smallholders and a considerable number are with no land ownerships. Another important job is working in the public and private sectors as well as self employed. Although the income earners of RM1,000.00 which is below the poverty line income (PLI) are still significant, households with income earning between RM1,000.00 and RM6,000.00 have significantly increased, with some of them earning up to RM20,000.00.

Generally, the households of all the villages are not dependant on forest produce from PSFR for their daily needs. Forest reserves are used only for gravity water supply although some villages have received government pipeline supplies. Kinabatangan River is still a source for fish and shrimp supplies for a small number of residents especially in Kg Mengaris either for their daily consumption or for source of income.

On the other hand, some people, possibly from other villages sometimes encroached into PSFR either for fishing or hunting. This usually creates tension between villages or even within a village. Sometimes, the problems were exagerrated beyond truth. Therefore, there is a need for them to discuss and settle any issues amicably. This justifies the importance of establishing a PSFR Social Forestry Committee, headed by the Kota Kinabatangan DFO and members are all the four villages concerned.

Socio-economically, all the villages are quite organized, particularly Kg Batu Puteh and it can be generalized that majority of the villages around PSFR are still developing their agricultural activities. As so far, there is no big impact of the local communities to the PSFR, except for some forest encroachment before (farming and hunting), that has been effectively controlled by the Kota Kinabatangan DFO. Regarding HCV5&6, PSFR is an important water source for some of the villagers that cannot receive or far away from the government piped-water supply.

ACKNOWLEDGEMENT

The Social Survey Team would like to thank the District Forestry Officer of Kota Kinabatangan and his staff for rendering various assistances during the field surveys at the four villages particularly during the Phase I to Phase III of this study.

APPENDIX 1: PRE-SBS RESULTS

No	1	2	3	4
BASIC VILLAGE INFO				
DFO	KINABATANGAN			
FR Name	HS Pin Supu			
Village Name	**Kg. Batu Putih**	**Kg. Mengaris**	**Kg. Perpaduan**	**Kg. Sentosa Jaya**
Year Established	1956	1962	1981	1981
Houses	98	85	83	53
Household	133	132	87	67
Population	751	520	452	422
Race/ Ethnic Group	Dusun	Sungai	Sungai	Dusun
Main Economic Activity	Agriculture	Agriculture/ Fisheries/ Commerce	Agriculture	Agriculture
Main Crop	Rubber/ paddy/oil palm	Oil palm	Oil palm	Oil palm
Village Size (acre)	3,500	439	NA	50
Village Size inside FR (acre)	150	NA	NA	None
No of Houses inside FR	13	NA	NA	None
Farms Size (acre)	80	NA	NA	165
Farm Size inside FR (acre)	862	NA	NA	NA
AVAILABLE INFRASTRUCTURE				
Road	Tar	Tar	Tar	Gravel
House	Concrete, Wooden	Concrete, Wooden	Concrete, Wooden	Concrete, Wooden
Water Source	Streams, River	Pipe, Streams, Gravity	Pipe (Govt)	Gravity
Electricity	Govt	Govt	Govt	Govt
Clinic	None	Rural Clinic, Maternal Cliic	None	None
Community Hall	None	Yes	Yes	Yes
Rest House	None	None	None	None
Surau	None	None	Yes	None
Chapel	Yes	None	None	Yes
Primary Schoo;	None	Yes	None	None

Kindergarten	None	Yes	None	None
Playing Field	None	VolleyBall	None	Bolasepak
Public Telephone	None	Yes	None	None
Handphone Line	Yes	Yes	Yes	None
Transportation	Car	Car, Boat	Car	Car
Workshop	None	Yes	None	None
Village Internet		Yes	None	None
Village Library	None	None	None	None
GPS-N	06°00′56.7″	05°59′53.7″	05°58′46.9″	05°58′46.9″
GPS-E	116°28′58.5″	117°17′34.3″	116°29′11.1″	116°29′11.1″

APPENDIX II: ACTIVITY PHOTOS

a: Resident house and their fruit trees at Kg. Perpaduan.

b: Interview with PJKKK Kg Perpaduan.

c: One of the resident' house at Kg. Mengaris

d: Discussion and information gathering from the Head of Village of Kg. Mengaris.