

BIG MAMMALS OF PULONG TAU NATIONAL PARK

ITTO Project PD 224/03 Rev.1 (F)
Transboundary Biodiversity Conservation -
The Pulong Tau National Park, Sarawak, Malaysia

Engkamat Lading
2007



Muntiacus muntjac



International Tropical Timber Organization
Sarawak Forest Department
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ISBN: 978-983-43255-5-8

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ABSTRACT

Twenty species of big mammals were detected during the survey period in four study sites. The cryptic behavior as well as nocturnal behavior of some mammals and locations of transects contributed to the non-sighting of certain species. For wild boar (*Sus barbatus*), for instance, in spite of the presence of heavy signs in all the four study sites, especially in its lower altitude, only accounts for 8.20 per cent of the total number detected. Peeling-off of tree bark indicates the presence of sun bear but none was seen during the survey.

No signs of tembadau or Sumatran rhinoceros were detected during the survey. Non-sighting of the species does not indicate that the species is extinct. This assumption was supported by a recent sighting of Sumatran rhinoceros (*Dicerorhinus sumatrensis*), not very far from Pa' Lungan, by a couple of tourists, as reported in a local newspaper (The Borneo Post, June 25, 2006).

There was evidence of hunting in all the study sites and several spent cartridges of shot guns were found in a number of locations along the trails. There were semi-permanent hunter huts in Long Menalio and Pa' Lungan, and the storage of wild boar fat in drums in Long Menalio indicates heavy hunting of wild boar in the area. The use of snares was also evidenced. This could be one of the reasons why only two game species were detected during the survey in Long Menalio. Arboreal species, however, did not seem to be badly affected, thus the population of Bornean gibbons, pig-tailed macaque and the giant squirrel were relatively high. Timber extraction activities by local communities were rampant, particularly in Merario and Pa' Lungan areas.

The Index of detection was high amongst the arboreal species especially amongst Bornean gibbon. High index of detection were also recorded for barking deer, probably that of Bornean yellow muntjac, and the bearded pigs. This indicates that timber extraction and hunting activities did not affect the abundance of these species.

The giant squirrels (*Ratufa afinis*) were found in all the four study sites with highest estimated density in Pa' Lungan. The Index of Detection in Pulong Tau National Park is higher than those obtained for Lambir Hill or Similajau National Parks (Liam, 2002). It suggests that the present level of human disturbance, like timber extraction and hunting activities have not come to a detrimental stage to the population of the two species.

Relative Density of the Bornean gibbon (*Hylobates muelleri*) were comparable to that reported by Meredith (1993) in Batang Ai National Park but was lower than the logged forests of the Balingian/Belakin Model Forest Management Area (Stuebing, 1995). Bornean gibbons were recorded in all study sites except in Long Lobang, a place dominated by the Penan community. Unlike the Kelabit communities on the other side of the national park where hunters used shot guns and usually go after big game species like bearded pigs or sambar deer, the Penans use blowpipe with poisoned darts to hunt. This hunting method is less effective on terrestrial game species such as bearded pigs that always hide in thick bushes but proven to be very effective on arboreal primate species such as the Bornean gibbons. Unlike other communities the Penans seemed to favor primate species as much as bearded pigs. Thus it is not surprising that the Bornean gibbon was not even heard during the survey in Long Lobang. In contrast, population of Bornean

gibbon in the other three sites, particularly in Long Menalio, was relatively abundant and less wary to human presence.

Quite contrary to that of the bornean gibbons the other primate species, the Hose's langur and the long-tailed macaques were found to be quite abundance in Long Lobang. This could be due to the fact that the two species were more abundance and could adapt well and more resilient to hunting pressure. A long-tailed macaque can elude hunters very well when it wanders, or forages in a disturbed forest like the 'temuda' in the nearby area.

The estimated density per km² of barking deer (*Muntiacus* sp.) is highest in Pa' Lungan and lowest in Long Lobang. It could easily be found in all the four study sites, indicating that the species could easily be found in most parts of the Park. It seemed that the barking deer is adapting well, or resilient to human disturbance. Generally browsing ungulates like the barking deer benefits from vegetation changes brought about by logging activities, or even by agricultural activities in area surrounding the park.

Studies in the past have recorded only three to four species of primates in the Park (Tajuddin *et. al.*, 1999 and MNS, Miri Branch, 1998). In comparison the present study recorded five species of primates. The white-fronted langur (*Presbytis frontata*,) which are normally found in the same habitat with Hose's langur (*P. hosei*) in lowland area of central Sarawak (Payne *et. al.*, 2005), and are quite common in Lanjak Entimau Wildlife Sanctuary (LEWS), has not been seen in all the four study sites in Pulong Tau National Park, neither has it been reported in the past in the area. One possible explanation is that the species may not favor the highland habitat.

Orangutan (*Pongo pygmeus*) was reported by a Penan Field Assistant (Oda, T., *pers. comm.*) to be present in Long Sabai forest, a remote Penan village near Long Lellang in the south-east of the Park. Since the presence of the species in Long Sabai has never been documented before, further study in the area is required to verify the report.

Other species recorded in the present study, and not been reported previously, are the Malay weasel (*Mustela nudipes*) and couple of viverrid species. Scientifically, very little has been known on the ecology of the Malay weasel and more emphasis on future study on the species is necessary.

Among the four study sites, Merario has the highest index in term of species diversity (0.937) while Long Menalio was the lowest (0.534). This difference was found to be of highly significant. Similar results are seen between Long Menalio and Long Lobang, and Long Menalio and Pa'Lungan. There were relatively more species found in Long Lobang and Pa'Lungan as compared to that in Long Menalio. One possible explanation is the fact that there was a timber concession in a nearby area. Species such as pig-tailed macaque, long-tailed macaque, pangolin, porcupine and sambar deer may prefer food available in disturb forest which is found in the logging area nearby. Another possible reason is the altitude. Long Menalio is relatively of lowland (hardly above 3,000 feet above sea level) while the transect lines in Merario were cut across altitude of 5,000 - 6,000 feet above sea level. This could mean that lower altitude could support more game species like the bearded pigs and consequently attract more hunters into the area. Higher hunting activities means more animals were harvested and the remaining ones would probably been chased out of the forests into the nearby area.

ACKNOWLEDGEMENTS

With this opportunity I would like to thank Mr Wilfred Landong, General Manager of Protected Areas Biodiversity Conservation for his approval to participate and eventually ensure the success of this study. My thanks is also extended to Mr Oswald Braken, Dr. Paul Chai and Miss Zarina Shebli for their concerted efforts and support in getting our direct involvement in the ITTO Project. I would also like to express my appreciation for the cooperation and the collaboration of my present and former colleagues from PABC and the Forests Department respectively like Mr Paschal Dagang, Mr Taha Wahap, Mr Lim Tingang and Mr Lian Lugun, and Mr Wan Omar, Mr Roy Mason, Mr Staban Lanjang, Mr Shamat Amit, Mr Malik Zainuddin, Mr Mohd. Saupi, Mr Rafi and Mr Jongkar Grinang. Without the assistance of the local communities from Kpg Bario Asal, Arur Dalan, Pa' Lungan, a number of Penan from Long Lobang, too many for me to mention each one of them here by names, and the assistance from Mr Alexander Wong, Manager of Kubaan Camp, Shin Yang Sdn Bhd in Ulu Tutoh who kindly provided us with a transport and accommodation, the study would not have been as successful as it was. Once again thank you very much to all of you.

1.0 INTRODUCTION

Malaysia has been identified as one of the most important countries containing the world's "mega-diversity". Sarawak and Sabah, which are parts of Borneo are the most species-rich area in Malaysia. Borneo, the third largest island, lies on the equatorial belt harbours rich mammalian fauna. A total of 119 indigenous species of mammals have been recorded in Borneo. High rates of endemism were enhanced by the relatively long and stable history of the Bornean rain forest. Much of this virgin rain forest of the island is located within the Pulong Tau National Park that lies in between GPS location of 03° 5' - 3° 57' N and 115° 12' - 115° 34' E. A part of the park is located along the plateau of Tama Abu Range and was popularly known as a last refuge for Sumatran rhinoceros (*Dicerorhinus sumatrensis*) in Sarawak. Verbal report by local communities stated that the last sighting of the rhinoceros in the area occurred in late 50s. The absence of the species in the area may not necessarily indicate that the species has gone extinct but could probably be due to migration to the Indonesian side of Borneo. Due to uncertainty of species status of big mammal in the park, which include that of the Sumatran rhinoceros, it seemed critical that International Tropical Timber Organization (ITTO) should include a project to carry out a proper survey on big mammals for Pulong Tau National Park this year. For this purpose a total of four sites have been chosen; upper Merario in the North-West of Bario Asal, forested areas around Pa' Lungan in the North-East of Bario, Long Menalio in the south and Long Lobang in the west of the Park. Rugged topography blanketed by the green hill dipterocarp forests of the areas provides sort of promising refuge for wildlife particularly those of the large mammal species. However, human disturbance, like the extraction and conversion of timbers inside the boundary of the park, may have impacted on the distribution and population status of certain species. This is in addition to impact from hunting activities done within the park.

1.1 Objectives

The main objectives of the survey are as follows;

1. To do inventory of big mammal species (3 kg and above in weight) for the selected sites in Pulong Tau National Park.
2. To study big mammal species diversity and relative density in the selected sites in the park.
3. To study big mammal species richness in the selected sites in the park.
4. To determine population status of certain species in the park.
5. To look for new signs of the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) presence in Pulong Tau National Park.

2.0 METHODOLOGY

2.1 Line Transects Survey (King's Census Method)

Two or three transect lines, each of 1.8 to 3 km long, were cut in each of the selected study sites. All the transect lines were cut across different types of topography and altitude, starting from about 500 m to 2,100 m a.s.l. Each line was marked with flagging tapes at a 50 m interval while each transect in each site was cut about 2-3 km apart. Surveys along the transect lines normally started as early as 0630 hours, during fine mornings, and ended at around 1100 hours or as late as 1500 hours, depending on the transect distance or length and weather condition. Each site, where two to three transect lines were cut was surveyed for a period of seven to ten days by two or three surveyors. While walking the transects, observations were made all the way but focus was made on every marking point where surveyors are to stop for 1 to 2 minutes to scan areas around them for presence of animals. Every sighting is noted, compass bearings of the animal(s) sighted, and the bearings of the transect line were recorded. Estimated distance of animal(s) sighted was also noted. Species, number of individuals and activities of the animals were also recorded. Signs of animal presence like calls, track, and scratches on trees or ground, foot prints, bite marks and faeces were also recorded to determine the species concerned.

Vegetation types, topography and human activities in and around each study site were also noted. Abundance of certain species of vegetation usually determines the presence of certain mammal species of the area.

2.2 Description of Study Area

Pulong Tau National Park (see Plate 1) lies between 03° 5' - 3° 57' N; 115° 12' - 115° 34' E is located in Miri and Limbang Divisions in the northern interior of Sarawak. With an area of 164,500 ha, the eastern tip of the park is contiguous to Kayan Mentarang National Park in Kalimantan, Indonesia. The park also lies approximately at an altitude between 500 m and over 2, 200 m above sea level and comprises rugged and mountainous terrain that includes Gunung Murud, Sarawak's highest peak. Terrain is hilly to steep and there is little evidence of disturbance to the forest. The park falls within a humid tropical climatic zone, and is distinctly cooler and wetter than the rest of Sarawak. The park forms an important water catchment area for the northern part of Sarawak especially Sungai Baram and Sungai Limbang.

A total of four sites have been selected for the mammal surveys (Figure 1). These were: Sungai Merario near Bario Asal, Pa' Lungan, Long Menalio and Long Lobang.

2.2.1 Sungai Merario (Bario Asal)

The site is located at a GPS location of 03° 44' 30.7" N and 115° 27' 55.0" E, lies between an altitude of 1,200 to 2,100 m above sea level. Vegetation along the study sites are generally of primary and mixed dipterocarp forest, particularly at the lower part and of mixed sub-montane forest towards the slope of the highest peak.

2.2.2 Arur Panipat and Arur Bada Lawit (Pa' Lungan)

The sites are located between 03° 50'55.7" N to 03° 50'59.9" N and 115° 30' 36.3" E to 115° 30' 29.1" E. The study site located at the lower elevation was slightly exploited by timber extraction activities where a number of trees have been cut and converted into timbers. Similar to the first study site the vegetation are generally of mixed dipterocarp forest with sub-montane vegetation towards the peak of the hill where one of the transect lines ended. Elevation of the study site ranges within 1,000 to 1,800 m above sea level.

2.2.3 Long Menalio

Located at 03° 34' 07.6" N and 115° 24' 21.6" E. The study sites were generally located at low altitude, mainly lies between 1,010 to 1,080 m above sea level. Similar to the other two sites surveyed previously the vegetation of the area are mainly of mixed dipterocarp forests.

2.2.4 Long Lobang

The site is located in between 03° 41' 21.8" N; 115° 17' 21.8" E and 03° 41' 00.2" N; 115° 16' 55.7" E. The lower part of the study site has been cleared for padi farming and was vegetated by secondary forest and scrubs while the rest of the area were mainly of virgin mixed dipterocarp forests (see Plate 2). Elevation of the study site lies within the range of 500 m to 700 m above sea level.

3.0 RESULTS

A total of 20 species of big mammals (body weight of 3 kg and above) from seven different families were detected during the survey period in the four different locations of the Pulong Tau National Park (Table 1). Barking deer (*Muntiacus* sp.), wild boar (*Sus barbatus*) and giant squirrel (*Ratufa afinis*) were found in all the four sites. However, Bornean gibbons (*Hylobates muelleri*) were detected in only three of the sites, i.e. in Sg. Merario (Bario Asal), Pa' Lungan and Long Menalio while the Hose's langurs (*Presbytis*

hosei) were only recorded in Sg. Merario (Bario Asal), Long Menalio and Long Lobang. The most detected species was the Bornean gibbon (*Hylobates muelleri*) with a percentage of 34.32 per cent while amongst the least detected (0.37 %) were Malay weasel (*Mustela nudipes*), common palm civet (*Paradoxurus hermaphroditus*), oriental small-clawed otter (*Aonyx cinerea*) and bearcat (*Arctictis binturong*) (Figure 2).

Table 1: Total number of big mammal species detected through Line Transect Survey in four different study sites in Pulong Tau National Park. SM=Sungai Merario, PL=Pa'Lungan, LM=Long Menalio, LL=Long Lobang, TL=Total

No	Common Name	Scientific Name	SM	PL	LM	LL	TL	%
1.	Long-tailed macaque	<i>Macaca fascicularis</i>	-	24	-	11	35	13.05
2.	Pig tailed macaque	<i>Macaca nemestrina</i>	5	-	3	-	8	2.98
3.	Hose's langur	<i>Presbytis hosei</i>	3	12	-	18	33	12.31
4.	Red leaf monkey/ Maroon langur	<i>Presbytis rubicunda</i>	3	-	-	-	3	1.11
5.	Sambar deer	<i>Cervus uicolor</i>	-	-	-	1	1	0.37
6.	Barking deer	<i>Muntiacus</i> sp.	6	7	12	7	32	11.94
7.	Bornean gibbon	<i>Hylobates muelleri</i>	17	37	38	-	92	34.32
8.	Common porcupine	<i>Hystrix brachyura</i>	1	-	-	3	4	1.49
9.	Long-tailed porcupine	<i>Trichys fascicularis</i>	-	1	-	-	1	0.37
10.	Pangolin	<i>Manis javanica</i>	-	1	-	1	2	0.74
11.	Oriental small-clawed otter	<i>Aonyx cinerea</i>	1	-	-	-	1	0.37
12.	Malay weasel	<i>Mustela nudipes</i>	1	-	-	-	1	0.37
13.	Giant squirrel	<i>Ratufa afinis</i>	4	8	11	1	24	8.95
14.	Wild boar	<i>Sus barbatus</i>	7	5	4	6	22	8.20
15.	Lesser mouse deer	<i>Tragulus javanicus</i>	-	-	-	1	1	0.37
16.	Sun bear	<i>Helarctos malayanus</i>	3	-	-	-	3	1.11
17.	Bearcat	<i>Arctictis binturong</i>	-	-	-	1	1	0.37
18.	Small-tooth palm civet	<i>Arctogalidia trivirgata</i>	-	1	-	-	1	0.37
19.	Masked palm civet	<i>Faguma larvata</i>	1	-	-	1	2	0.74
20.	Common palm civet	<i>Paradoxurus hermaphroditus</i>	1	-	-	-	1	0.37
Total							268	

In term of detection per km, again, the *Hylobates muelleri* shown the highest index (2.42) as compared to other species detected throughout the survey period (see Table 2 & Figure 3). Other species that have shown relatively high index of detection were mostly those of arboreal in nature such as the giant squirrel (*Ratufa afinis*, 0.56), Hose's langur (*Presbytis hosei*, 0.78) and the long-tailed macaque (*Macaca fascicularis*, 0.77). The only non-arboreal species that have shown a relatively high index of detection was the barking deer (*Muntiacus* sp., 0.84).

Based on the Shannon-Weiner Index (Table 3), Bario Asal (Sg. Merario) has recorded the highest diversity index with 0.937, followed by Long Lobang

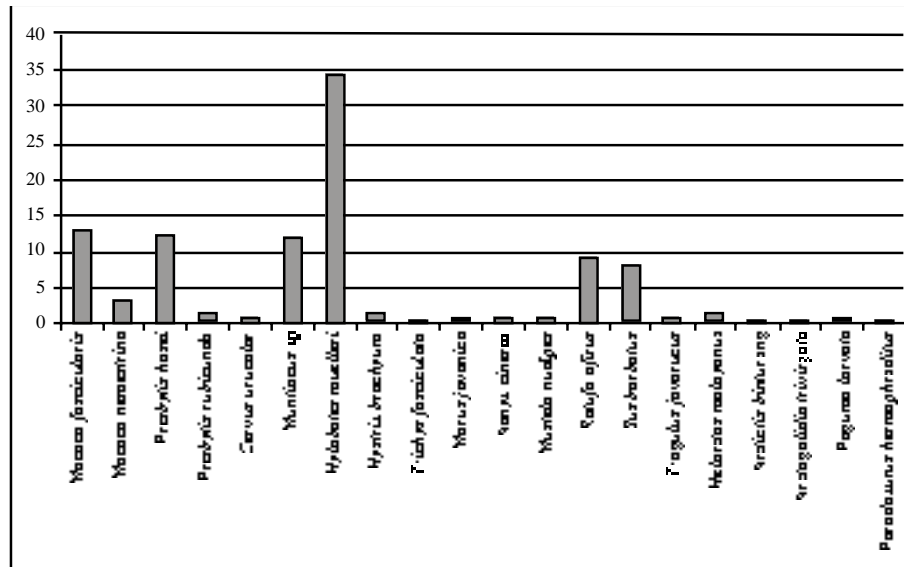


Figure 2: Percentage of mammal species detected through Line Transect Survey in the four study sites at Pulong Tau National Park.

Table 2: Index of mammals detected per km of survey walk (No. of species/km). SM=Sungai Merario, PL=Pa' Lungan, LM=Long Menalio, LL=Long Lobang, TL=Total

No	Common Name	Scientific Name	SM	PL	LM	LL	TL
1.	Long-tailed macaque	<i>Macaca fascicularis</i>	0	0.50	0	0.27	0.77
2.	Pig tailed macaque	<i>Macaca nemestrina</i>	0.13	0	0.07	0	0.20
3.	Hose's langur	<i>Presbytis hosei</i>	0.08	0.25	0	0.45	0.78
4.	Red leaf monkey/Maron langur	<i>Presbytis rubicunda</i>	0.08	0	0	0	0.08
5.	Sambar deer	<i>Cervus unicolor</i>	0	0	0	0.03	0.03
6.	Barking deer	<i>Muntiacus sp.</i>	0.16	0.25	0.27	0.18	0.84
7.	Bornean gibbon	<i>Hylabates muelleri</i>	0.45	0.97	1.00	0	2.42
8.	Common porcupine	<i>Hyatrix brachyura</i>	0.03	0	0	0.08	0.11
9.	Long-tailed porcupine	<i>Trichys fascicularis</i>	0	0.02	0	0	0.02
10.	Pangolin	<i>Manis javanica</i>	0	0.02	0	0.03	0.05
11.	Oriental small-clawed otter	<i>Aonyx cinerea</i>	0.03	0	0	0	0.03
12.	Malay weasel	<i>Mustela nudipes</i>	0.03	0	0	0	0.03
13.	Giant squirrel	<i>Ratufa affinis</i>	0.11	0.17	0.25	0.03	0.56
14.	Wild boar	<i>Sus barbatus</i>	0.18	0.10	0.09	0.25	0.52
15.	Lesser mouse deer	<i>Tragulus javanicus</i>	0	0	0	0.03	0.03
16.	Sun bear	<i>Helarctos malayanus</i>	0.08	0	0	0	0.08
17.	Beaufort	<i>Arctictis bismarong</i>	0	0	0	0.03	0.03
18.	Small-tooth palm civet	<i>Arctogalidia trivirgata</i>	0	0.02	0	0	0.02
19.	Masked palm civet	<i>Puguma larvata</i>	0.03	0	0	0.03	0.06
20.	Common palm civet	<i>Pardaliparus hermaphroditus</i>	0.03	0	0	0	0.03
Total			1.42	2.20	1.68	1.31	6.64

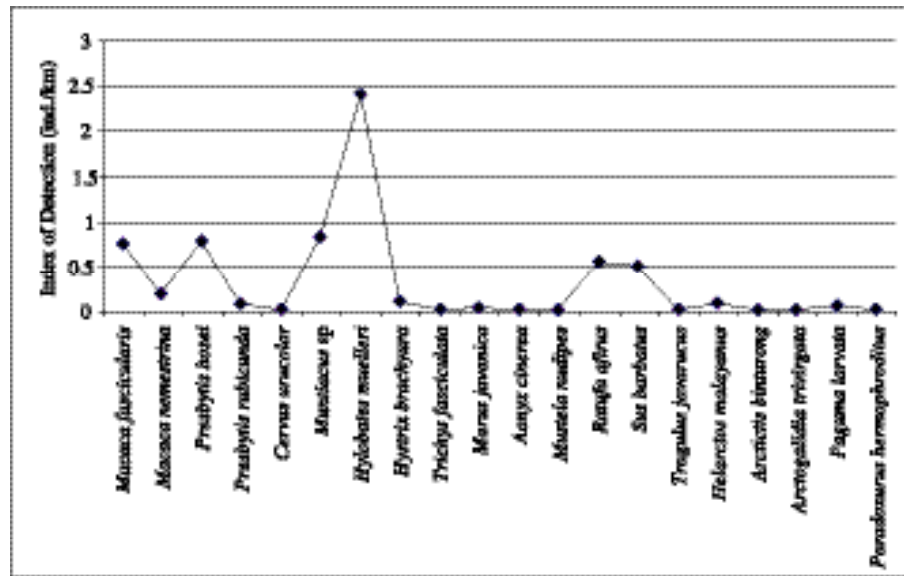


Figure 3: Index of Detection of Big Mammal Species in four sites in Pulong Tau National Park.

with 0.804, Pa’ Lungan with 0.725 and the lowest diversity among the big mammal species encountered was Menalio, with an index of only 0.534. When comparison is made, based on 95% confidence limit, between pairs of sites the mammal species diversity in Bario Asal (Sg. Merario area) was found to be of highly significant as compared to that of Menalio, so as between Bario Asal (Sg. Merario) and Pa’Lungan, Long Lobang and Menalio, and Pa’Lungan and Menalio. However there was found to be no significant difference in species diversity between Bario Asal (Sg. Merario area) and Long Lobang, and between Long Lobang and Pa’ Lungan (Table 4).

In term of Species Richness (R), again, Bario Asal (Sg. Merario area) has recorded the highest figure (6.959), followed by Long Lobang (5.856), Pa’ Lungan (4.036) and Menalio of a figure of 2.183 (Table 5).

Table 3: Comparison of Diversity Indices between four different study sites in Pulong Tau National Park

Study Sites	Merario, Bario Asal	Pa’ Lungan	Long Menalio	Long Lobang
No. of individuals	53	96	68	51
No. of species	13	9	5	11
Shannon-Weiner Diversity	0.937	0.725	0.534	0.804
Simpson Diversity				
[infinite population (1-D)]	0.841	0.758	0.625	0.79
[infinite population (1/D)]	6.284	4.133	2.667	4.772
Brillouins Diversity (H)	2.678	2.215	1.624	2.309

Table 4: Comparison of significance in species diversity of big mammal species in four different study sites in Pulong Tau National Park**Hypothesis:**

Ho: No significant difference in species diversity between the two sites if the value of t-calculated is less than t-critical value (t, 0.05).

Ha: Significant difference in diversity between the two sites if the value of t-calculated is more than t-critical (t, 0.05).

Study Sites	t-calculated	t-critical	Conclusion
Bario Asal vs Menalio	6.0363883	1.96	Highly significant
Bario Asal vs Long Lobang	1.75689562	1.96	Not significant
Bario Asal vs Pa' Lungan	3.33994903	1.96	Highly significant
Long Lobang vs Pa' Lungan	1.19239894	1.96	Not significant
Long Lobang vs Menalio	3.8710322	1.98	Highly significant
Pa' Lungan vs Menalio	3.3748135	1.96	Highly significant

Table 5: Comparison of Species Richness (R) between four different study sites in Pulong Tau National Park.

Study Sites	No. of Individuals	No. of Species	R
Bario Asal (Merario)	53	13	6.959
Pa' Lungan	96	9	4.036
Long Menalio	68	5	2.183
Long Lobang	51	11	5.856

Population densities of the big mammals detected have also been estimated for species based on calls and sightings while 'Observed densities' of the population were done for those seen only during the survey. These were among Bornean gibbon (*Hylobates muelleri*), maroon-leaf monkey (*Presbytis rubicunda*), macaques (*Macaca* spp.), giant squirrels (*Ratufa afinis*) and barking deer (*Muntiacus* sp.).

For the estimated density (no. of est. ind./km²) Bornean gibbon was found to be the highest in Sg, Merario (Bario Asal), as compared to the other three sites, with a figure of 11.74 ind./km² (Table 6). Surprisingly there was no sign of Bornean gibbon presence in Long Lobang area during the period of the survey. The total estimated densities of Bornean gibbon in the other three study sites were 14.4 individuals per km². On the other hand the Malay weasel (*Mustela nudipes*) and the maroon-leaf monkey (*Presbytis rubicunda*) were only seen in Sg, Merario (Bario Asal) area with an estimated density of 0.74 individual per km² and 1.81 individuals per km² respectively. The densities gave a total figure of 0.74 and 1.81 individuals per km², respectively.

The barking deer (*Muntiacus* sp.) and the giant squirrel (*Ratufa afinis*) were heard and seen in all the four study sites with Pa' Lungan recording the highest estimated density (6.87 ind./km²) for the barking deer and the giant squirrel

Table 6: Estimated density of certain mammal species (D = No. ind. species detected through calls and sightings/area) in four different study sites in PTNP. SM=Sungai Merario, PL=Pa'Lungan, LM=Long Menalio, LL=Long Lobang

Common Name	Scientific Name	SM	PL	LM	LL	Total
Bornean gibbon	<i>Hylobates muelleri</i>	11.74	1.71	0.95	0	14.4
Malay weasel	<i>Mustela nudipes</i>	0.74	0	0	0	0.74
Barking deer	<i>Muntiacus</i> sp.	1.61	6.87	2.97	0.55	12.00
Giant squirrel	<i>Ratufa afinis</i>	0.87	4.72	0.70	0.27	6.56
Maroon-leaf monkey	<i>Presbytis rubicunda</i>	1.81	0	0	0	1.81
Hose's langur	<i>Presbytis hosei</i>	0	4.03	1.12	5.56	10.71
Long-tailed macaque	<i>Macaca fascicularis</i>	0	0	13.26	5	18.26
Pig-tailed macaque	<i>Macaca nemestrina</i>	0	0	2.22	0	2.22

(4.72 ind./km²) respectively. The total estimated densities for the barking deer in all the four study sites was 12.00 individuals per km² and 6.56 individuals per km² for the giant squirrel.

Interestingly there were no sign of Hose's langur (*Presbytis hosei*), long-tailed macaque (*Macaca fascicularis*) and pig-tailed macaque (*Macaca nemestrina*) presence at Sg. Merario. While it seems to be having a very low estimated density in any other species detected, the Long Lobang area seems to inhabit relatively high density of Hose's langur (*Presbytis hosei*, 5.56 ind./km²) and the long-tailed macaque (*Macaca fascicularis*, 5 ind./km²), thus giving total estimated densities of 10.71 ind./km² and 18.26 ind./km² respectively.

On the other hand the Sg. Merario (Bario Asal) has recorded the highest 'observed density' of Bornean gibbon (*Hylobates muelleri*) with a figure of 7.32 ind./km². Barking deer (*Muntiacus* sp.) was seen in all the four study sites, however, Pa' Lungan recorded the highest density with 2.78 ind./km² (Table 7), giving a total 'observed density' of 5.74 ind./km² for the whole of the four study areas.

Giant squirrel (*Ratufa afinis*) was also seen in all the study sites except for Long Lobang while the Malay weasel (*Mustela nudipes*) and the maroon-leaf monkeys (*Presbytis rubicunda*) were only sighted in Sg. Merario (Bario Asal area). The long-tailed macaque (*Macaca fascicularis*) and the pig-tailed macaque (*Macaca nemestrina*) were only seen in Long Menalio, Long Lobang and Long Menalio respectively. For all the species sighted within the four study sites, long-tailed macaque (*Macaca fascicularis*) formed the highest observed density (10.06 ind./km²) while Bornean gibbon (*Hylobates muelleri*) came second (8.06 ind./km²), and Hose's langur (*Presbytis hosei*) came third (6.34 ind./km²). On the other hand the Malay weasel (*Mustela nudipes*) was the least dense population encountered (0.74 ind./km²).

Table 7: Observed density of certain mammal species (D = No. ind. species observed /area) in four different study sites in PTNP. SM=Sungai Merario, PL=Pa'Lungan, LM=Long Menalio, LL=Long Lobang

Common Name	Scientific Name	SM	PL	LM	LL	Total
Bornean gibbon	<i>Hylobates muelleri</i>	7.32	0.44	0.30	0	8.06
Malay weasel	<i>Mustela nudipes</i>	0.74	0	0	0	0.74
Barking deer	<i>Muntiacus sp.</i>	0.99	2.78	1.42	0.55	5.74
Giant squirrel	<i>Ratufa afinis</i>	0.70	1.39	0.45	0	2.54
Maroon-leaf monkey	<i>Presbytis rubicunda</i>	1.21	0	0	0	1.21
Hose's langur	<i>Presbytis hosei</i>	0	2.65	0.95	2.74	6.34
Long-tailed macaque	<i>Macaca fascicularis</i>	0	0	7.31	2.75	10.06
Pig-tailed macaque	<i>Macaca nemestrina</i>	0	0	2.22	0	2.22

Except for Malay weasel (*Mustela nudipes*), maroon-leaf monkey (*Presbytis rubicunda*), and pig-tailed macaque (*Macaca nemestrina*) which were only seen in Merario (Bario Asal) and Manalio respectively, the population densities of the other species had no significant difference between sites when tested by using Chi-square (X^2) distribution test (Table 8). Species which were found in only one study site were not tested for the difference.

Table 8: Calculation of Chi-square (X^2) distribution test. $X^2 = (O - E)^2/E$, where O: Observed density, E: Estimated density. SM=Sungai Merario, PL=Pa'Lungan, LM=Long Menalio, LL=Long Lobang

Hypothesis:

Ho: No significant difference in density between the four sites if the value of calculated $X^2 < \text{Critical value of } X^2 (X^2, 0.05, \text{d.f.}=3)$.

Ha: Significant difference in density between the four sites if the value of calculated $X^2 > \text{Critical value of } X^2 (X^2, 0.05, \text{d.f.}=3)$. d.f. = S-1, S = sites

Study Sites	Species	O	E	O - E	(O-E) ²	(O-E) /E ²
SM	<i>Muntiacus sp.</i>	0.99	1.61	-0.62	0.38	0.238757764
PL	<i>Muntiacus sp.</i>	2.78	6.87	-4.09	16.73	2.434949054
LM	<i>Muntiacus sp.</i>	1.42	2.97	-1.55	2.40	0.808922558
LL	<i>Muntiacus sp.</i>	0.55	0.55	0	0	0
					X² =	3.482629376
Result:						
X² = 3.483 < Critical value of X² (X², 0.05, 3) = 7.815, therefore it is concluded that there is no significant difference in densities of <i>Muntiacus sp.</i> in the four different study sites.						
SM	<i>Hylobates muelleri</i>	7.32	11.74	-4.42	19.54	1.664088586
PL	<i>Hylobates muelleri</i>	0.436	1.71	-1.27	1.62	0.949167251
LM	<i>Hylobates muelleri</i>	0.297	0.95	-0.653	0.426409	0.448851578
LL	<i>Hylobates muelleri</i>	0	0	0	0	0
					X² =	3.062107415
Result:						
X² = 3.062 < Critical value of X² (X², 0.05, 2) = 5.991, therefore it is concluded that there is no significant difference in densities of <i>Hylobates muelleri</i> in the three different study sites. (No sighting or detection of <i>H. muelleri</i> in Long Lobang).						

SM	<i>Ratufa afinis</i>	0.70	0.87	-0.17	0.0289	0.03321839
PL	<i>Ratufa afinis</i>	1.39	4.72	-3.33	11.09	2.34934322
LM	<i>Ratufa afinis</i>	0.45	0.70	-0.25	0.0625	0.089285714
LL	<i>Ratufa afinis</i>	0	0.27	-0.27	0.0729	0.2700
					X² =	2.741847324
Result:						
X² = 2.741847324 < Critical value of X² (X², 0.05, 3) = 7.815, therefore it is concluded that there is no significant difference between the population of <i>Ratufa afinis</i> densities in the four different study sites.						

4.0 DISCUSSION

There were only 20 species of big terrestrial mammals (body weight of 3 kg and above) detected throughout the survey period in all the four sites. The result, however, did not indicate that there were only 20 species of big mammal in the area. As the transect lines were cut along rugged terrain, thick undergrowth of shrubs and *Gleichenia* species in some parts of the forests, making limited visibility, and the cryptic behaviour of some species, it is believed that a number of big mammal species of the park have not been encountered. The nocturnal behaviour of some species has also contributed to the non-sighting of certain species. Wild boar (*Sus barbatus*), for instance, despite the fact that there were heavy signs in all the four study sites, especially in its lower altitude, it only comprises of 8.20 per cent of the total number detected. Apart from species like wild boar, barking deer, gibbons and langurs, Davies (1958) reported that other large mammal species that used to be abundant in the highlands were sun bear (*Helarctos malayanus*), tembadau (*Bos sundaicus*) and Sumatran rhinoceros (*Dicerorhinus sumatrensis*). Tajuddin *et. al.* (1999) reported the presence of most of the species listed in Table 1 above. During the survey there were no signs of tembadau or Sumatran rhinoceros detected. There were few signs of bark being peeled off from trees near the transect line, an indication of the presence of sun bear but none was seen during the survey (see Plate 3). The existence of the species in the area was supported by other reports (Davies, 1958) which also indicated the abundance of other species like the bearcat or binturong and tembadau.

On the other hand the absence of the tembadau (*Bos sundaicus*) and Sumatran rhinoceros (*Dicerorhinus sumatrensis*) were probably due to heavy hunting activities of the species. Labang (*pers. comm.*) has reported that tembadau and Sumatran rhinoceros were the most favoured species by hunters in the fifties and late sixties, mainly because of the high price of its trophies like horns, or even bones. However, non-sighting of the species does not indicate that the species is extinct. The hunting, as well as logging activities in the area may have eliminated some of the individuals and scared the others off, and eventually chased the remaining population out of the highland to the

Kalimantan side of the border. The latter may have come back to the Kelabit highland, which currently is part of the Pulong Tau National Park, foraging for food and refuge. This assumption was supported by a recent sighting of Sumatran rhinoceros (*Dicerorhinus sumatrensis*), not very far from Pa' Lungan, by a couple of tourists, as reported in a local newspaper (The Borneo Post, June 25, 2006).

In addition hunting activities may also have made the species too wary of human presence, thus very few were detected during the surveys. Heavy hunting of wild boar in the study sites, particularly in Long Menalio was evidenced by the massive collection of wild boar lard (see Plate 4) by a hunter from Bario. Hunters built a semi-permanent hunting camp at Long Menalio and the area is frequently visited by hunters from Bario Asal. This camp was once used as a centre to harvest wild game and supply the schools in Bario Asal with fish and meat from the wild. Several spent cartridges of shot guns were found in a number of locations within the study areas

The use of snares was also evident. A pair of nylon snares were discovered by a group of surveyors in one of the transect lines in Long Menalio (see Plate 5). This could be another reason why there were only two terrestrial species detected throughout the survey period in this study site. Arboreal species, however, did not seem to be badly affected, thus the population of Bornean gibbons, pig-tailed macaque and the giant squirrel were relatively high.

Timber extraction activities were rampant, particularly in Merario and Pa' Lungan areas (see Plate 6). Fortunately the activities did not heavily affect the abundance and diversity of certain species, particularly the Bornean gibbons and the barking deer. The index of detection was also high amongst the arboreal species, highest amongst Bornean gibbon. This is another indication that timber extraction and hunting activities did not really affect the abundance of these species. There were also relatively high rate of detection amongst the barking deer, probably that of Bornean yellow muntjac, and the bearded pigs. It suggests that the present level of human disturbance, like timber extraction and hunting activities have not come to a detrimental stage to the population of the two species, and at least in two occasions the barking deer was seen fleeing away from timber extraction site upon our approach. The detection rate per kilometre survey of the barking deer (yellow muntjac or *Muntiacus antherodes*) in the four study sites in Pulong Tau National Park was much higher than that found by Liam (2002) in Lambir Hills and Similajau National Parks. This suggests that the area provides better refuge for the species as compared to the other two National Parks, despite the fact that the two places were being given better protection.

Wild boar (bearded pigs), though only seen in Pa Lungan, were also detected by signs (foot prints) in the other three sites. The abundance of the species is expected to increase dramatically during fruiting season despite the fact that they are the most preferred by hunters. Wild boar fat collection in Long Manalio indicated that at least 20 individuals had been killed in that particular area alone this year. Though wild boar seemed to be resilient to human disturbance the recently constructed logging road provides accessibility for hunters from other areas including Miri to the area. Without proper protection the abundance of this game species would soon be affected.

The giant squirrel (*Ratufa afinis*) was found in all the four study sites with an Index of Detection higher than those obtained for Lambir Hills or Similajau National Parks (Liam, 2002). This also indicates that the highland of the Pulong Tau National Park supports the population of the species better.

Generally the Relative Density of the Bornean gibbon (*Hylobates muelleri*) in the four survey sites were relatively comparable to that reported by Meredith (1993) in Batang Ai National Park but was relatively lower than that found in the logged forests of the Balingian/Belakin of the Model Forest Management Area (Stuebing, 1995). Surprisingly the species was only recorded in the three study sites of the park and none was recorded in Long Lobang, a place predominantly dominated by the Penan community. Unlike the Kelabit communities on the other side of the Park where hunters used shot guns and usually go after big game species like bearded pigs or sambar deer, the Penan use blowpipes with poisoned darts to hunt. This hunting method is less effective on terrestrial game species such as bearded pigs that always hide in thick bushes but proven to be very effective on arboreal primate species such as the Bornean gibbons. Unlike other communities the Penan seemed to favor primate species as much as bearded pigs. Thus it is not surprising that the Bornean gibbon was not even heard during the survey in Long Lobang. In contrast, population of Bornean gibbon in the other three sites, particularly in Long Manalio, was relatively abundant and less wary of human presence. A group comprising of five individuals and one infant, clinging to its mother, was seen foraging on 'bintangor' fruits just a few metres overhead of the surveyors in one of the transect lines in Long Manalio (see Plate 7). This could possibly suggest that hunters in this area, who were mostly Kelabit from Bario, may not prefer the species and excluded it in their hunted list. Thus, gibbons were less disturbed as compared to bearded pigs or other game species, resulting in less wary behaviour. Despite the fact that no Bornean gibbons were detected in Long Lobang, the species seemed to be uniformly distributed in other areas of the park, particularly areas that are readily accessible by tourists.

The presence of the infant was another excellent indication on the population status of the primate. It suggests that the area was supporting healthy breeding

population of the Bornean gibbon, a species which is totally protected under the Wildlife Protection Ordinance, 1998. Though the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) and the tembadau (*Bos sundaicus*) are now very rare, or extinct from the area, the conservation and proper protection of the remaining vulnerable and important species, like the Bornean gibbon should be given top priority by the management agency. Eco-tourism activities in Bario is a lucrative business that seem to continuously generate extra income for the local communities, apart from income derived from sale of their popular Bario rice. This is evidenced by the fact that most of the local casual laborers and porters have in one way or another been involved in guiding foreign tourists wandering in the Kelabit Highland forests, simply to enjoy nature. The other evidence on the importance of eco-tourism to local communities is the rapid development of lodging houses and other facilities used to cater for tourists.

Quite contrary to that of the Bornean gibbons the other primate species, the Hose' langur and the long-tailed macaques were found to be quite abundant in Long Lobang. This could be due to the fact that the two species were more abundant and could adapt well and are more resilient to hunting pressure. A long-tailed macaque can elude hunters very well when it wanders, or forages in a disturbed forest like the 'temuda' in the nearby area. Tajuddin *et. al.* (1999) reported the occurrence of Hose's langur in other parts of the park, and Long Lobang forest seems to be part of their range.

For the barking deer (*Muntiacus* sp.) the estimated density is highest per km² in Pa' Lungan and was very low in Long Lobang. It could easily be found in all the four study sites, indicating that the species could easily be found in most parts of the national park. The giant squirrel (*Ratufa afinis*) has also demonstrated similar result, found in all study sites, with highest estimated density in Pa' Lungan. This is an indication that the species could be found anywhere in the park, though its abundance varies by locality but were not likely to be threatened by hunting and timber extraction activities. It seemed that the barking deer is adapting well, or resilient to human disturbance.

Game management specialists suggest that reproduction in game species is actually stimulated by harvesting, but more accurate data is required for a long-term management of the game stock like the barking deer of the park. Harvest percentages of exploited game populations such as that of feral pigs in Australia are about 6% of the standing crop, and if proper protection is given to the park it is not likely that the current rate of hunting by the local community, for own consumption, would cause extinction of the species, at least in the short term. Generally browsing ungulates like the barking deer benefit from vegetation changes brought about by logging activities, or even by agricultural activities in areas surrounding the park.

The barking deer and the Bornean gibbons are usually highly visible and make loud calls while foraging in the forest. With this kind of ecological behaviour those species would easily be noticed by eco-tourists wandering in the park and thus should be given high priority in the management of the area, though the existence of the Sumatran rhinoceros in the park should not be ruled out yet. It is still the most important asset to attract tourists to the area.

In term of species diversity of mammals none of the four study sites in Pulong Tau National Park exceeded those recorded for Bako National Park and those recorded for the Ulu Ayam/Sekawi area of the Model Forest Management Area (Stuebing, 1995). This could probably be due to the fact that the observations in Pulong Tau National Park were focused on big mammal species only. For this reason the giant squirrel (*Ratufa afinis*) body weight is estimated to be hardly beyond 3 kg. Mammal species which are smaller than the giant squirrel are not included in calculation and analysis. On the contrary, a similar survey by UNIMAS (Abd. Aziz, 2005) in Bako National Park included mammal species as small as *Sundasciurus lowii*. This was also the case for the Model Forest Management Area (Stuebing, 1995).

Studies in the past have recorded only three to four species of primates in the national park (Tajuddin *et. al.*, 1999). In comparison the present study recorded five species of primates. It is expected that a more extensive study could probably add up with additional primate species into the current species list. The white-fronted langur (*Presbytis frontata*,) which are normally found in the same habitat with Hose's langur (*P. hosei*) in lowland area of central Sarawak (Payne *et. al.*, 2005), and are quite common in Lanjak Entimau Wildlife Sanctuary (LEWS), has not been seen in all the four study sites in Pulong Tau National Park, neither has it been reported in the past in the area. One possible explanation is that the species may not favour the highland habitat. However, the orangutan (*Pongo pygmeus*) was reported by a Penan Field Assistant (Odau, T., *pers. comm.*) to be present in Long Sabai forest, a remote Penan village near Long Lellang in the south-east of the park. Since the presence of the species in Long Sabai has never been documented before, further study in the area is required in the near future to verify the report. Similar information has also been reported (Malcolm D., *pers. comm.*) on possible occurrence of the orangutan in Binyu-Penyilam forest in Tatau District, an area where the species has never been reported in the past. If these reports are true then it is obvious that the species is able to diversify and extend their habitat preference and not just confine themselves to certain areas only. Thus the right strategy for survival of such species is to properly protect its preferred habitat.

Other species recorded in the present study, but not been reported previously, are the Malay weasel (*Mustela nudipes*) and a couple of viverrid species. This does not mean that the animals are new to the area but the thoroughness and

the extensiveness of the study would normally result in the finding of more species, cumulatively, until it reaches its asymptotic level, a level when no more new species is discovered. Due to time constraint and manpower the present study was only restricted to about ten days in each of the four sites, which are representative of the park. Scientifically, very little has been known on the ecology of the Malay weasel and more emphasis on future study on the species is necessary.

Among the four study sites, Merario has the highest index in term of species diversity (0.937) while Long Menalio was the lowest (0.534). This difference was found to be highly significant. One possible explanation is the fact that there was a timber concession in a nearby area. Species such as pig-tailed macaque, long-tailed macaque, pangolin, porcupine and sambar deer may prefer food available in disturbed forest which is found in the logging area nearby. Paschal (*pers. comm.*) reported that a sambar deer and a pair of bearded pigs were seen foraging in the timber concession area bordering the park adjacent to Long Menalio. Future survey should include logging areas.

Another possible reason is the altitude. Long Menalio is relatively of lowland (hardly above 3,000 feet a.s.l.) while the transect lines in Merario were cut across altitudes of 5,000 - 6,000 feet a.s.l. This could mean that lower altitude could support more game species like the bearded pigs and consequently attract more hunters into the area. Higher hunting activities means more animals were harvested and the remaining ones would probably be chased out of the forests into the nearby area. Nevertheless this is only an assumption and the difference in the species diversity could only be confirmed by conducting field study of species in the two areas. Similar results are seen between Long Menalio and Long Lobang, and Long Menalio and Pa' Lungan. There were relatively more species found in Long Lobang and Pa' Lungan as compared to that in Long Menalio.

In term of the species richness the result from the four sites has shown similar sequence to that of the species diversity indices for the four different areas. Again, better access to the area by hunters and availability of huge areas of disturbed forests nearby Long Menalio are the possible explanation to the above situation. Unlike the other three study sites, where hunters were normally those staying nearby, Long Menalio receives hunters from all over the Kelabit Highlands, inclusive of those from Bario Asal, Pa'Umur, Pa'Ukat, Arur Dalan as well as those who may come from as far as Miri by the newly constructed logging road nearby.

5.0 RECOMMENDATIONS

A long-term programme to monitor key species within Pulong Tau National Park should be implemented through systematic surveys throughout the park, including the four areas currently studied. Wildlife protection can be enhanced through educating hunters to be more responsible, and by soliciting their cooperation in maintaining game stocks and other important species for the future. These goals can be achieved through extension programmes involving staff of the park and local communities, through their representatives in the Special Park Committee (SPC).

Systematic surveys must continue to monitor wildlife populations, particularly those of important assets for tourism activities, like the Bornean gibbon, Sumatran rhinoceros, barking deer, etc. The recent report on the sighting of the Sumatran rhinoceros by the tourists is an important basis for the authority to continue tracking and determining the actual status of the species in the area. The proposal by State Planning Unit to reintroduce rhinoceros into the area (Tukau, A. *pers. comm.*) should be followed up and be given proper consideration, especially once the actual status of the species has been determined.

The existing Public Education and Awareness Programmes can be tailored for use amongst local communities surrounding the parks, including the Penan in the remote areas of Pa' Tik, Long Lobang, Long Sabai and those who are still practising the nomadic way of life within the national park. This programme should also be extended to the timber concessionaires near Long Lobang and Long Menalio. The establishment of the Honorary Wildlife Rangers and the Special Park Committee for the park should not be confined to the Kelabit communities only but should also include the Penan and officials from the timber companies in the surrounding area.

Production of simple but informative educational leaflets on wildlife of the park has to be continuous, and should be made available at the Ranger Station in Bario, the airports in Bario, Miri and Kuching. This is to improve community perceptions of the role of wildlife in the park ecosystem and tourism, and at the same time to attract tourism into the park.

The region possesses several areas of impressive natural beauty like the 'Batu Lawi', apart from presence of wildlife. These areas have great potential to attract not only foreign tourists but also Malaysian 'weekenders'. Thus development of these areas, such as construction of proper trails, shelters, camp sites and construction of more Ranger Stations; training tourist guides, establishing information services centres, improving of existing tourist facilities, and recruitment of more staff are required. These Ranger Stations are

particularly important to be put up near logging areas to ensure that no encroachment into the park occurs. It has been proven that commercial hunters were detrimental to the survival of wildlife in the past.

Some parts of the park boundary have not been clearly demarcated, and most of the FD plates were damaged. In order to implement proper enforcement duties the park boundary's has to be clearly demarcated. Potential dispute with local communities on the layout of the boundary have to be resolved through negotiation with the communities through their representatives in the Special Park Committee.

Reports on recent sightings of certain species believed to have gone extinct from the park (e.g. Sumatran rhinoceros), and report on the sighting of species that previously has never been recorded in the area (e.g. orangutan) have to be given serious attention. A proper survey team has to be established and systematic survey has to be conducted.

Should the privileges of hunting in the park be given to the Penan communities, killing of totally protected species like the Bornean gibbon, rhinoceros and langurs should be strictly forbidden. Penalties should be imposed on those found to purposely break the rules.

To reduce dependency of certain communities, like the Penan, on the forest of the park, certain community-development projects and programmes should be drawn up for them. This may include a number of agricultural projects like establishment of rubber gardens, planting of fruit trees and fish rearing. Other activities like development of handicraft should also be encouraged. These activities and programmes of course need to be implemented hand-in-hand with relevant courses and training.

In view of the fact that the Pulong Tau National Park is still largely unexplored scientifically, and the fact that it could offer a valuable opportunity for the education of school and university groups, a small Field Study Centre, or a simple laboratory has to be put in place. It should compliment the existing facilities that are already available at the Ranger Station at Bario. For this purpose a hostel that could accommodate ten scientists at any one time is recommendable.

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APPENDICES

Appendix 1: Analysis of species diversity of big mammals in Pulong Tau National Park.

Species/Sites	Bario	$-BI * LOG(BI)$	$-BI * (LOG(BI) * LOG(BI))$
Species1	6	4.668907502	3.633116211
Species2	1	0	0
Species3	7	5.91568628	4.999334881
Species4	17	20.91763166	25.73807732
Species5	1	0	0
Species6	4	2.408239965	1.449904933
Species7	3	1.431363764	0.682934075
Species8	5	3.494850022	2.442795335
Species9	3	1.431363764	0.682934075
Species10	1	0	0
Species11	1	0	0
Species12	1	0	0
Species13	3	1.431363764	0.682934075
Total	53	41.69940673	40.3120309
Variance			0.002671313
Species/Sites	Pa' Lungun	$-BI * LOG(BI)$	$-BI * (LOG(BI) * LOG(BI))$
Species1	7	5.91568628	4.999334881
Species2	5	3.494850022	2.442795335
Species3	37	58.02346379	90.99249595
Species4	8	7.224719896	6.524572197
Species5	12	12.95017495	13.97558594
Species6	1	0	0
Species7	1	0	0
Species8	1	0	0
Species9	24	33.1250698	45.71959372
Total	96	120.7339647	164.654378
Variance			0.001390392
Std. Dev(H1-H2)			0.063731512
Shanon-Weiner 1	0.93749		
Shanon-Weiner 2	0.72463		
t-calculated			3.339949029
V-calculated	1.64975E-05	1.54777E-07	106.5883135
t-critical	1.96		
(from t-table)			
Conclusion	Highly Significant		

Species/Sites	Bario	=BI*LOG(BI)	=BI*(LOG(BI)* LOG(BI))
Species1	6	4.668907502	3.633116211
Species2	1	0	0
Species3	7	5.91568628	4.999334881
Species4	17	20.91763166	25.73807732
Species5	1	0	0
Species6	4	2.408239965	1.449904933
Species7	3	1.431363764	0.682934075
Species8	5	3.494850022	2.442795335
Species9	3	1.431363764	0.682934075
Species10	1	0	0
Species11	1	0	0
Species12	1	0	0
Species13	3	1.431363764	0.682934075
Total	53	41.69940673	40.3120309
Variance			0.002671313
Species/Sites	Long Menalio	=BI*LOG(BI)	=BI*(LOG(BI)* LOG(BI))
Species1	12	12.95017495	13.97558594
Species2	4	2.408239965	1.449904933
Species3	38	60.03177667	94.83721606
Species4	11	11.45531954	11.92948597
Species5	3	1.431363764	0.682934075
Total	68	88.27687489	122.875127
Variance			0.001789582
Std. Dev(H1-H2)			0.066789938
Shanon-Weiner 1	0.93749		
Shanon-Weiner 2	0.53432		
t-calculated			6.0363883
V-calculated	1.98996E-05	1.81737E-07	109.4966169
t=critical	1.96		
(from t-table)			
Conclusion	Highly Significant		

Species/Sites	Bario	=BI* LOG(BI)	=BI*(LOG(BI)*LOG(BI))
Species1	6	4.668907502	3.633116211
Species2	1	0	0
Species3	7	5.91568628	4.999334881
Species4	17	20.91763166	25.73807732
Species5	1	0	0
Species6	4	2.408239965	1.449904933
Species7	3	1.431363764	0.682934075
Species8	5	3.494850022	2.442795335
Species9	3	1.431363764	0.682934075
Species10	1	0	0
Species11	1	0	0
Species12	1	0	0
Species13	3	1.431363764	0.682934075
Total	53	41.69940673	40.3120309
Variance			0.002671313
Species/Sites	Long Lobang	=BI* LOG(BI)	=BI*(LOG(BI)*LOG(BI))
Species1	7	5.91568628	4.999334881
Species2	6	4.668907502	3.633116211
Species3	3	1.431363764	0.682934075
Species4	1	0	0
Species5	1	0	0
Species6	18	22.59490509	28.36276312
Species7	1	0	0
Species8	11	11.45531954	11.92948597
Species9	1	0	0
Species10	1	0	0
Species11	1	0	0
Total	51	46.06618218	49.60763426
Variance			0.003074958
Std. Dev(H1-H2)			0.075804162
Shannon-Weiner 1	0.93749		
Shannon-Weiner 2	0.80431		
t-calculated			1.756895615
V-calculated	3.30196E-05	3.20039E-07	103.1737027
t-critical	1.96		
(from t-table)			
Conclusion	Not Significant		

Species/Sites	Long Lobang	=BI*LOG(BI)	=BI*(LOG(BI)*LOG(BI))
Species1	7	5.91568628	4.999334881
Species2	6	4.668907502	3.633116211
Species3	3	1.431363764	0.682934075
Species4	1	0	0
Species5	1	0	0
Species6	18	22.59490509	28.36276312
Species7	1	0	0
Species8	11	11.45531954	11.92948597
Species9	1	0	0
Species10	1	0	0
Species11	1	0	0
Total	51	46.06618218	49.60763426
Variance			0.003074958
Species/Sites	Long Manali o	=BI*LOG(BI)	=BI*(LOG(BI)*LOG(BI))
Species1	12	12.95017495	13.97558594
Species2	4	2.408239965	1.449904933
Species3	38	60.03177667	94.83721606
Species4	11	11.45531954	11.92948597
Species5	3	1.431363764	0.682934075
Total	68	88.27687489	122.875127
Variance			0.001789582
Std. Dev(H1-H2)			0.069746255
Shannon-Weiner 1	0.80431		
Shannon-Weiner 2	0.53432		
t-calculated			3.871032204
V-calculated	2.36638E-05	2.32496E-07	101.7811293
t^{critical}	1.98		
(from t-table)			
Conclusion	Highly Significant		

Species/Sites	Lang Lobang	=BI* LOG(BI)	=BI*(LOG(BI)*LOG(BI))
Species1	7	5.91568628	4.999334881
Species2	6	4.668907502	3.633116211
Species3	3	1.431363764	0.682934075
Species4	1	0	0
Species5	1	0	0
Species6	18	22.59490509	28.36276312
Species7	1	0	0
Species8	11	11.45531954	11.92948597
Species9	1	0	0
Species10	1	0	0
Species11	1	0	0
Total	51	46.06618218	49.60763426
Variance			0.003074958
Species/Sites	Pa' Lungan	=BI* LOG(BI)	=BI*(LOG(BI)*LOG(BI))
Species1	7	5.91568628	4.999334881
Species2	5	3.494850022	2.442795335
Species3	37	58.02346379	90.99249595
Species4	8	7.224719896	6.524572197
Species5	12	12.95017495	13.97558594
Species6	1	0	0
Species7	1	0	0
Species8	1	0	0
Species9	24	33.1250698	45.71959372
Total	96	120.7339647	164.654378
Variance			0.001390392
Std. Dev(H1-H2)			0.066823273
Shannon-Weiner 1	0.80431		
Shannon-Weiner 2	0.72463		
t-calculated			1.192398935
V-calculated	1.99393E-05	2.05537E-07	97.01113645
t-critical	1.98		
(from t-table)			
Conclusion	Not Significant		

Species/Sites	Pa' Lungan	=BI* LOG(BI)	=BI*(LOG(BI)*LOG(BI))
Species1	7	5.91568628	4.999334881
Species2	5	3.494850022	2.442795335
Species3	37	58.02346379	90.99249595
Species4	8	7.224719896	6.524572197
Species5	12	12.95017495	13.97558594
Species6	1	0	0
Species7	1	0	0
Species8	1	0	0
Species9	24	33.1250698	45.71959372
Total	96	120.7339647	164.654378
Variance			0.001390392
Species/Sites	Long Manali o	=BI* LOG(BI)	=BI*(LOG(BI)*LOG(BI))
Species1	12	12.95017495	13.97558594
Species2	4	2.408239965	1.449904933
Species3	38	60.03177667	94.83721606
Species4	11	11.45531954	11.92948597
Species5	3	1.431363764	0.682934075
Total	68	88.27687489	122.875127
Variance			0.001789582
Std. Dev(H1-H2)			0.056391264
Shannon-Weiner 1	0.72463		
Shannon-Weiner 2	0.53432		
t-calculated			3.374813502
V-calculated	1.01122E-05	6.72345E-08	150.4024428
t-critical	1.96		
(from t-table)			
Conclusion	Highly Significant		

Appendix 2: Field data sheet for Line Transect Surveys in Pulong Tau National Park, Bario.

TRANSECT NO.: T1, LOCATION: Ulu Merario, Bario DATE: 27.7.05 OBSERVERS: Engkamat & Staban

TIME STARTED: 0700 hrs. TIME FINISHED: 1623 HRS. WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	Activity	No. seen	No. est.	L/R	Remark
Barking deer (<i>Muntiacus</i> sp.)	0905	26	30	80	160	N	?	-	1	L	call
Malay weasel	0935	32	15	195	145	N	fleeing	1	1	R	seen
Wild boar	0935	34	0	-	-	-	-	-	-	-	track
Bornean gibbon	1345	40	20	290	320	T	fleeing	3	3	L	1 juv. & 2 adults

TRANSECT NO.: T2, LOCATION: Ulu Merario, Bario DATE: 28.7.05 OBSERVERS: Engkamat, Willie & Staban

TIME STARTED: 0730 hrs. TIME FINISHED: 1045 HRS. WEATHER: Fine but misty in early morning

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	Activity	No. seen	No. est.	L/R	Remark
Barking deer (<i>Muntiacus</i> sp.)		1	15	240	180	N	footprint	-	-		on transect line
Sun bear		2									scratch on tree

TRANSECT NO.: T3, LOCATION: Ulu Merario, Bario DATE: 30.7.05 OBSERVERS: Engkamat & Staban

TIME STARTED: 0715 hrs. TIME FINISHED: 1345 HRS. WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	Activity	No. seen	No. est.	L/R	Remark
Barking deer (<i>Muntiacus</i> sp.)	0955	27	0	-	-	-	footprint	-	-	-	on transect line
Bornean gibbon	1010	31	30	290	230	N	foraging	3	3	R	seen
Porcupine	1015	32	0	-	-	-	foraging	-	1	L	sign
Giant Squirrel	1450	3	35	320	330	T	-	-	1	L	call

TRANSECT NO.: T2, LOCATION: Ulu Merario, Bario DATE: 31.7.05 OBSERVERS: Engkamat, Willie, Roy & Staban

TIME STARTED: 0750 hrs. TIME FINISHED: 1000 HRS. WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	Activity	No. seen	No. est.	L/R	Remark
Giant squirrel	0853	-	50	160	230	N	?	-	1	R	calls
Bornean gibbon	0955	5	20	110	80	T	moving	3	3	R	seen

TRANSECT NO.: T1, LOCATION: Ulu Merario, Bario DATE: 1.8.05 OBSERVERS: Engkamat, Willie & Staban

TIME STARTED: 0800 hrs. TIME FINISHED: 1630 HRS. WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	Activity	No. seen	No. est.	L/R	Remark
Wild boar	0820	7	0	-	-	-	footprint	-	4		crossing
Pig-tailed macaque	0830	10	0					-	3		feeding on ginger
Barking deer	0845	15	7	130	195	N	Moving	1	1	L	seen near timber
Barking deer	0950	29	20	80	170	N	Resting on slope	1	1	L	seen
Wild boar	1030	35	0	-	-	-	(sign)	-	1	-	foot print
Maroon leaf monkey	1140	45	20	220	170	N	resting	2	2	R	fleeing

TRANSECT NO.: T3, LOCATION: Ulu Merario, Bario DATE: 2.8.05 OBSERVERS: Engkamat, Willie, Peter & Staban

TIME STARTED: 0800 hrs. TIME FINISHED: 1400 HRS. WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	Activity	No. seen	No. est.	L/R	Remark
Barking deer (<i>Muntiacus</i> sp.)	0825	5	300	50	130	N	-	-	1	L	calls scratch on tree
Wild boar	0945	24	0			N	foraging	-	2		footprint
Bornean gibbon	1210	39	40	220	330	T	?	-	3	L	calls
Sun bear		7	-	-	-	T	-	-	1	R	nest
Barking deer		7	1						1		sleeping site

TRANSECT NO.: T2, LOCATION: Ulu Merario, Bario DATE: 3. 8. 05 OBSERVERS: Engkamat, Lim & Staban

TIME STARTED: 0750 hrs. TIME FINISHED: 12:30 HRS. WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	Activity	No. seen	No. est.	L/R	Remark
Bornean gibbon	0845	56	300	150	230	N	crossing transect	-	?	L/R	calls
Wild boar											track/prints
Barking deer	0926		70	320	240			1	1		moving
Sunbear											scratches on tree.

TRANSECT NO.: T1, LOCATION: Ulu Merario, Bario DATE: 4. 8. 05 OBSERVERS: Engkamat, Lim & Staban

TIME STARTED: 0740 hrs. TIME FINISHED: 1400 HRS. WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	Activity	No. seen	No. est.	L/R	Remark
Giant squirrel	0820	10	40	260	170	N	?	1	1	R	calls
Bornean gibbon	0840	16	-500	40	160	N	?	-	?	L	calls
Giant Squirrel	0920	24	15	60	130	N	moving	1	1	L	seen
Pig-tailed macaque	1000	36	-	-	-	N	feeding ginger	-	?	R	sign
Barking deer	1110	51	50	140	225	N	-	-	1	L	calls
Maroon leaf monkey	1141	58	50	150	260	T	?	-	?	L	calls (same group?)
Bornean gibbon	1225	40	20	310	320	T	moving on trees	1	3	L-R	seen

TRANSECT NO.: 1, LOCATION: Arur Panipat, Pa' Lungan, Bario, DATE: 10/2/06 OBSERVERS: Engkamat, Staban, Malik, Chris, Maran, TIME STARTED: 0725 hrs. TIME FINISHED: 1040 hrs.

WEATHER: Cloudy followed by fine drizzling

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Barking deer (<i>Muntiacus sp</i>)	0800	11	20	160	130	N	call	-	1	R	fleeing away
Wild boar (<i>Sus barbatus</i>)	0915	28	10	150	130	N	seen	1	2	R	fleeing away
Long-tailed porcupine (<i>Trichys fasciculata</i>)	0830	19	5	-	-	N	remain of spine on transect	-	1	On transect	spine (fur)
Pangoline (<i>Manis javanica</i>)	0900	14	0	-	-	N	digging hole	-	1	On transect	feeding on ants
Barking deer (<i>Muntiacus muntjac</i>)	1000	37	4	-	-	N	track	-	?	On transect	crossing

Note: GPS coordinate at St. 37: N03° 50' 55.7", E115° 30' 36.3"

Elevation: 1,486m

Location ±21m

GPS Coordinate at top of the hill (end of Transect 1), i.e. at St. 42;

N03° 50' 59.9", E115° 30' 29.1"

Elevation: 1,538 m, Location: ±8m

TRANSECT NO.: 2, LOCATION: Arur Bada Lawit, Pa' Lungan, Bario DATE: 11/2/06
OBSERVERS: Engkamat, Malik, Chris, Maran, TIME STARTED: 0730 hrs. TIME FINISHED: 0940 hrs.

WEATHER: Cloudy followed by fine drizzling

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wak-wak (<i>Hylobates muelleri</i>)	0835	29	200	120	220	N	calls	-	1	L	could be the group seen earlier
Wak-wak (<i>Hylobates muelleri</i>)	0900	16	300	350	210	N	calls	-	3	R	

Note

Animals, either seen or heard were;

- (i) Sun bear (*Helarctos malayanus*), seen walking behind the camp.
- (ii) Small-toothed Palm Civet (*Arctogalidia trivirgata*), heard roaming and foraging around the camp at night.
- (iii) 2 groups of gibbons heard from the camp during the day of the transect cutting.

GPS coordinate at St. 22: N03° 50' 36.9", E115° 31' 34.8"

Elevation: 1,216 m, Location ± 17 m

TRANSECT NO.: 1, LOCATION: Arur Panipat, Pa' Lungan, Bario, DATE: 11/2/06

OBSERVERS: Staban, Braken, Lian

TIME STARTED: 0734 hrs. TIME FINISHED: 1543 hrs.

WEATHER: Fine in early morning, scattered rain in a/noon

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wak-wak (<i>Hylobates muelleri</i>)	0739	1	500	315	170	N	calls	-	2	R	likely to be the group seen earlier
Wak-wak (<i>Hylobates muelleri</i>)	0905	15	-	330	140	N	calls	-	3	L	
Unidentified	1007	26	10	200	110	N	fleeing sound	-	1	R	
Hose's langur (<i>Presbytis hosei</i>)	1048	34	8	200	130	N	roosting on tree	4	4	L	with juveniles
Barking deer (<i>Muntiacus muntjac</i>)	1405	31	2	90	35	T	fleeing away from transect	2	2	L	
Wild boar (<i>Sus barbatus</i>)	1437	23					rubbing signs on tree	-	-		

TRANSECT NO.: 1, LOCATION: Arur Panipat, Pa' Lungan, Bario, DATE: 12/2/06

OBSERVERS: Engkamat, Christopher

TIME STARTED: 0745 hrs. TIME FINISHED: 1035 hrs.

WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Giant squirrel (<i>Ratufa affinis</i>)	0800	3	10	180	160	N	seen	1	1	L-R	traveling on trees, 30 ft high
Giant squirrel (<i>Ratufa affinis</i>)	0850	17	20	180	130	N	seen	1	1	R	on trees
Wak-wak (<i>Hylobates muelleri</i>)	1010	33	500	240	140	N	calls	-	?	R	

Note: GPS reading at end of the transect (summit) N03° 50' 59.7", E115° 30' 29.2"

Location: ±9m Elevation: 1,539m

TRANSECT NO.: 2, LOCATION: Arur Bada Lawit, Pa' Lungan, Bario, DATE: 12/2/06

OBSERVERS: Staban, Malik, Phillip

TIME STARTED: 0745 hrs. TIME FINISHED: 1500 hrs.

WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wak-wak (<i>Hylobates muelleri</i>)	1217	6	400	190	230	T	calls	-	1	L	group seen earlier?

Note: No animal seen on the way up.

TRANSECT NO.: 1, LOCATION: Arur Panipat, Pa' Lungan, Bario, DATE: 13/2/06

OBSERVERS: Staban, Malik, Phillip

TIME STARTED: 0811 hrs. TIME FINISHED: 1400 hrs.

WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wak-wak (<i>Hylobates muelleri</i>)	1818	2	500	280	180	N	calls	-	3	R	probably the group seen earlier
Giant Squirrel (<i>Ratufa affinis</i>)	0823	3	2	220	195	N	seen	1	1	R	feeding on teak fruits.
Small-tooth palm civet (<i>Arctogalidia trivirgata</i>)	1012	28	20	185	55	N	seen	1	1	R	fleeing away
Giant Squirrel (<i>Ratufa affinis</i>)	1016	28	15	95	70	N	seen	1	1	R	traveling on trees
Hose's langur (<i>Presbytis hosei</i>)	1043	40	20	170	125	N	seen	3	4	R	probably the group seen earlier on
Wak-wak (<i>Hylobates muelleri</i>)	1139	28	800	105	188	T	calls	-	3	L	
Wak-wak (<i>Hylobates muelleri</i>)	1159	18	200	230	120	T	calls	-	1	R	

TRANSECT NO.: 2, LOCATION: Arur Bada Lawit, Pa' Lungan, Bario, DATE: 14/2/06

OBSERVERS: Staban, Malik, Phillip

TIME STARTED: 0747 hrs. TIME FINISHED: 1300 hrs.

WEATHER: Cloudy in early morning, rainy in late morning

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wak-wak (<i>Hylobates muelleri</i>)	0834	12	700	290	195	N	calls	-	3	R	
Wak-wak (<i>Hylobates muelleri</i>)	0849	16	30	340	220	N	calls	-	2	R	
Wak-wak (<i>Hylobates muelleri</i>)	0855	17	200	260	200	N	calls	-	2	R	
Wild boar (<i>Sus barbatus</i>)		18					foot print seen	-	1	R	
Barking deer (<i>Muntiacus muntjac</i>)	0921	23	30	80	110	N		1	1	L	

TRANSECT NO.: 2, LOCATION: Arur Bada Lawit, Pa' Lungan, Bario, DATE: 16/2/06

OBSERVERS: Staban, Phillip

TIME STARTED: 0730 hrs. TIME FINISHED: 1315 hrs.

WEATHER: Fine in the morning

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wak-wak (<i>Hylobates muelleri</i>)	0803	7	600	320	250	N	calls	-	2	R	
Wak-wak (<i>Hylobates muelleri</i>)	0819	8	400	315	245	N	calls	-	2	R	
Barking deer (<i>Muntiacus muntjac</i>)		17					track				
Wak-wak (<i>Hylobates muelleri</i>)	0913	18	400	130	210	N	calls	-	3	L	
Wild boar (<i>Sus barbatus</i>)		18					track	-	1		
Barking deer (<i>Muntiacus muntjac</i>)	1000	23	10	175	Transect end	N	seen	1	1	R	
Primate (unknown species)	1102	5	10	170	200	T	seen	-	1	L	

TRANSECT NO.: 1, LOCATION: Arur Panipat, Pa' Lungan, Bario, DATE: 16/2/06
 OBSERVERS: Malik, Mado
 TIME STARTED: 0722 hrs. TIME FINISHED: 1400 hrs.
 WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Barking deer (<i>Muntiacus muntjac</i>)		13					foot print/track	-	-		crossing the transect
Pangolin (<i>Manis javanica</i>)		18					track				crossing the transect
Barking deer (<i>Muntiacus muntjac</i>)		22					track	-	-	-	
Wak-wak (<i>Hylobates muelleri</i>)	0830	28	500	225	95	N	calls	-	2	R	fleeing away
Wild boar (<i>Sus barbatus</i>)		31				N					
Barking deer (<i>Muntiacus muntjac</i>)	0930	38	25	120	110	N	seen	1	1	R	fleeing away on the ground
Giant Squirrel (<i>Ratufa affinis</i>)	0950	40	20	210	130	N	seen	1	1	R	traveling on trees
Giant Squirrel (<i>Ratufa affinis</i>)	1130	31	15	50	130	T	seen	1	1	L	foraging on trees

TRANSECT NO.: 1, LOCATION: Arur Panipat, Pa' Lungan, Bario, DATE: 17/2/06
 OBSERVERS: Staban, Maran, Phillip
 TIME STARTED: 1313 hrs. TIME FINISHED: 1700 hrs.
 WEATHER: Rainy in early morning, shiny in afternoon

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wak-wak (<i>Hylobates muelleri</i>)	1316	0	160	220	5	N	calls	-	2	R	

TRANSECT NO.: 2, LOCATION: Arur Bada Lawit, Pa' Lungan, Bario, DATE: 17/2/06
OBSERVERS: Malik, Phillip TIME STARTED: 1319 hrs. TIME FINISHED: 1630 hrs. WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Giant Squirrel (<i>Ratufa affinis</i>)	1413	20	15	140	155	N	seen	1	1	L	fleeing away
Hose's langur (<i>Presbytis hosei</i>)	1515	16	40	170	220	T	seen	7	7	R	at least one juvenile

TRANSECT NO.: 2, LOCATION: Arur Bada Lawit, Pa' Lungan, Bario, DATE: 18/2/06
OBSERVERS: Staban, Malik, Phillip, Maran
TIME STARTED: 0834 hrs. TIME FINISHED: 1233 hrs.
WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wak-wak (<i>Hylobates muelleri</i>)	0847	-5	400	150	290	N	calls	-	1	L	
Hose's langur (<i>Presbytis hosei</i>)	0921	8	60	170	250	N	seen	1	1	L	fleeing away
Wak-wak (<i>Hylobates muelleri</i>)	0922	8	200	310	245	N	calls	-	2	R	
Long-tailed macaque (<i>Macaca fascicularis</i>)	0947	12	50	150	210	N	calls	-	1	L	
Giant Squirrel (<i>Ratufa affinis</i>)	1211	7	60	15	240	N	seen	1	1	R	

TRANSECT NO.: 1, LOCATION: Long Menalio, DATE: 7/4/06
OBSERVERS: Malik, Taha Odeu & Lim
TIME STARTED: 0707 hrs. TIME FINISHED: 1230 hrs.
WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Bornean gibbon	730	9	400	220	247	N	calls	-	5	L	
Barking deer		11					foot prints	-	-	L	
Barking deer		16						-	1	R	
Barking deer		26						-	1		
Barking deer	850	29	20	155	250	N	1	seen	1	L	feeding
Barking deer	923	39	200	230	35	N	-	call	1	L	
Barking deer	1100	31	30	95	105	T	1	seen	1	L	
Hose's langur	1103	30	200	152	79	T	3	seen	7	R	fleeing

TRANSECT NO.: 2, LOCATION: Long Menalio, DATE: 8/4/06

OBSERVERS: Malik, Taha Odau

TIME STARTED: 0845 hrs. TIME FINISHED: 1300 hrs.

WEATHER: cloudy/rainy

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Bornean gibbon		17				N	print	-	1	R	
Barking deer		29				N	print	-	-	L	
Barking deer		31				N	print	-	1	-	
Barking deer		32	20	340	300	N	seen	1	1	R	
Hose's langur	1037	39	200	210	325	N	calls	-	6	L	

TRANSECT NO.: 1, LOCATION: Long Menalio, DATE: 9/4/06

OBSERVERS: Malik, Taha Odau

TIME STARTED: 0719 hrs. TIME FINISHED: 1130 hrs.

WEATHER: Fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Barking deer		0				N	print	-	1	-	
Hose's langur	0723	1	60	200	175	N	seen	1	1	R	
Hose's langur	0727	2	30	90	145	N	seen	4	4	L	
Barking deer		19				N	print	-	1	-	
Barking deer		28				N	print	-	1	-	
Barking deer		30				N	print	-	1	-	
Bornean gibbon	0849	34	50	310	260	N	seen	3	3	R	
Barking deer	0853	35	60	230	293	N	seen	1	1	L	
Bornean gibbon	0917	40	700	315	15	N	call	-	5	L	
Hose's langur	1055	4	30	14	348	T	seen	1	1	R	

TRANSECT NO.: 1, LOCATION: Long Menalio, DATE: 10/4/06

OBSERVERS: Engkamat &, Lim

TIME STARTED: 0710 hrs. TIME FINISHED: 1305 hrs.

WEATHER: cloudy

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Barking deer	0845	18	35	100	60	N	seen	2	2	R	1♀ & 1♂
Hose's langur	0930	23	300	280	180	N	call	-	3	R	-
Barking deer	1005	29	-	-	-	N	print	-	1	-	near stream.
L. tailed macaque	1030	34	30	10	90	N	seen	10	15	L	stream.
Giant squirrel	1045	36	100	180	80	N	call	-	1	R	foraging

TRANSECT NO.: 2, LOCATION: Long Menalio, DATE: 10/4/06

OBSERVERS: Malik, Taha Odau

TIME STARTED: 0700 hrs. TIME FINISHED: 1300 hrs.

WEATHER: cloudy

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
L. tailed macaque	0732	4	100	140	20	N	seen	2	6	R	
Barking deer	-	13	-	-	-	N	print	-	1	R	
L. tailed macaque	0817	13	30	75	175	N	seen	1	1	L	
Barking deer	-	24	-	-	-	N	print	-	-	L	
Barking deer	-	34	-	-	-	N	print	-	1	R	
Barking deer	-	40	-	-	-	N	print	-	1	R	
Bornean gibbon	0945	40	35	230	310	N	seen	3	5	L	

TRANSECT NO.: 2, LOCATION: Long Menalio, DATE: 11/4/06
OBSERVERS: Lim & Engkamat
TIME STARTED: 0725 hrs. TIME FINISHED: 1335 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Giant squirrel	0750	2	25	340	315	N	Seen	1	1	R	moving
Barking deer	0945	29	20	30	5	N	Seen	2	2	L-R	1♀ & 1♂

TRANSECT NO.: 1, LOCATION: Long Menalio, DATE: 12/4/06
OBSERVERS: Lim & Engkamat
TIME STARTED: 0730 hrs. TIME FINISHED: 1400 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Barking deer	0748	3	300	80	350	N	call	-	1	R	
Giant squirrel	0802	6	300	90	30	N	call	-	1	R	
Giant squirrel	0814	8	200	50	140	N	call	-	1	L	
Bornean gibbon	0835	13	300	50	0	N	call	-	3	R	
Giant squirrel	0845	14	20	315	230	N	call	-	2	L	
Bornean gibbon	0920	20	10	140	100	N	seen	5	5	R	Feeding (bintangor fruits)
Bornean gibbon	1030	29	500	120	70	N	call	-	3	R	
P.tailed macaque	1050	31	20	110	60	N	seen	3	3	R	
Giant squirrel	1225	39	40	60	120	T	call	-	1	L	
Wild boar	1225	39	-	-	-	T	print	-	-	-	

TRANSECT NO.: 2, LOCATION: Long Menalio, DATE: 12/4/06
OBSERVERS: Malik & Brian
TIME STARTED: 0730 hrs. TIME FINISHED: 1500 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
L.t.macaque	0748	2	40	130	103	N	seen	2	2	R	
Giant squirrel	0836	11	50	204	140	N	seen	1	1	R	
Bornean gibbon	0854	14	18	80	183	N	call	-	3	L-R	
Hose's langur	0941	24	80	160	250	N	seen	7	7	L-R	

TRANSECT NO.: 2, LOCATION: Long Menalio, DATE: 13/4/06
OBSERVERS: Lim & Engkamat
TIME STARTED: 0735 hrs. TIME FINISHED: 1230 hrs. WEATHER: raining/drizzling

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Bornean gibbon	0855	22	400	30	50	N	call	-	3	L	transect
Long-tailed macaque	0854	40	20	150	170	N	seen	1	2	L	end
Wild boar	-	40	-	-	-	T	print	-	-	-	

TRANSECT NO.: 1, LOCATION: Long Menalio, DATE: 13/4/06

OBSERVERS: Malik & Taha Odau

TIME STARTED: 0745 hrs. TIME FINISHED: 1400 hrs. WEATHER: rainy

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Bornean gibbon	0855	17	500	125	240	N	call	-	3	L	
Barking deer	-	30	-	-	-	N	-	-	-	-	
Barking deer	1220	30	50	120	75	T	seen	1	1	R	

TRANSECT NO.: 1, LOCATION: Long Lobang, DATE: 30/4/06

OBSERVERS: Malik & Taha Odou, TIME STARTED: 0800 hrs. TIME FINISHED: 1300 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wild boar		0				N	print		1	R	
Porcupine		7				N	print		-	R	
Barking deer		17					print		1	L	
Barking deer		30					print		1	R	

TRANSECT NO.: 2, LOCATION: Long Lobang, DATE: 30/4/06

OBSERVERS: Jemas & Engkamat

TIME STARTED: 0800 hrs. TIME FINISHED: 1300 hrs. WEATHER: fine/cloudy

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wild boar		0				N	track		1	-	
Wild boar		1				N	print		1	R	
Porcupine		1				N	print		1	L	
Wild boar		5				N	track		1	R	
Masked palm civet	1045	30	3	150	70	N	seen	1	1	R	
Barking deer	1125	35	10	140	120	N	seen	2	2	R	

TRANSECT NO.: 1, LOCATION: Long Lobang, DATE: 1/5/06

OBSERVERS: Taha Odau & Engkamat

TIME STARTED: 0820 hrs. TIME FINISHED: 1420 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
L.t.macaque	0925	13	10	90	130	N	seen	2	3	L-R	on trees
Sambar deer	1230	28	-			T	print	0	1		crossing

TRANSECT NO.: 2, LOCATION: Long Lobang, DATE: 2/5/06
 OBSERVERS: Taha Odau & Engkamat
 TIME STARTED: 0820 hrs. TIME FINISHED: 1410 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wild boar		4				N	track		1	R-L	crossing transect
Wild boar		5				N	track		1	L-R	
Giant squirrel	1030	34	50	30	100	N	call		1		

TRANSECT NO.: 2, LOCATION: Long Lobang, DATE: 1/5/06
 OBSERVERS: Malik & Jemas
 TIME STARTED: 0828 hrs. TIME FINISHED: 1415 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wild boar		0				N	print			L	resting on branch
Porcupine		0				N	print			R	
Wild boar		3				N	-				
Porcupine		6				N	-				
Bear cat	1330	18	40	190	263	N	seen	1	1	L	

TRANSECT NO.: 1, LOCATION: Long Lobang, DATE: 2/5/06
 OBSERVERS: Malik & Jemas
 TIME STARTED: 0836 hrs. TIME FINISHED: 1426 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Wild boar		4				N	print			R	
Wild boar		6				N	print			L	
Wild boar		8				N	print			R	
Porcupine		27				N	print			R	
Wild boar		36				N	print			L	
Hose's langur	1113	38	100	245	299	N	call		6	L	

TRANSECT NO.: 1, LOCATION: Long Lobang, DATE: 3/5/06
 OBSERVERS: Taha Odau & Engkamat
 TIME STARTED: 0715 hrs. TIME FINISHED: 1105 hrs. WEATHER: raining/cloudy

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Long-tailed macaque	0800	13	50	230	140	N	call	-	3	R	

TRANSECT NO.: 2, LOCATION: Long Lobang, DATE: 3/5/06
 OBSERVERS: Malik & Noh Balan
 TIME STARTED: 0715 hrs. TIME FINISHED: 1200 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Porcupine		3				N	print			R	
Wild boar		3				N	print			R	
Wild boar		4				N	print			L	
Barking deer		9				N	print			R	
Barking deer		34				N				R	
Hose's langur	1113	22	80	215	230	T	seen	2	5	L	
Hose's langur	1129	22	80	213	240	T	seen	3	7	L	

TRANSECT NO.: 1, LOCATION: Long Lobang, DATE: 4/5/06
 OBSERVERS: Malik & Noh Balan
 TIME STARTED: 0735 hrs. TIME FINISHED: 1130 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
Pangoline		1				N				L	
Lesser mouse deer	0800	9				N				R	
Barking deer		12				N				R	
Barking deer		14				N				R	
Barking deer		25				N				R	
Barking deer	0910	34	70	140	245	N	call	-	1	L	
L.t.macaque	1035	23	30	315	285	T	seen	4	8	R	
Hose's langur	1104	13	25	265	325	T	seen	3	7	L	

TRANSECT NO.: 2, LOCATION: Long Lobang, DATE: 4/5/06
 OBSERVERS: Taha Odau & Engkamut
 TIME STARTED: 0730 hrs. TIME FINISHED: 1005 hrs. WEATHER: fine

Species	Time	Near Trail Mark	Mark-Animal Dist. (m)	Compass bearing (°)	Transect bearing (°)	N/T	How detected	No. seen	No. est.	L/R	Remark
-	-	-	-	-	-	-	-	-	-	-	-

GPS Coordinate at end of T2 : N 03° 41' 21.8", E115° 17' 21.8"
 Altitude: 558 m, Location: ± 15m, 30m

GPS coordinate at end of T1 : N03° 41' 00.2", E 115° 16' 55.7"
 Location: ±20m
 GPS coordinate at Camp Site : N03° 41' 34.2", E115° 16' 30.8"
 Location: ±14m

PLATES

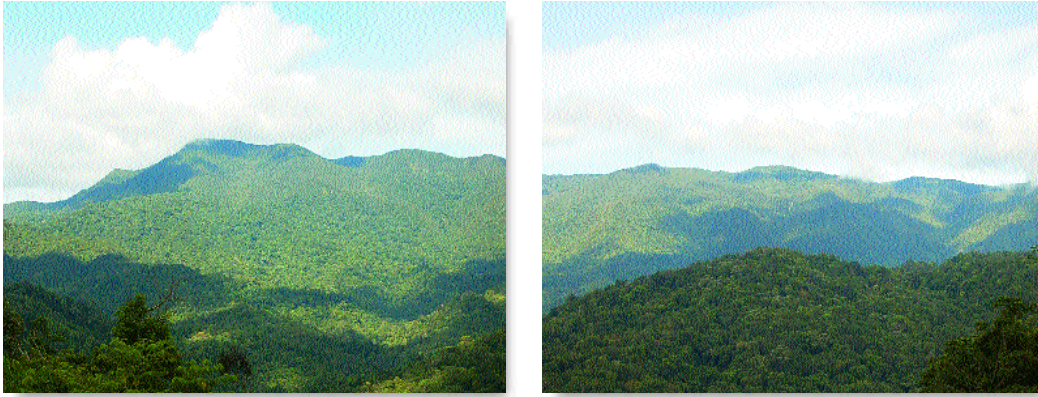


Plate 1: View of Pulong Tau National Park



Plate 2: View of Long Lobang side of the Pulong Tau National Park.



Plate 3: Signs of sun bear (*Helarctos malayanus*) scratch marks (pug marks) on tree trunks in Merario, Bario.



Plate 4: Collection of wild boar fat in Long Menalio, being kept in a drum by local hunters for cooking food.



Plate 5: A snare set up by poachers near one of the transect lines in Long Menalio.



Plate 6: The pictures show some of the timber extraction activities in some parts of the transect lines in Merario, Bario Asal and Pa'Lungan. Buffaloes (right) were used to drag timber from the forest.



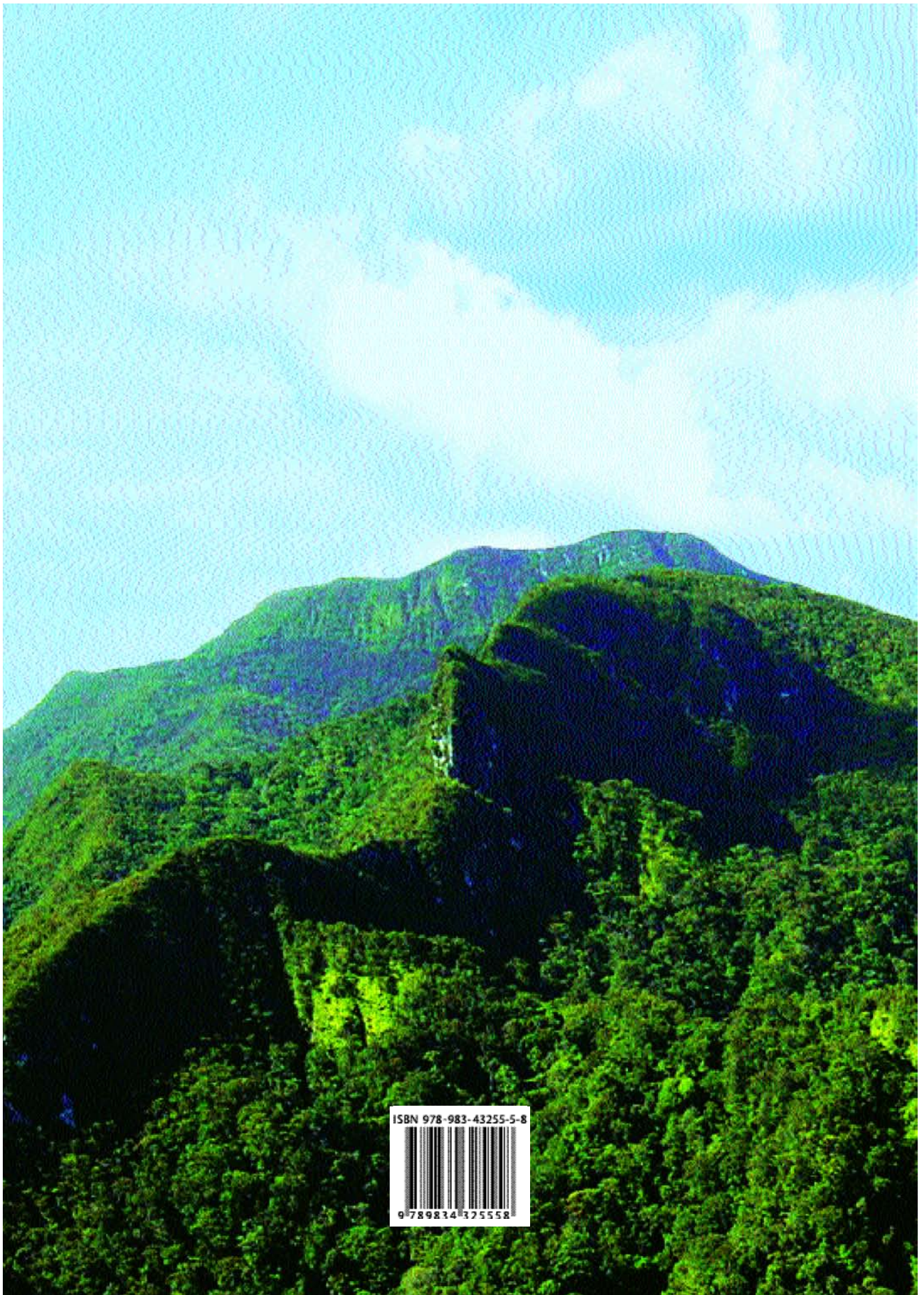
Plate 7: A picture shows a Bornean gibbon (*Hylobates muelleri*) feeding on a wild fruit (bintangor) right at the transect line in Long Menalio.



Plate 8: Shows footprint of a wild boar (*Sus barbatus*) in Long Lobang area.



Plate 9: A sign of primate, probably a pig-tailed macaque (*Macaca nemestrina*) feeding on ginger on one of the transect lines in Long Menalio.



ISBN 978-983-43255-5-8



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