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CAMERA TRAPPING AND CONSERVATION IN LAMBIR HILLS NATIONAL PARK, SARAWAK

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***ABSTRACT.* –** A rapid assessment using camera traps was carried out in Lambir Hills National Park from February 2004 to September 2004. In 1127 trap nights, six CamTrakker units and one DeerCam unit recorded a total of 225 wildlife photographs, which included seven orders, 11 families and 18 species of animals. *Macaca nemestrina* had the highest frequency of photo records with 63 exposures, while single exposures were recorded for *Arctictis binturong, Echinosorex gymnurus, Prionodon linsang*, *Rheithrosciurus macrotis, Sus barbatus*, and *Macaca fascicularis*. The rare *Neofelis nebulosa* was also recorded during this study. Activity patterns were calculated for five species. Low photo records of large mammals were noted and is believed to be caused by illegal hunting. The conservation of these species is discussed.

***KEY WORDS.* –** Large mammals, Protected areas, Activity pattern, Management.

INTRODUCTION

Borneo, the third largest island in the world, covering approximately 746,337 km^2 is the biologically richest unit of the Sundaic sub-region and a center of distribution for many genera of the Indomalayan fauna (Mac Kinnon et al., 1996). Wildlife diversity is high on the island, with 221 species of terrestrial mammals (Payne et al., 1985), and about 19% of the mammalian fauna are endemic (Bennet et al., 1996). In Sarawak, forests outside protected areas are currently being utilized for timber extraction, agriculture and various other land developments. Habitat destruction and unsustainable hunting are major threats for many wildlife species (Payne et al., 1985; Bennet et al., 1996; Nowell & Jackson, 1996). Thus species conservation efforts and priority is being concentrated in protected areas. Approximately 36.2% of total land area in Sarawak has been gazetted as protected area. Despite the fact that a substantial proportion is classified as protected, no comprehensive survey has been carried out to assess the distribution of large mammals in most of these protected sites. One of these protected areas, Lambir Hills National Park (LHNP), has the highest reported diversity of tree species in the world (Lee et al., 2002) but little information is available on the park's large mammals.

Observations on large mammals in tropical rain forest are difficult as many species are either secretive, nocturnal or generally avoid humans (Griffiths & Van Schaik, 1993). Thus, it is difficult to estimate population size, relative abundance or the activity patterns of these species (Silveira et al., 2003). Inexperienced observers using line-transect sampling and track counts sometimes fail to identify or notice the animal's presence, which results in unreliable estimates. The development of camera-trapping techniques has, however, greatly advanced our understanding of animal diversity and provides a means to detect secretive and low-density mammals (Mohd. Azlan & Sharma, 2002; Mohd. Azlan, 2003; Mohd. Azlan et al., 2003; Kawanishi & Sunquist, 2003). In view of this, a camera-trapping exercise was carried out in LHNP to assess the diversity of large terrestrial mammals. This information will provide insight to the species diversity in the park and contribute to the collection of distributional records of large mammals within protected areas in Sarawak.

MATERIALS AND METHODS

***Study site*. –** LHNP was gazetted on 15 May 1975 and it covers an area of approximately 6,823 ha, which is approximately 2.4% of the total protected area in Sarawak. This isolated protected area is surrounded by oil palm

Table 1: Sampling effort (number of trap night) expanded in LHNP from February to September 2004.

Trapping Site	Camera Number	Camera type	Date	No. of days
Waterfall	DC1	Deercam	11/2 - 8/4/2004	57
Bukit Pantu	CT3	CamTrak	11/2 - 8/4/2004; 8/4 - 28/5/2004	107
Riam	CT4	CamTrak	11/2 - 8/4/2004; 8/4 - 28/5/2004; 27/5-24/7/2004	166
Edutrail	CT5	CamTrak	12/2 - 7/4/2004; 8/4 - 27/5/2004; 27/5- 24/7/2004	162
Bakam Trail1	CT6	CamTrak	12/2 - 7/4/2004; 7/4 - 27/5/2004; 27/5- 28/7/2004; 28/7 - 15/9/2004	213
OilWell	CT8	CamTrak	12/2 - 7/4/2004; 7/4 - 27/5/2004; 27/5 - 28/7/2004; 28/7 - 11/9/2004	209
Bakam Trail2	CT9	CamTrak	12/2 - 7/4/2004; 7/4 - 27/5/2004; 27/7 - 28/7/2004; 28/7 - 15/9/2004	213
TOTAL	**7**			**1127**

plantation, settlement, major roads and shifting cultivation. The human population around the park is dominated by Iban communites and there are seven Iban longhouses in this area. Their local activities involve agriculture and handicrafts. The park's trail system is linked to six waterfall sites and various forest types. There are two major types of forest in LHNP, namely mixed dipterocarp forest (MDF) (85%) and *Kerangas* forest (15%) at northern side of Lambir Hill (465 m). However, after logging and other human modification, the remaining primary MDF has been reduced to about 54% (Watson, 1985). The Pan Borneo Expressway divides the park into two separate portions and approximately 2/3 of the park lies west of this road. The cameras were concentrated in this area. The MDF of LHNP is considered the richest in Malaysia due to its high tree density with 1173 tree species in 286 genera and 81 families in only 52 ha (Lee et al., 2002). Most of the emergents in this forest are *meranti* (*Shorea* sp.), keruing (*Dipterocarpus* sp.) and kapur (*Dryobalanops* sp). The kerangas forest is dominated by *Rhu ronang (Gymnostoma nohile*) and *Selunsor padang* (*Tristaniopsis obovata*). A survey carried out in LHNP about 10 years ago reported 32 species of mammals, which included 18 species of small to medium-sized mammals and five species of primates (Watson, 1985).

Camera trapping was conducted from February to September 2004. Six CamTrakker units (manufactured by Cam Trak South, Inc., 1050 Industrial Drive, Watkinsville, GA 30677, US) and one DeerCam unit (manufactured by Non Typical Inc., 860 Park Lane, Park Falls, WI 54552, US) were deployed during the study. Camera units were secured to trees with cable locks to prevent theft or disturbance by wild animals. Each unit was fully enclosed within a weatherproof casing to reduce moisture getting inside. Each CamTrakker unit consists of a 35mm Yashica camera attached to an inbuilt infrared sensor. Four 'C' sized alkaline batteries power each unit. Exposure delay was set at an interval of 3 minutes to reduce film wastage. The DeerCam unit is designed with a passive infrared sensor and constructed of super-durable ABS plastic. Each DeerCam unit consists of an Olympus Infinity XB 35 mm camera, powered by a Lithium CR123A battery, while two 9V alkaline batteries power the infrared sensor. The DeerCam unit was set to operate at high sensitivity level in order to increase detection and set at two minutes delay to reduce exposures of the same animal. Silica gel was placed inside camera units to further reduce the moisture in the casing due to condensation. Date and hour reading was imprinted on each photograph taken for both models to provide information needed for estimation of activity patterns (Laidlaw, 1999; Wong et al*.,* 2003).

***Setting up cameras*. –** The cameras are designed to detect wild animals using a passive infrared sensor, which acts as a mechanism to trigger a photograph. All camera trap units were tested for functionality and loaded with new film and batteries prior to going to the field. Camera trap units were mounted on trees at least 0.25 m above the ground. The conical ranges of the sensor is approximately 18 m in horizontal plane; about 0.9 m in diameter at 9 m length. The cameras were set along wildlife trails, paths or tracks. All cameras are operational 24 hours a day as long as the camera was functional. Cameras were left in the field for a minimum of 30 days (Laidlaw, 1999). We used FUJI ASA 400 to obtain the best quality of photograph in the forests. None of the cameras ran out of film between reloading of new film.

***Photo Analysis*. –** Animal identification was determined based on illustrations and description by Payne et al. (1985) and Medway (1977). Exposures without an image were categorized as ghost shots, which may occur due to sudden shift in ambient temperature. Some animals could not be identified due to poor angle of wildlife shots, the animals were too far away or they moved during the exposure. *Tragulus napu* and *T. javanicus* are relatively similar morphologically, although. *T. napu* is larger with flaked coloration while *T. javanicus is* smaller with relatively plain reddish-brown coloration (Payne et al., 1985). *Muntiacus muntjac* and *M. arthodes* are also relatively similar in body coloration, varying between dark reddish and yellowish-red (Payne et al., 1985; Yasuma & Andau, 2000). Thus, muntjacs and mousedeers are only identified to genera to facilitate discussion.

***Activity Patterns*. –** Activity levels were calculated from the date and time imprinted on the photograph (Wong et al., 2003). Photos without a time imprint were discarded from the analysis. Photo records of animal species with less than 10 photographs were not included. The percentage of activity

Table 2: Summary of mammals recorded via camera traps from LHNP from February 2004 till September 2004.

Order/ Family	Scientific name	Common name	Photo records	WPO 1998
Artiodactyla				
Cervidae	*Muntiacus* sp.	Barking deer	14	N/A
Suidae	*Sus barbatus*	Beared pig	1	N/A
Tragulidae	*Tragulus* sp.	Mouse deer	33	N/A
Carnivora				
Felidae	*Neofelis nebulosa*	Clouded leopard	3	TP
Viverridae	*Viverra tangalunga*	Malay civet	25	P
	Arctictis binturong	Binturong	1	P
	Prionodon linsang	Banded linsang	1	P
Chiroptera	Unknown	unknown	1	N/A
Insectivora				
Erinaceidae	*Echinosorex gymnurus*	Moonrat	1	N/A
Pholidota				
Manidae	*Manis javanica*	Pangolin	5	P
Primate				
Cercopithecidae	*Macaca fascicularis*	Long-tailed macaque	1	P
	Macaca nemestrina	Pig-tailed macaque	63	P
Rodentia				
Hystricidae	*Hystrix brachyura*	Common porcupine	2	P
	Thecurus crassispinis	Thick-spined porcupine	52	P
	Trichys fasciculata	Long-tailed porcupine	9	P
Muridae	Unknown	Rat	3	N/A
Sciuridae	*Rheithrosciurus macrotis*	Tufted ground squirrel	1	TP
	Unknown	Squirrel	2	N/A
TOTAL			**218**	
Number of species			**18**	
Number of photo records / TN			**0.193**	

ABBREVIATIONS
L= Legal status: P-Protected; TP-Totally Protected; N/A-Not Protected (Under Wildlife Protection Ordinance, 1998)

level was used to indicate whether the mammal species are nocturnal or diurnal.

Activity recorded between 1800-0600 hr were classified as nocturnal and those between 0601-1759 hr were classified as diurnal.

***Trap nights*. –** A 24-hour period as long as the camera was functional.

RESULTS AND DISCUSSION

A total 225 of wildlife photographs consisting of seven orders, 11 families and 18 species were recorded. Order Rodentia had the highest recorded frequency of 69 exposures, which mainly consist of Hystricidae, Muridae and Sciuridae. The pig-tailed macaque (*Macaca nemestrina*) had the highest frequency of records with 63 exposures (Table 2). Approximately 11% of the total mammals recorded are given total protection while 50% are documented on in the protected list of Wildlife Protection Ordinance (1998). The percentage of nocturnal vs. diurnal activity was only calculated for five species (Fig. 2). *Thecurus crassispinis* was strictly nocturnal while *Macaca nemestrina* and *Muntiacus* sp. represented the only diurnal mammals (Fig. 2). Activity pattern was only calculated for five species (Figs. 4-8).

All photographs were of terrestrial animals or aboreal mammals that spend substantial time on the ground. No cameras were deployed near streams to avoid losing cameras to flooding or near steep rocky slopes. Thus, a comprehensive mammal list is yet to be obtained, especially for secretive animals that are strictly arboreal and strongly related to

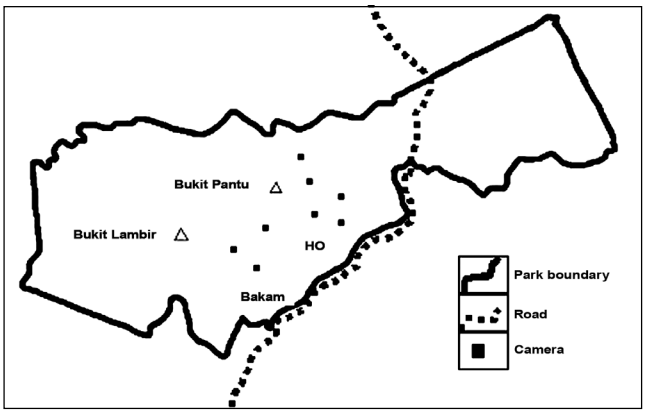

Fig. 1. Map of LHNP showing approximate camera sites and the Pan Borneo Expressway.

aquatic habitat. The species accumulation curve appeared to reach a plateau (Fig. 3), suggesting that few additional species would have been detected with increased trapping effort. Animals that appear with single records are *A. binturong, E. gymnurus, P. linsang*, *R. macrotis, S. barbatus*, and *M. fascicularis* as they may occur in a low abundance or are highly arboreal.

Artiodactyla

Three species from three families were recorded. *Sus barbatus* (Suidae), which was assumed common in this area was only recorded as a single subadult in blackish color. *Sus barbatus* may occur in low abundance in LHNP. The Cervidae were represented by *Muntiacus* sp., which was observed grazing on young shoots or sapling near open trails. This may have attracted these animals to browse in front of the cameras, suggest that this species are saplings predators. *Muntiacus* sp. (Fig. 5) are 100% diurnal with five bouts of activity between 0500 hr and 1900 hr. The peak of activity occurred at 0600 hr. *Tragulus* sp. (Tragulidae) were crepuscular (Fig. 7) with 69% of nocturnal activity. No activity was noted from 0800 hr to 1700 hr. These species are usually solitary, but were sometimes noted in pairs (Medway, 1977). Three exposures were recorded with pairs throughout the study period.

Carnivora

The Viverridae and Felidae were represented by three and one species, respectively. The arboreal behavior of *P. linsang* and *A. binturong* (Medway, 1977; Payne et al., 1985) may have reduced the photo record probability. All the photo records of *V. tangalunga* were of single animals and showed 84% nocturnal activity with peaks between 2300 hr until 0030 hr. The absence of large predators such as tigers and leopards may have contributed to the diurnal activities (Colón, 2002). Clouded leopard (*Neofelis nebulosa*), the largest felid in Borneo was recorded three times in this park. Based on the two-left side photo record, the pelt pattern clearly indicated that it was the same animal. This adult male was recorded near Bakam area and behind the park HQ. *Neofelis nebulosa* are thought to travel extensively on the ground (Mohamad Momin, 1992; Grassman et al., 2005), but only three photo records were obtained suggesting this species occurs in a low abundance in this park. Home range for a male *N. nebulosa* is estimated 42.2 km^2 (Grassman et al., 2005), this area cover approximately 62% of the park area.

Primates

According to Watson (1985) primates in LHNP are diverse comprising three families, namely Cercopithecidae, Lorisidae and Hylobatidae. However, the cameras only recorded *Macaca nemestrina* and *M. fascicularis*. This suggests that *M. nemestrina* spends substantial time on the ground compared to *M. fasicularis.* This finding is consistent with Kawanishi et.al (1999) in Taman Negara. *Macaca fasicularis* have been reported as a specialist of disturbed forest habitats (Johns, 1992). The flexibility of *M. nemestrina* to utilize various strata of the forest for protection and to feed (Payne

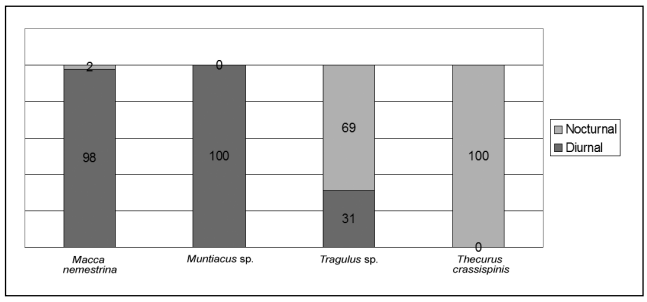

Fig. 2. Percentage of nocturnal and diurnal activity recorded for selected mammalian species in LHNP from February 2004 till September 2004.

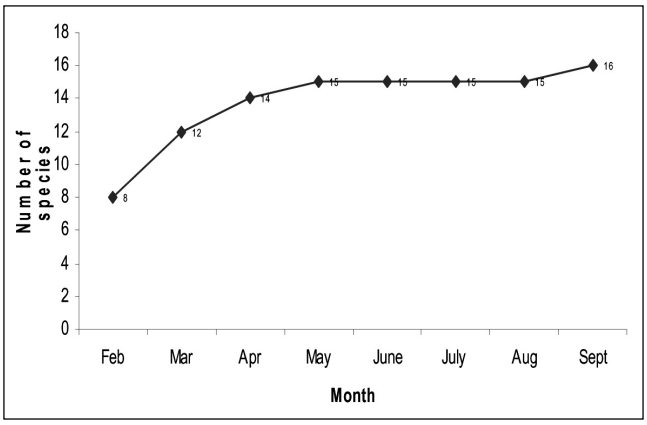

Fig. 3. Cumulative number of species photographed in LHNP from February until September 2004 as a function of increasing number of camera-trap nights.

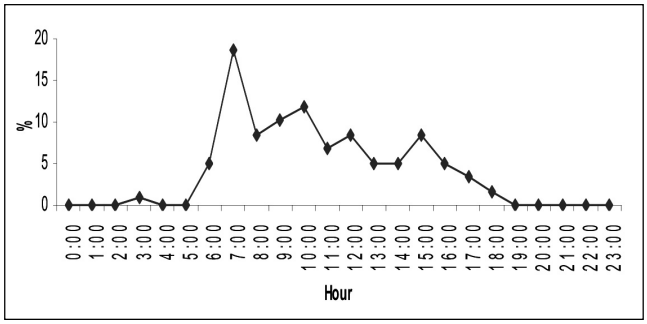

Fig. 4. Activity pattern of *Macaca nemestrina* species in LHNP from February 2004 till September 2004 (n = 59 photos).

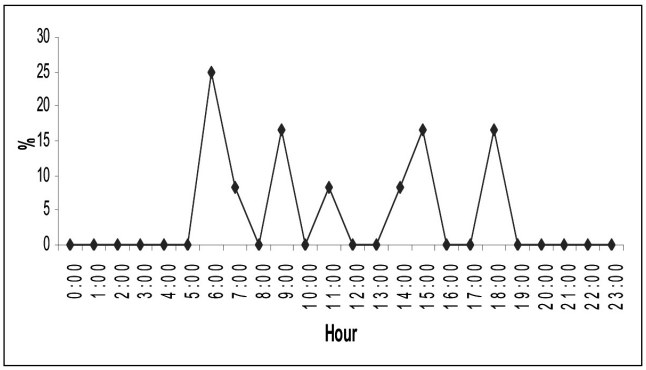

Fig. 5. Percentage of activity level of *Mutiacus* sp. species in LHNP from February 2004 to September 2004 (n = 12 photos).

et al., 1985) contributes to the success of its distribution and resilience to various habitat alteration and conditions compared to other mammals.

Other mammals

All three species of porcupine (Hystricidae) that occur in Borneo were recorded. *Trichys fasciculata* is smaller in size compared to *Thecurus crassispinis,* which also has a brush of hollow bristles at the end (Payne et al., 1985). While *Hystrix brachyura* and *Thecurus crassispinis* are similar to each other, they can be distinguished by spine size, body size and color. *Hystrix brachura* have long spines, white with black band towards the tip and front part of the body is mostly blackish (Medway, 1977; Payne et al., 1985), while *Thecurus crassispinis* are generally dark brown and smaller in size (Payne et al., 1985; Yasuma & Andau, 2000). *Echinosorex gymnurus*, (Erinaceidae) from the order Insectivora was recorded in the kerangas forest. An unidentified rat (Muridae) and squirrels (Sciurinae), except the tufted ground squirrel (*Rheithrosciurus macrotis*), could not be identified even to genera level due to poor image quality. The rare *R. macrotis* was recorded with a single exposure. *Manis javanica* (Pholidota) usually nocturnal (Payne et al., 1985) was recorded with five exposures between 0100 hr to 0600 hr.

Excisions and Intrusion

Four photos of poachers were noted: 1520 hr (Bakam trail), 2112 hr (Education trail), 0433 hr (Bakam trail) and 0835 hr (Bakam trail), respectively. Two of these photo records show poachers carrying shotguns, while the rest were armed with *parangs*. Two photographs were of two hunters, although the elapsed time between shots may have missed out other individuals who are walking behind. We also found evidence of what was probably a civet that had been cooked and consumed near a gazebo at Bukit Pantu. Apart from this, the park staff also reported shotguns being fired during the night. Thus, the number of hunters given is probably a minimum estimation of activities as the study was conducted only for a period of eight months. In addition to this some hunters may have avoided areas where cameras were set. Three cameras were sabotaged - they were either smashed on site, left hanging, thrown far away from the camera site - and were believed to be caused by these poachers. The remains of consumed animal bones were collected and these incidents were reported to the park authority.

The scarcity of large mammal photographs is probably because of the high activity of hunting. The banteng, *Bos javanicus*, known to occur in this area in the 1950s was extirpated due to over hunting (Watson, 1985). Other large terrestrial mammals reported by Watson (1985) and Shanahan & Debski (2002) but not recorded during this survey are *Herlactos malayanus*, *Hemigalus derbyanus*, *Paradoxurus hermaphroditus, Pardofelis marmorata* and *Cervus unicolor*. It is believed these animals may occur in extremely low abundance or might have been wiped out in LHNP due to hunting. Tracks of *S. barbatus* and *Muntiacus* sp. were occasionally observed in the MDF and Kerangas forest but none was noted near areas that were close to the Pan Borneo Expressway.

Access from almost all sides of LHNP is relatively easy and there is a good road from Miri, which means that it is a quick spot for town hunters and local community around this park. LHNP has relatively long boundary along the Pan Borneo Highway, which splits the park into two separate portions. The status of large mammal populations in the park is uncertain but is vital to control the hunting before the existing populations of mammalian species such as the clouded leopard, civets, barking deer and porcupines are depleted beyond recoverable condition.

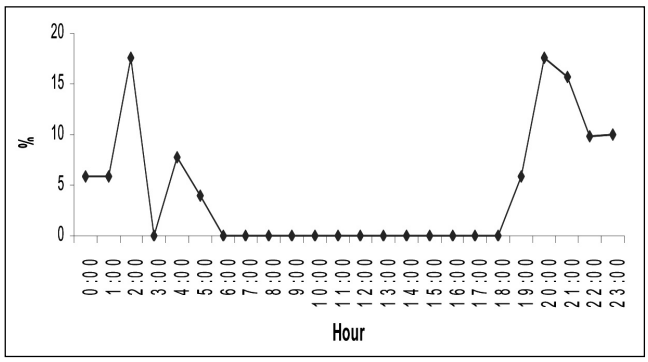

Fig. 6. Percentage of activity level of *Thecurus crassispinis* in LHNP from February 2004 to September 2004 (n = 51 photos).

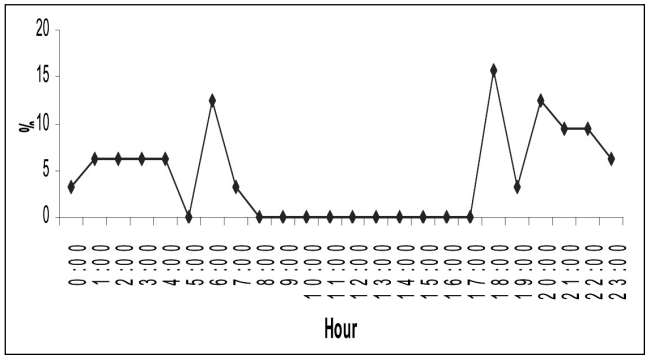

Fig. 7. Percentage of activity level of *Tragulus* sp. in LHNP from February 2004 to September 2004 (n= 32).

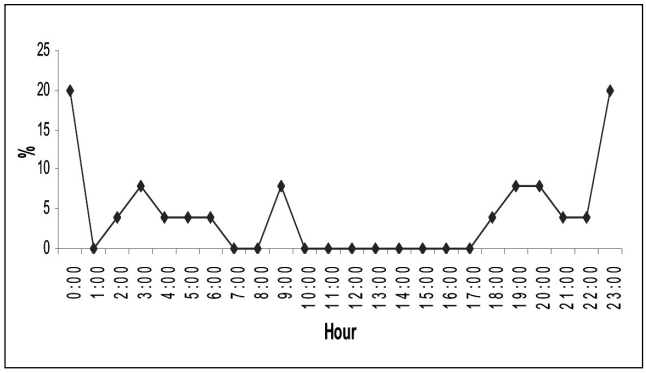

Fig. 8. Percentage of activity level of *Viverra tangalunga* based on camera trap in LHNP from February 2004 to September 2004 (n = 25).

RECOMMENDATIONS

Long-term wildlife monitoring with increase effort using camera traps should be implemented by National Parks in Sarawak. The park Management should consider owning and maintaining several sets of camera traps to monitor wildlife throughout the year. The number of cameras needs to be increased to have a wider coverage of the Park to provide comprehensive information on the diversity and relative abundance of large mammals.

Immediate steps should be taken to control hunting in this protected area. Introducing barriers near entrance far from the park HQ such as the Bakam area. A sub ranger station, which may include information center, should be considered near the Bakam area. Permanent guard post needs to establish near these areas. Patrols should not only be concentrated near park HQ but also along the main road. To save on staff and time of the park, the local police authority and the Enforcement unit of Sarawak Forestry Corporation should be informed to conduct regular patrol along these sections. Vehicles parked at these entrances should also be investigated. Setting up fence along the main road should be considered; this may also avoids animals from being hit by vehicles.

A functional park steering committee, which includes local community members, needs to be involved in park management. This will enhance ownership towards the park. This can be achieved through wildlife and biodiversity awareness and education campaigns and activities. Involvement of local community in selected research project within the park should also be considered.

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