THE RAFFLES BULLETIN OF ZOOLOGY 2007 **55**(1): 209-215
Date of Publication: 28 Feb.2007
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A CAMERA TRAPPING INVENTORY FOR MAMMALS IN A MIXED USE PLANTED FOREST IN SARAWAK

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ABSTRACT. – A series of camera trapping surveys was done in and around an *Acacia* plantation in central Sarawak to monitor wildlife populations within the planted forest. The study area was divided into 1 km^2 blocks with two cameras placed in each block for thirty days at each position, and placed in five study areas for a period of approximately six months. Camera sites were baited with a variety of commercially available scent lures. During 1,632 trap-nights, a total of 25 species of mammals were detected and photographed, comprising 15 families, and 23 genera, including local Bearded Pig (*Sus barbatus*), Sambar Deer (*Cervus unicolor*), Sun Bear (*Helarctos malayanus*), and an Otter Civet (*Cynogale bennettii*). Some lures failed to attract any mammals, while oily lures such as Fish Oil, seemed to better withstand rain, increasing the long-term chances for obtaining species photographs. Magna Glan, producing a very strong odor, attracted numerous terrestrial mammals and remained detectable even to humans for at least one month, even during the rainy season. The implications of the results of this study for successfully monitoring tropical forest wildlife is discussed.

KEYWORDS. – Camera trapping, scent lures, planted forest, Sarawak.

INTRODUCTION

The primary focus of conservation biology is justifiably on wilderness areas and cataloguing and description of species that inhabit these little-explored regions. Most of the earth, however, is becoming a managed world with wildlife species coping with a human-dominated landscape. In forested ecosystems this management takes the form of timber management and its attendant processes of road construction, and fire management. The pressure on forest ecosystems to provide wood products for consumers is so severe that many timber companies have converted forests into managed plantations that are dominated by fast-growing tree species. In North America and other temperate climates this sustainable forestry takes the form of coniferous forests; in tropical forests it often involves *Acacia* species. The difficulty for these plantations is to maintain both timber harvest and wildlife diversity (Bennett, 2000; Meijaard et al., 2005). There is a distinct need to monitor wildlife populations within these planted forests (Forest Stewardship Council, 2005).

Mammals are a significant group often considered for monitoring because of their vulnerability to poaching and their sensitivity to human activity (Robinson & Bodmer, 1999). There are at least 221 species of mammals in Borneo (Payne et al., 1985), but only 48 are large mammals (> 2 kg), which leaves > 75% of these species relatively small and difficult to detect. Prior to the use of automatic cameras and sensor technology, mammals had to be surveyed either by walking through the habitat or searching for animal signs such as tracks or droppings (Wemmer et al., 1996). However, poor visibility in brushy secondary habitats, coupled with the difficulty of finding tracks on the forest floor, especially in the thick leaf litter of tree plantations, often has led to poor results. Trapping can be inefficient from the standpoint of time requirement, and the non-random nature of what species will enter traps. Since the 1990s various camera trapping schemes have been used in tropical forest of Asia and Africa (Griffiths & Van Schaik, 1993; Karanth & Nichols, 1998; Franklin et al., 1999). Camera traps, which have increasingly been used in wildlife studies (Wemmer et al., 1996), are ideal for identifying the species inhabiting a particular area, monitoring relative and absolute abundance of species, and studying activity patterns (Karanth, 1995; van Schaik & Griffths, 1996; Miura et al., 1997; Karanth & Nichols, 1998; Kawanishi et al., 1999; Koerth & Kroll, 2000; McCullough et al., 2000; Martorello

et al., 2001; O'Brien et al., 2003). Camera records also can help to answer a variety of ecological and conservation-related questions such as nest predation, frugivory and seed dispersal, etc. (Liemgruber et al., 1994; Miura et al., 1997; Yasuda & Azman, 2000; Otani, 2001, 2002). The method has wide applicability in species inventories, presence-absence studies, and population surveys of individually recognizable species, such as Sambar Deer. Automatic cameras can provide surveillance of a site over a 1–2 month period and solve problems associated with traditional methods for monitoring mammals in tropical forests.

In February 2005, the US National Zoo's (Smithsonian Institution) Conservation and Research Center and the Conservation Department of Grand Perfect Sdn Bhd began a collaborative study, to document the species of mammals in the Planted Forest Zone (PFZ) of the Sarawak Forest Department's Planted Forests (Pulp and Paper) Project, Bintulu Division. Additional goals were to determine differences in distribution and abundance based on habitat, which includes forested conservation zones, remnant forests (buffer zones, steep terrain and other unplanted, forested areas) and blocks of the *Acacia* plantation. In order for this larger study to be successful, it was necessary to determine proper protocols for camera trapping in tropical forests, aspects such as the attractiveness of various scent lures to local species, periods of activity for these species, as well as list of species known from the general area. The development of light-weight, weather-proof, simple-to-use camera traps with built-in heat and motion sensors made it both easy and economical to obtain this type of information.

STUDY AREA

The USNZ-CRC/GP Conservation joint project encompasses five study areas e.g., Samarakan Planted Forest *Acacia and remnant forest* (T1C, T1A and T2B), Bukit Sarang Conservation Area (BSCA) and Tubau Planted Forest *Acacia and remnant forest* (E2M, E2N and E2L); all of which are all in the Bintulu Division of Sarawak (Fig. 1). Most of the areas have been planted with *Acacia mangium* (Family Leguminosae), a fast-growing tree species. About 26% of the study area contains secondary forest, which functions as reservoirs for native species, and has been left as buffer zones along streams and uncleared areas on steep terrain. The species of trees in secondary growth forests are generally dominated by species such as *Macaranga triloba, Macaranga hypoleuca, Macaranga hosei* (Family Euphorbiaceae) and *Calamus* sp. (rattan – Family Palmae). Most of the secondary

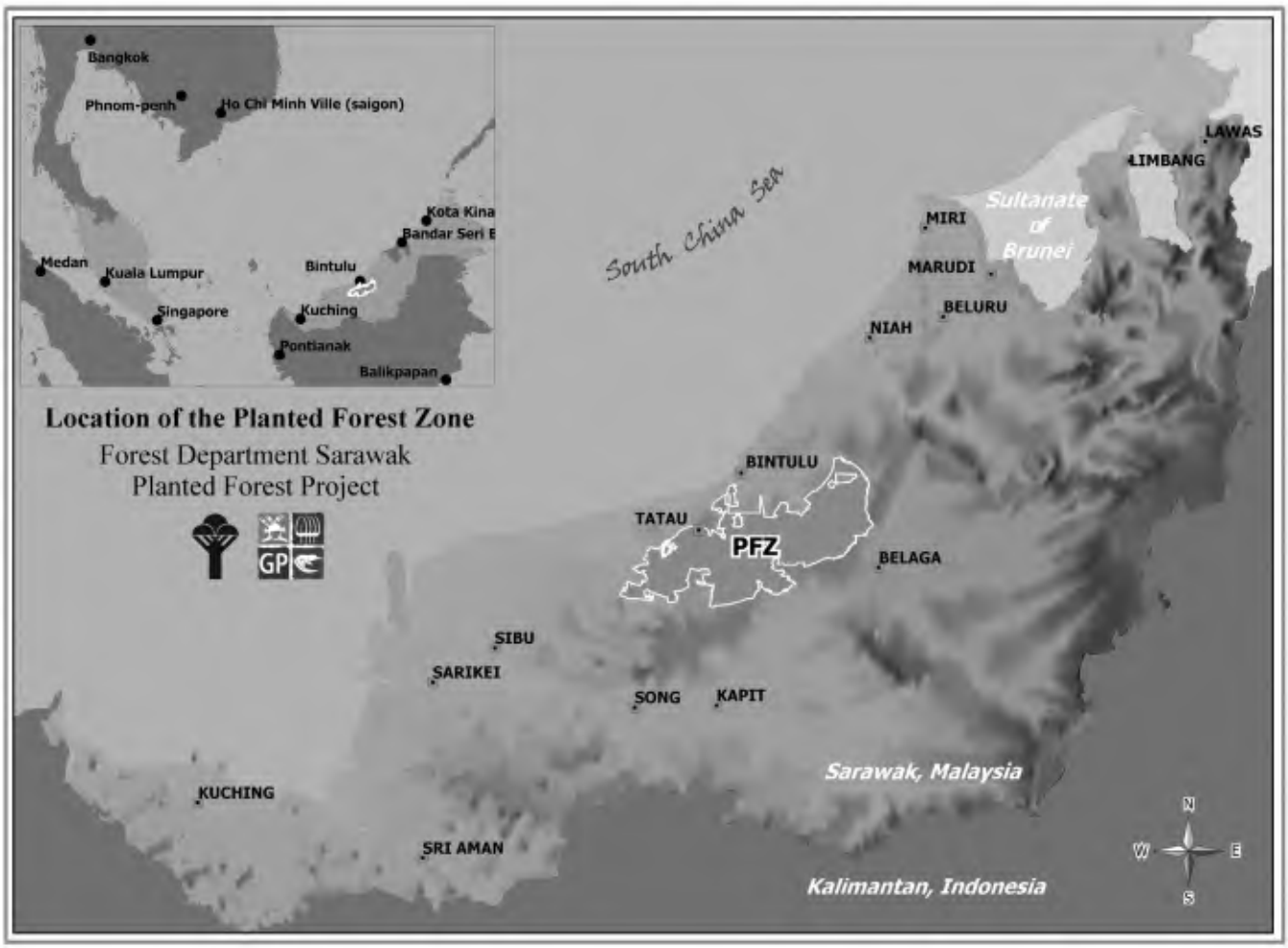

Fig. 1. Location of Planted Forest Zone within Bintulu Division in Sarawak, Malaysia. Planted Forest Zone is indicated in dark striped areas in center of map.

species also occur in "Temuda" with the present of bushy ferns, lianas and wild grasses.

MATERIAL AND METHODS

This study utilized commercially sold DeerCam cameras (Non-Typical Inc. Park Falls, Wisconsin, USA), which function well under local tropical conditions. The study area was divided into 1 km^2 blocks with two cameras placed in each block; a minimum distance of 200 m was set between each camera location. Each camera was positioned adjacent to game trails, pathways, natural salt licks and random places. The DeerCam uses a 28 mm Olympus Trip 505 camera combined with a built-in heat / motion sensor that detects heat from an animal passing in front of it. The range of detection is variable due to ambient temperature and body size, so to standardize detections we placed the camera in a manner such that the natural background limited the detection range to < 30 m. Two "AA" alkaline size batteries and two 9-volt alkaline batteries power the camera and sensor, while 400 ASA Fujifilm color print film was used to obtain photographs. Sensor units are equipped with an option whereby the camera may be delayed in taking a photograph before a prescribed interval of time has expired. The time delay was set to a minimum of one minute, which reduces wastage of film per single observation. Time and date are automatically recorded on each exposure. Deercams are mounted on trees at about 50 cm above ground, at least 2.5 m from the lure. All camera trap sites were marked using a Global Positioning System (GPS) (Garmin 60 CS). The Deercams were checked (batteries and films) and the lure was replenished after 14 days (two weeks) and removed on the fourth week, for an interval of approximately 30 days. Several types of lure were used to make the camera site more attractive to mammals. Eight scent lures (e.g., Magna Glan, Pro Choice and Wildcat) and two food lures (e.g., Fish Oil and Urban Wildlife) were purchased from a commercial dealer (Montgomery Fur, Ogden, Utah, USA). A small dab of lure was placed on a small stick that has been cut near the center of the detection range for the camera. To protect the lure against ants and termites, we wrapped adhesive tape around the base of the pole with the adhesive side facing outwards.

For this species inventory, all major habitat types of the PFZ were covered. Generally productive sites were assumed to be trails (especially where two trails cross), although not all the camera were in natural corridors, drinking sites, and underneath fruiting trees. Animal signs were noted, e.g., tracks, footprints, pig wallows, sleeping sites of ungulates and scratching trees of Sun Bear, Pangolin and mature Sambar Deer.

RESULTS

A total of 1,632 trap nights was achieved over five months (March to July 2005), yielding a total of 25 species of mammals detected and photographed in the study area (Table 1). These species comprised of 15 families, and 23 genera. Approximately 64% of the total species recorded at all study sites are protected under the Sarawak Wildlife Ordinance, 1998 (State of Sarawak, 1998a, b). The species most frequently recorded was *Sus barbatus* (Bearded Pig) and *Callosciurus notatus* (Plantain Squirrel). For the Bearded Pig, a total of 12 photographs were recorded from March to July 2005. Most pigs were recorded in the late afternoon to evening, ranging from 1700 to 2000. The four pictures of *Cervus unicolor* (Sambar Deer) and *Muntiacus atherodes* (Bornean Yellow Muntjac) were photographed in the hours after midnight until early morning. Eleven species of terrestrial mammals such as *Cynogale bennettii* (Otter Civet), *Manis javanica* (Pangolin), *Prionailurus bengalensis*

Fig. 2. Some of the photographs taken by camera during the study period showing how animals respond to a lure. A, *Helarctos malayanus*, Malayan Sun Bear; B, *Sus barbatus*, Bearded Pig; C, *Viverra tangalunga*, Malay Civet / Tangalung.

Table 1. List of species (family, scientific, and common name), detected during camera surveys of Planted Forest Zone, Sarawak, Malaysia in 2005. For each detection, we list date, time, and whether detectable sign (i.e. tracks, scraps, rubs) was observed. We list the total number of photographs, but some involved multiple detections of the same social group or individual over a short period, and we provide details for only the first detection for these events.

Family/ *Species*	Number of Photographs	Date (day/month)	Time	Location (Block)	Sign Found (Y/N)
Cercopithecidae					
Macaca nemestrina	16	17/02	10:30	T1C, Samarakan PFZ	N
Pig-tailed Macaque		02/03	15:58	Tubau PFZ	N
		15/03	07:35	Tubau PFZ	N
		29/03	13:41	Tubau PFZ	N
Cervidae					
Cervus unicolor	5	05/03	19:51	T1C, Samarakan PFZ	Y
Sambar Deer		24/03	01:54	T1C, Samarakan PFZ	Y
		17/04	00:42	T2B, Samarakan PFZ	Y
		29/04	07:55	T1A, Samarakan PFZ	N
Muntiacus atherodes	6	09/05	06:53	T2B, Samarakan PFZ	N
Bornean Yellow Muntjac		10/05	18:28	T1A, Samarakan PFZ	Y
		30/05	16:37	T1A, Samarakan PFZ	N
		18/07	17:41	T1C, Samarakan PFZ	N
Erinaceidae					
Echinosorex gymnurus	2	09/05	20:47	T1A, Samarakan PFZ	N
Moonrat		25/05	05:35	T1A, Samarakan PFZ	N
Felidae					
Prionailurus bengalensis	1	14/05	05:04	T1A, Samarakan PFZ	N
Leopard Cat					N
Herpestidae					
Herpestes brachyurus	1	09/07	06:49	T1C, Samarakan PFZ	*N*
Short-tailed Mongoose					
Hystricidae					
Hystrix brachyura	5	26/06	21:13	Tubau PFZ	N
Common Porcupine		28/06	00:24	Tubau PFZ	N
		16/07	01:43	T1C, Samarakan PFZ	N
Thecurus crassispinis	4	29/04	20:22	T2B, Samarakan PFZ	N
Thick-spined Porcupine		10/06	22:38	Tubau PFZ	N
Trichys fasciculata	2	06/05	02:09	Tubau PFZ	N
Long-tailed Porcupine		05/06	06:12	Tubau PFZ	N
Manidae					
Manis javanica	1	04/04	05:31	T1A, Samarakan PFZ	N
Pangolin					
Muridae					
Leopoldamys sabanus	1	26/06	21:58	T1C, Samarakan PFZ	N
Long-tailed Giant Rat					
Maxomys rajah	4	15/06	06:18	Tubau PFZ	N
Brown Spiny Rat		17/06	04:10	Tubau PFZ	N
		30/06	19:33	Tubau PFZ	N
Sundamys muelleri	1	15/04	04:57	T2B, Samarakan PFZ	N
Mueller's Rat					

Table 1. Continued.

Sciuridae					
Callosciurus notatus	8	20/06	07:59	T1C, Samarakan PFZ	N
Plantain Squirrel		26/06	13:21	T1C, Samarakan PFZ	N
		27/06	10:38	T1C, Samarakan PFZ	N
		01/07	10:42	T1C, Samarakan PFZ	N
		01/07	13:55	T1C, Samarakan PFZ	N
		05/07	12:10	T1C, Samarakan PFZ	N
		17/07	07:58	T1C, Samarakan PFZ	N
Suidae					
Sus barbatus	19	10/03	17:16	T1C, Samarakan PFZ	N
Bearded Pig		16/03	18:11	T1A, Samarakan PFZ	Y
		18/03	06:46	T1A, Samarakan PFZ	Y
		20/03	19:08	T1C, Samarakan PFZ	Y
		12/04	19:57	Tubau PFZ	N
		14/04	14:09	T2B , Samarakan PFZ	Y
		11/05	17:09	T1C, Samarakan PFZ	N
Tragulidae					
Tragulus napu	1	16/06	18:44	Tubau PFZ	N
Greater Mouse Deer					
Tupaiidae					
Tupaia glis	2	18/06	06:35	Tubau PFZ	N
Common Tree Shrew					
Tupaia gracilis	1	26/06	11:17	T1C, Samarakan PFZ	N
Slender Tree Shrew					
Tupaia tana	2	17/07	07:49	T1C, Samarakan PFZ	N
Large Tree Shrew		15/05	06:12	Tubau PFZ	N
Ursidae					
Helarctos malayanus	2	17/06	18:39	Tubau PFZ	Y
Sun Bear		29/06	00:59	Tubau PFZ	N
Viverridae					
Cynogale bennettii	1	20/03	01:44	BSCA	N
Otter Civet					
Hemigalus derbyanus	1	17/07	20:21	T1C, Samarakan PFZ	N
Banded Palm Civet					
Paradoxurus hermaphroditus	3	01/04	02:12	T2B, Samarakan PFZ	N
Common Palm Civet		19/07	00:12	T1C, Samarakan PFZ	N
Viverra tangalunga	5	25/07	00:23	T1C, Samarakan PFZ	N
Malay Civet		13/04	19:42	T1A, Samarakan PFZ	N
		28/04	03:41	Tubau PFZ	N
		30/04	06:28	Tubau PFZ	N

Table 2. List of commercial scent and food lures used in the study, with the number of stations they were placed at and the species detected at those stations. Each station was monitored throughout the sampling period. Lures are listed by the number of species detected.

[1] Lures were purchased from a commercial firm (Montgomery Fur Co. Ogden, UT, USA)

Lure Name[1]	Type of Lure		Total Locations Monitored	Species Detected
	Scent	Food		
Magna Glan	X		23	Cervidae (*Cervus unicolor* and *Muntiacus atherodes*); Erinaceidae (*Echinosorex gymnurus*); Felidae (*Prionailurus bengalensis*); Hystricidae (*Thecurus crassispinis*); Manidae (*Manis javanica*); Muridae (*Sundamys muelleri*); Suidae (*Sus barbatus*); Ursidae (*Helarctos malayanus*); Viverridae (*Cynogale bennettii* and *Viverra tangalunga*)
Fish Oil		X	15	Cercopithecidae (*Macaca nemestrina*); Cervidae (*Cervus unicolor*); Hystricidae (*Hystrix brachyura*); Muridae (*Leopoldamys sabanus* and *Maxomys rajah*); Sciuridae (*Callosciurus notatus*); Tupaiidae (*Tupaia glis* and *Tupaia gracilis*); Ursidae (*Helarctos malayanus*); Viverridae (*Paradoxurus hermaphroditus*)
Urban Wildlife		X	13	Cercopithecidae (*Macaca nemestrina*); Cervidae (*Muntiacus atherodes*); Hystricidae (*Hystrix brachyura*); Mustelidae (*Martes flavigula*); Sciuridae (*Callosciurus notatus*); Tragulidae (*Tragulus napu*); Tupaiidae (*Tupaia glis*)
Pro Choice	X		8	Cercopithecidae (*Macaca nemestrina*); Cervidae (*Cervus unicolor);* Suidae (*Sus barbatus*); Viverridae (*Viverra tangalunga*)
Beaver Butter	X		6	Herpestidae (*Herpestes brachyurus*); Hystricidae (*Hystrix brachyura);* Suidae (*Sus barbatus*); Viverridae (*Hemigalus derbyanus*)
Deer Success	X		5	Cercopithecidae (*Macaca nemestrina*); Hystricidae (*Hystrix brachyura* and *Trichys fasciculata*); Tupaiidae (*Tupaia tana*)
Fox	X		4	Suidae (*Sus barbatus*)
Wildcat	X		3	Suidae (*Sus barbatus*)
Bobcat	X		6	None detected

(Leopard Cat), *Martes flavigula* (Yellow-throated Marten) and a *Hemigalus derbyanus* (Banded Palm Civet) were photographed only once. Three species of porcupines, *Thecurus crassispinis* (Thick-spined Porcupine), *Trichys fasciculata* (Long-tailed Porcupine) and *Hystrix brachyura* (Common Porcupine) were also recorded. All but the *Martes flavigula* (Yellow-throated Marten) were photographed during the night.

Magna Glan (scent lure) attracted 11 species, including *Cynogale bennettii* (Otter Civet), for 44% of total species recorded. Fish Oil (food lure) was the next most attractive, with 10 species (40%), including *Helarctos malayanus* (Sun Bear). A variety of species (numbering seven) were attracted by the Urban Wildlife Lure, a food odor lure. Fox and Wildcat scent baits attracted only Bearded Pigs. The Deer Estrus lure (scent lure) attracted four species, none of them cervids.

A total of 94 photographs of large and small mammals were from the camera traps in the PFZ, but most did not leave sign around the camera site (Table 1). Only the larger mammals, Sambar Deer, Bearded Pig, Sun Bear and Pig-tailed Macaque, left detectable signs in the camera area. The remaining 21 species would not have been detected without the cameras. A total of 19 photos of *Sus barbatus* (Bearded Pig) were photographed representing slightly more than 20% of all photos taken. *Macaca nemestrina* (Pig-tailed Macaque) appeared in 16 photos (17%) and, was the second most commonly photographed species. A total of 11 species including *Cynogale bennettii* (Otter Civet), *Prionailurus bengalensis* (Leopard Cat) and *Hemigalus derbyanus* (Banded Palm Civet) consisted of a single photo each. Approximately 32% of the medium to large-bodied mammals found in Borneo were recorded.

DISCUSSION

As expected, all photographic records were of terrestrial or semi-terrestrial mammals. Carbone et al. (2000) suggested a minimum of 1000 trap-nights were required to obtain comprehensive information on diversity and population estimation of certain cryptic mammalian species. Our survey had accumulated approximately 160% of that figure over five months, consisting of 94 photographs of small to large sized species. As new records of species continued to be detected throughout this period, it appears that a comprehensive survey requires considerably more effort than 1,000 trap-nights.

Some lures may have failed to attract any mammals due to rainy season from mid April to late June. In our opinion, oily lures such as Fish Oil seemed to better withstand rain, increasing the long-term chances for attracting the animals to the camera. Magna Glan, which produces a very strong odor, was the lure most able to attract terrestrial mammals and remained pungent to the researchers for one month even during the rainy season.

Even though the presence of a species was easily detected with the cameras, it will be difficult to estimate abundance unless individuals can be identified (Karanth & Nichols, 1998). Our comparison between detection rates for species (Table 1) should be viewed as a list of what species can be monitored with the camera system. We would not recommend using the table as an index of relative abundance because we do not know how differences in body size, trail use, and degree of arboreal behavior affect the detection rate for the species. However, the cameras will allow us to make comparisons between sites for any single species or group of similar species. This will greatly enhance our ability to monitor small to medium-sized mammals.

Wildlife surveys are an effort to detect species that are of conservation or management concern. Most of the focus is on locations where species of interest are detected. Of equal importance though are areas where the species is not detected. Only by a rigorous comparison of detection and non-detection sites can managers learn what factors regulate the distribution of species. Therefore, a critical issue is discriminating between non-detection sites where the animal is absent and non-detection sites where the animal is present but not recorded. Our data indicate the use of cameras does eliminate some problems of detection based on sign. The use of scent lures also appears to enhance our ability to detect animals that are present but previously unrecorded. There can be refinement of the camera technique with regards to placement, expense, and types of lures, but we feel that it has still provided a significant advance in our ability to monitor mammal populations in Malaysia.

ACKNOWLEDGEMENTS

This study was a collaborative project between Grand Perfect Sdn. Bhd. and the MOU partner – the Conservation and Research Center, Smithsonian Institution, USA. The authors would like to thank the Conservation staff, Mr. Azizan Juhin, Ms. Angela Paul, Ms. Chin Sing Yun and Ms. Diana Junau and also to Mr. Engkamat Lading of Sarawak Forestry for their administrative and field support during the camera trapping survey. Thanks also to Mr. Su See Kong and his staff in Bukit Sarang Conservation Area for all their assistance in the field.

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