Biodiversity and Conservation (2006) 15:1013–1025
DOI 10.1007/s10531-004-3953-0

Mammal diversity and conservation in a secondary forest in Peninsular Malaysia

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Received 20 January 2004; accepted in revised form 14 September 2004

Key words: Camera trapping, Conservation, Disturbed forest, Malaysia, Mammal survey

Abstract. A comprehensive survey on large mammal diversity from a disturbed forest in Peninsular Malaysia has been carried out for over a period of 21 months. A total of 24 camera traps which accumulated to 5972 trap days. A total of 33 species 27 genera and 15 families of mammals were recorded via camera trapping and observations. The use of camera traps provides detailed information on diversity of some cryptic and secretive mammals. Secondary forest may support a wide diversity of mammals at a stable condition where intrusion, excision and fragmentation are reduced or avoided. The threats to mammals in the study are also discussed.

Introduction

Habitat alteration which includes forest clearing for agriculture have always been a major threat for most mammals in many parts of the world (Stevens 1968; Payne et al. 1985; Mickleburgh et al. 1992; Nowell and Jackson 1996). Approximately 45% of the total land area in Peninsular Malaysia is covered by forest. This includes selectively logged and secondary forest. However only 1.6 million hectares, or roughly 20% of the forested area is designated as protection forest, for various environmental reasons. At present, Peninsular Malaysia has 0.74 million hectares of national parks and other wildlife conservation areas distributed in all 11 states (Anon 2000). With rapid destruction of natural habitat, it is important to document the presence, diversity and distribution of large mammals occurring in various forest patches in Peninsular Malaysia.

Despite the fact that studies on mammal are difficult in tropical rain forest, due to the dense foliage coverage, many comprehensive researches have been conducted on large mammals in Peninsular Malaysia, (Jasmi and Vidyadaran 1993). This is mainly because, they are charismatic and flagship species for conservation of habitat or ecosystem.

In the past, mammals in Peninsular Malaysia were studied using various methods, which includes, live trapping, track counts, interview surveys and direct observations (Topani 1990; Ratnam et al. 1995). In recent times, with the

introduction of infra red sensored cameras, permits the location and study of many secretive and cryptic mammals species (Laidlaw 1999; Kawanishi 2002).

The Department of Wildlife and National Parks, Peninsular Malaysia (DWNP) has carried out various research on large mammals in collaboration with Malaysian and international institution (Laidlaw and Shaharuddin 1999; Kawanishi 2002; Kawanishi et al. 2002a). However almost all of these studies have been carried out in protected areas, however, the protected areas make up a small proportion of the forest in Peninsular Malaysia. Most of the remaining forests in Peninsular Malaysia consist of disturbed forest, which are affected by human activities. Therefore it is important to study mammals in disturbed forest, which will provide information essential for conservation on what species are not able to survive in disturbed forest. Additionally this data can provide vital information on the diversity of mammals which will be lost if similar secondary forest are being developed elsewhere in Peninsular Malaysia. This paper presents data on the large mammal fauna from the first thorough camera trap study in disturbed forest in Peninsular Malaysia.

Materials and method

Study area

This study was conducted at Jerangau Forest Reserve (JFR), situated on the eastern side of the Peninsular Malaysia, in the State of Terengganu (Figure 1) (4°55.5′ N, 103°05.7′ E). JFR covers an approximate area of 170 km^2 which is surrounded by (Federal Land Development Agency) FELDA Jerangau Barat (FJB), an oil palm scheme This includes an isolated hill dipterocarp forest, which is surrounded by settlements and plantation, with an approximate area of 40 km^2. Most of the oil palm schemes were established in the early 1970s. The total area of the oil palm scheme is 2108.61 ha while the total area of plantation coverage in is 1826.59 ha with 363 families of settlers. The major economic income for the settlers is oil palm production and livestock production. Occasionally some settler hunts for wild meat for personal consumption.

JFR, which receives an average annual rainfall of 2000 mm, consists mainly of selectively logged hill dipterocarp and lowland dipterocarp forest. This forest has been logged since the 1970s and is considered as a production forest. The vegetation composition of these forest types has been described by Symington (1974) and Whitmore (1975). Past logging history of more than 30 years has resulted in secondary growth forest with dense undergrowth, particularly in the area of forest to the south of FELDA Jerangau Barat, with abandoned log yards and along a complex network of old logging roads. Forest gaps of various sizes are common in most areas, which are normally caused by timber extraction process. Despite the disturbance from past and recent logging operations at JFR, some forest patches contain extensive stands

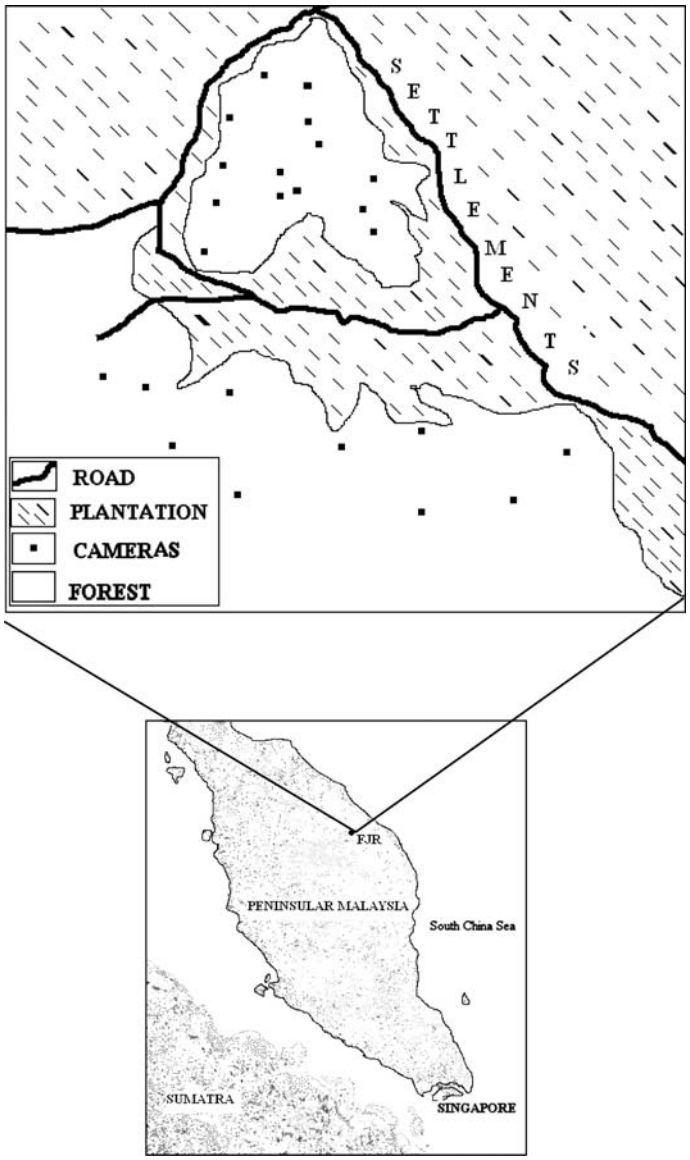

Figure 1. Location of the study area and the approximate location of cameras around JFR, at the state of Terengganu, Eastern Peninsular Malaysia.

of mature dipterocarp trees of the genera *Shorea*, *Dryobalanops* and *Hopea*. Some areas in the north and south of the forested areas surrounding the study site were logged for the second cycle from 2000 to 2002, during the study period. This has created a situation in which tigers and other wildlife have

come into conflict with domestic livestock around human settlements (Mohd. Azlan and Sharma 2003). Camera trapping was used to study this conflict, by placing cameras in the forest and at points along the forest edge. Six cameras were deployed along the plantation-forest fringe while the rest were deployed in disturbed forest. Approximately 77% of the total camera days were concentrated in the secondary forest.

Twenty four Cam Trakker camera traps (manufactured by Camtrak South, 1050 Industrial Drive, Watkinville, GA 30677, USA) were used. This passive infrared sensor transmits in a conical beam where the manufacturer has preset the sensitivity level, and is triggered by animals by moving in front of the sensoer. All camera units were mounted on trees, at least 2.5–3.5 m from the path or trail, with the infrared beam set approximately 50 cm from the ground. Having set cameras to record tigers, the chances of missing out data on smaller mammals are expected. Most of the trails and paths were old logging roads with thick undergrowth of secondary trees and shrubs.

Cameras were deployed in 24 different locations with different effort. Further detail of this method is described in (Mohd. Azlan and Sharma 2003) and Laidlaw (1999). Cameras were checked every 30 days to reload new film rolls. However there were several instances where the films had been fully consumed before checking, so there could be gaps in the record. The same camera locations were maintained throughout the duration of the study, from February 2000 till October 2001. Cameras were only removed or relocated to accommodate changing local conditions such as tree fall, dense undergrowth, and disturbance by elephants or inundation by rainwater. Due to these factors the trapping effort in each camera trap site was not similar. The total number of camera days, accumulated to 5972 camera days.

$$\text{Total camera days (TCD)} = \Sigma \text{cd}_i \tag{1}$$

Each photograph was printed with the date and time the picture was taken. However some photographs do not contain these records, such photographs were excluded from the activity pattern analysis. Repetitive shots of the same species at the same site are also excluded. We assumed that the numbers of photographs taken at various times were correlated to activity levels of mammals (Kawanishi 2002). Time periods were pooled to 1-h interval. The activity level is measured by the percentage of total qualified photos. The nocturnal activity is measured from 18:00 to 05:59 h.

In addition to camera trap data, field observations and road kills of larger mammals were also recorded to add to the species diversity list.

Results

A total of 2121 records where it was possible to safely identify the species were obtained. The result comprises of 13 families, 22 genera and 27 species of wild mammals recorded via camera trapping in the study area (Table 1). In addition

to this, two families, five genera and six species have been added to the diversity list through observation. A minimum of 12 individual tigers was identified based on the photos throughout the study period. Approximately 61% of the total mammals recorded in this area are totally protected and the remaining species receive protected status under the Wildlife Protection Act 1972, Peninsular Malaysia. Protected wild animal can be, killed or taken or be held in possession by a licensed hunter, while totally protected wild animal shall not be killed or collected except for scientific purpose and when causing danger to human life or property.

The percentage of nocturnal activity was only calculated for 16 species based on the filtered data. *Atherurus macrourus* and *Hystrix brachyura* were strictly nocturnal while *Macaca nemestrina* represented the only diurnal mammal (Figure 2).

Discussion

All the photographic results are targeted on terrestrial animals or aboreal mammals, which spend substantial time on the ground, in addition to this no cameras, were deployed near streams to prevent camera malfunction due to flooding and near steep rocky slopes. Due to this factor a comprehensive mammal list are yet to be achieved, especially on secretive animals that are strictly arboreal and associated to aquatic habitat. The species accumulation curve reached a plateau from as early as the 16th month of sampling (Figure 3), suggesting that additional effort may not yield new mammal species if the sampling sites were maintained. This study is the only study conducted on a non protected secondary forest in Malaysia, and there are no scientific reports available to make comparisons. Therefore comparisons were made with other similar studies conducted in protected primary forest in Peninsular Malaysia. The difference in the mammal diversity compared to Ratnam et al. (1995) and Kawanishi et al. (1999) varies due to various factors including variation in sampling methods and total effort, duration of study and the suitability of this mixed habitat forest compared to primary forest to support a great diversity of mammals (Table 2).

A total of six species of primates have been confirmed for JFR. Pig tailed macaque *Macaca nemestrina* and have been frequently recorded in the infrared sensored cameras compared to long tailed macaque *M. fascicularis* and were commonly encountered near the forest fringes during the day. 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 a primary forest in Peninsular Malaysia. *M. fasicularis* have been reported as a specialist of high productivity of secondary forest habitats (Johns 1992). Many locals have considered these macaques as pest. While siamang, *Symphalangus syndactylus*, dusky leaf monkey *Presbytis obscura*, white handed gibbon *Hylobates lar*, and banded leaf monkey *Presbytis melalophos* were observed or

Table 1. Summary of mammals recorded from JFR, Terengganu, Malaysia from February 2000 till October 2001.

	Scientific names	Common names	Photo Records	WPA 1972	**IUCN** 2000	CITES 2000	Survey Methods
PRIMATES							
Cercopithecidae	*Macaca nemestrina*	Pig tailed macaque	91	P	VU A1cd	II	C,A,V
	Macaca fasicularis	Long tailed macaque	21	P	LR/nt	II	C,A,V
	Presbytis melalophos	Banded leaf monkey	N/A	P	LR/nt		A,V
	Presbytis obscura	Dusky leaf monkey	N/A	P	nil		A,V
Hylobatidae	*Symphalangus syndactylus*	Siamang	N/A	TP	LR/nt	I	A
	Hylobates lar	White handed gibbon	N/A	TP	LR/nt	I	V
PHOLIDOTA							
Manidae	*Manis javanica*	Pangolin	N/A	TP	LR/nt	II	RK
RODENTIA							
Hystricidae	*Atherurus macrourus*	Brush tailed porcupine	26	P	nil	nil	C
	Hystrix brachyura	Common porcupine	13	P	nil	nil	C,Q, RK
	Trichys lipura	Long tailed porcupine	7	P	nil	nil	C
CANIVORA							
Canidae	*Cuon alpinus*	Dhole	13	TP	VU C2a	II	C
Ursidae	*Helarctos malayanus*	Sun bear	167	TP	DD	I	C,T,F,S
Mustelidae	*Martes flavigula*	Yellow throated marten	2	TP	nil	nil	C
	Lutra lutra	Common otter	N/A	TP	VU A2cde	I	RK
Viverridae	*Arctictis binturong*	Binturong	1	TP	nil	nil	C
	Paguma larvata	Masked palm civet	2	TP	nil	nil	C
	Paradoxurus hermaphroditus	Common palm civet	16	P	nil	nil	C,V,RK
	Prionodon linsang	Banded linsang	3	TP	nil	II	C
	Viverra tangalunga	Malay civet	28	P	nil	nil	C
	Viverra zibetha	Large indian civet	3	TP	nil	nil	C

Herpestidae	*Hespestes* sp.	Mongoose *	16	TP	nil	nil	C
Felidae	*Catapuma temminckii*	Golden cat	38	TP	VU C2a(i)	I	C
	Neofelis nebulosa	Clouded leopard	13	TP	VU C2a(i)	I	C
	Panthera pardus	Black panther	103	TP	nil	I	C
	Panthera tigris	Tiger	151	TP	EN C2a(i)	I	C,T,F,A,S, RK
	Pardofelis marmorata	Marbled cat	1	TP	VU C2a(i)	I	C
	Prionailurus bengalensis	Leopard cat	86	TP	nil	II	C,T,F,V
PROBOSCIDEA							
Elephantidae	*Elephas maximus*	Asian elephant	10	P	EN A1cd	I	C,T,F
PERISSODACTYLA							
Tapiridae	*Tapirus indicus*	Tapir	280	TP	EN A2c+3c+4c	I	C,T,F,S
ARTIODACTYLA							
Suidae	*Sus scrofa*	Wild pig	774	P	nil	nil	C,T,F,A,V, RK
Tragulidae	*Tragulus* sp.	Mouse deer *	83	P	nil	nil	C,T
Cervidae	*Muntiacus muntjac*	Barking deer	172	P	nil	nil	C,T,F,A,V
Bovidae	*Naemorhedus sumatraensis*	Serrow	1	TP	VU A2cd	I	C

WPA 1972: Protected status under the Protection of Wildlife Act 1972, Malaysia: TP- totally protected, P- protected, NP. *Survey methods*: C - camera; T- tracks; F- Feces; A- Acoustic; S- scrapes; V-visual; Q- quill; RK-road kill.

* Two species of mousedeer, *Tragulus* sp. and four species of mongoose, *Hespestes* sp. were pooled respectively as they are indistinguishable on photographs.

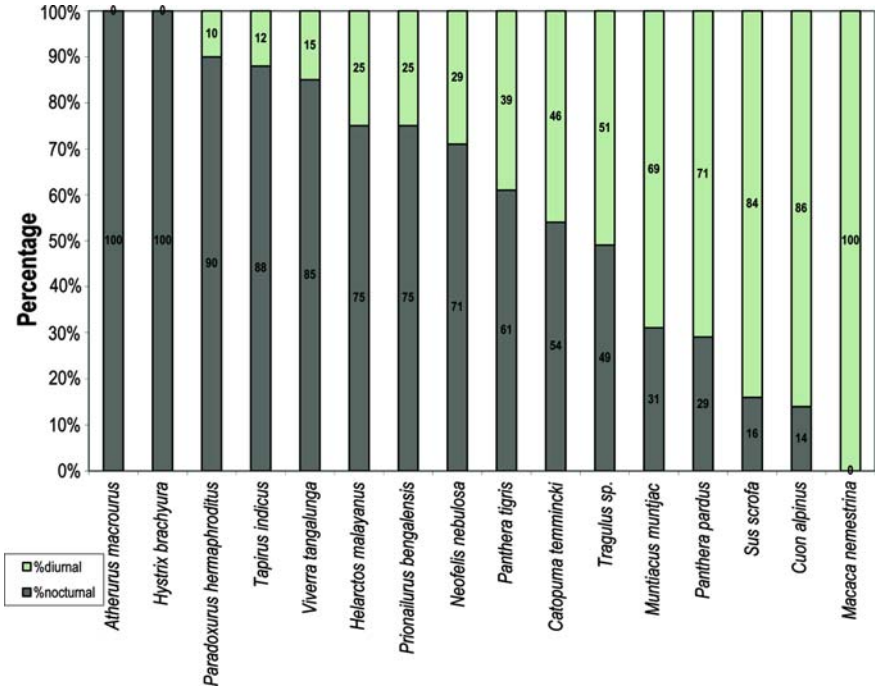

Figure 2. Nocturnal activity patterns between 18:00–05:59 h recorded by camera trapping around JFR.

heard in the hill dipterocarp forest north of the study site which has an intact canopy cover compared elsewhere within the study site.

Elephants *Elephas maximus* were frequently recorded in the lowland dipterocarp forest compared to the hill dipterocarp forest. *E. maximus* occasionally raids newly planted oil palm trees and fruit orchards in nearby areas where local community considers them as pest. At least five cameras were destroyed beyond repairable condition by elephants.

A total of five families of 17 species from the order carnivora, have been recorded in this study, this includes a single road kill specimen of the common otter, *Lutra lutra*. This represents approximately 56% of the total species recorded in this order by Medway (1983). In the family Mustelidae, the yellow throated marten, *Martes flavigula* was only represented by two records, suggesting that this species could be highly aboreal. The family Vivirridae was represented by seven genus in the study areas. A study conducted by Ratnam et al. (1995) in Temmengor forest reserve, a primary forest, revealed the presence of five genera which includes, banded linsang *Prionodon linsang*, masked palm civet *Paguma larvata*, banded civet *Hemigalus derbyanus*, common palm civet *P. hermaphroditus* and three striped civet *Artogalidia trivirgata*. Of all the seven species reorded only *M. flavigula* and large Indian civet *Viverra zibetha* are not considered common (Medway 1983). This high diversity of

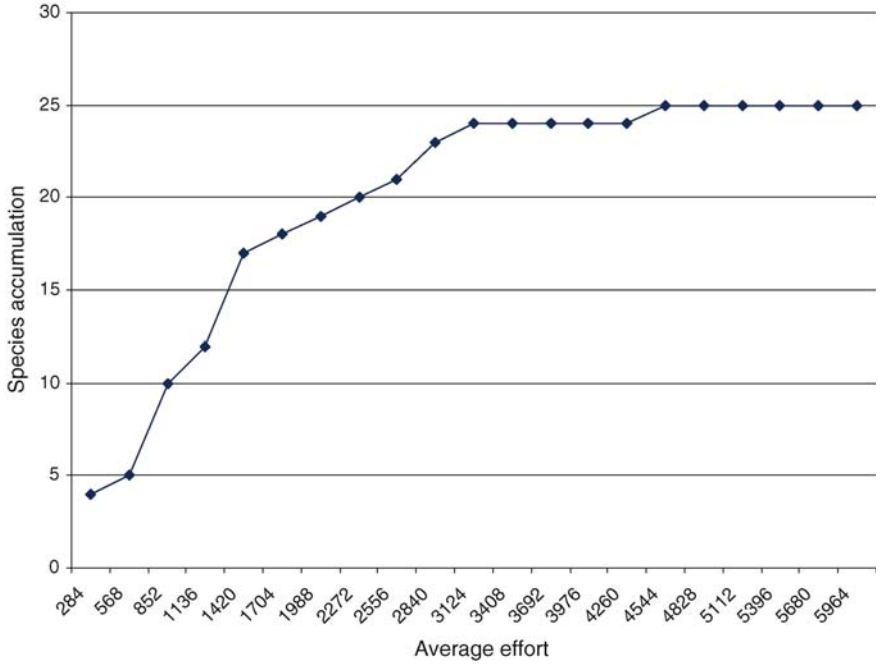

Figure 3. Species accumulation curve leveling out at the 16th month of camera trapping in JFR, Peninsular Malaysia.

Table 2. Comparison of present study with two different sides in Peninsular Malaysia

	Sungai Relau, taman Negara (Kawanishi et al. 2001)	Temengor forest reserve (to Ratnam et al. 1995)	Present study
Forest type	Primary forest	Primary forest	Secondary forest
Sampling effort	4192 camera days	35 days	5972 camera days
Total species of large mammals	27*	28	33
Total wildlife photo	1519	N/A	2121
Study area	200 km^2	N/A	170 km^2
Type of observation	Trail Master & Cam Trakker	Direct observation	CamTrakker
Focal range**	3–5 m	N/A	1–3 m
Height of camera	50 cm	N/A	50 cm

*Total number of large mammal species based only on camera trap result
**the distance between camera and the middle of the trail

viverrids may have contributed by abundance of food resource near oil palm plantations (Mohd Azlan 2003)

Felids are generally known to have adapted to various kinds of habitat alteration (Nowell and Jackson 1996). The flat-headed cat, *Prionailurus. planiceps*, and the fishing cat *P. vivverinus* was not detected in this study, which is strongly associated with wetlands (Medway 1983; Nowell and Jackson 1996). The Asiatic golden, *Catopuma temmnicki*, cat which was elusive and has been considered uncommon in Peninsular Malaysia (Medway 1983) until the utilization of camera trapping in Malaysian rainforest by Kawanishi (2002) and present study. The low frequency of photographic record for clouded leopard, *Neofelis nebulosa* and marbled cat, *Pardofelis marmorata* is consistent with suggestions that it spends substantial amount of time aboreal (Payne et al. 1985; Rabinowitz et al. 1987). All the 103 photographs of leopards, *Panthera pardus* were of the melanistic morph, even though Medway (1983) has described the yellow spotted morph from Peninsular Malaysia.

Tigers, having the highest photographic record among its relatives, suggest that this forest may provide adequate cover and artificial prey such as cattle for these large carnivores, which may have contributed to the high activity level around the study area. It is also believed that tigers may be dispersed out from surrounding forest due to human activities, such as quarrying and deforestation (Mohd Azlan and Sharma 2003). Three individuals of tiger cubs (approximately 11–12-months-old) were also recorded, during early periods of camera trapping. However only single cub had been able to be traced at the sub adult stage toward the end of the fieldwork. Tiger pugmarks, which sometimes accompanied by cubs, were often observed in the oil palm estate, near cattle paddocks, abandoned logging road, near fresh cattle kills and active logging roads.

The wild dog, *Cuon alpinus* were reported by the villagers move in packs of two to five sometimes even up to seven individuals. However all the records of this species is of single individual. This species has also reported to attack a calf, in packs of 4–5 near the forest fringe and the locals considered it as a rare occasion. This species were not considered a major threat to the livestock by the local community when compared to tigers around the study area.

Malayan tapir, *Tapirus indicus* are not consumed as food by local communities and does not have a natural predator, (Kawanishi et al. 2002b). There were several occasions where two adult individuals were photographed on a single camera location. The results showed that this species is widespread throughout the study area and found in an array of habitats, from hill dipterocarp forest to the degraded patches of the left over lowland forest. Two melanistic *T. indicus* were also recorded during this study (Mohd. Azlan 2002).

Most of the Artiodactylans in the study area were heavily hunted, except for *Sus scrofa* as settlers around this study site is 100% Muslim. The bearded pig is unlikely to be found in this area, as their distributions are mainly in southern Pahang and Johor (Medway 1983; Ratnam et al. 1995). Only a single record of *Naemorhedus sumatraensis* was observed in this study site is consistent with

Kawanishi et al. 1999, in Taman Negara National Park. The habitat of this species near forest slopes and limestone out crops (Medway 1983) are unsuitable for the camera set up, in which may have resulted in low photographic records. The local villagers occasionally hunt mouse deer and barking deer during the hunting season. Even though hunting licenses for sambar deer, *Cervus unicolor* has been issued by the Department of Wildlife and National Parks (DWNP) in Terengganu throughout the study period, there are no records or tracks of *C. unicolor* have been observed, suspecting that this species may have locally extinct in the study area due to over hunting. Only three species of large terrestrial mammals were not recorded here namely, *Bos. gaurus*, *C. unicolor* and *Dicerorhinus sumatrensis*. Except for *C. unicolor* the other two species may require an undisturbed forest condition. *B. gaurus* and *D. sumatrensis* has been recorded in primary forest (Ratnam et al. 1995; Kawanishi et al. 1999; Kawanishi et al. 2002a) suggest that these species may require a pristine and a protected forest as its prime habitat.

Even though this unprotected secondary forest may seems to support a wide diversity of large mammals, the threats to these species also seems to increase. Habitat fragmentation, due to oil palm plantation and road construction, road kill of large mammals, easy access for illegal hunting, and conflicts with local community are the major threats to large mammalian diversity around the study site.

Past logging history in the study area has created a network of abandoned logging roads, which creates easy access for hunters. Bullet cartridges and abandoned illegal campsites had been seen around the study area suspecting belonging to hunters or gaharu wood (*Aquilaria malaccensis)* collectors. During the survey, local villagers carrying shotguns were also noted along the main roads and in several instances in the logging roads as well. In the year 2000, 15 shot guns were registered for FELDA Jerangau Barat under security of the scheme, however it is feared that it would be misused. There were several photographs of hunters carrying shotgun were obtained by the camera traps.

Some mammal species seems to habituate the presence of humans on roads and near forest fringes associated with oil palm activities and changes in this forest stand after 30 years of logging history. Eight species have been observed killed on asphalt roads this includes an adult tigress. Habitat fragmentation due to highways poses a major threat for large mammals dispersing from one fragmented area to other forested area.

Disturbance in forest ecosystem are most likely to cause reduction in species abundance rather than extensive species disappearance (Pimm 1979). Nevertheless, some mammalian species would reinstate after a period of time (Johns 1992). However, It is suggested that this secondary forest may perhaps support a wide diversity of larger mammals at a stable condition where intrusion, excision and fragmentation are avoided.

Secondary forest can potentially be a suitable buffer zone or corridor for animal movement between protected sites. Buffer zones also increase protection by preventing development that may pose threats or create unauthorized

access. A great diversity of large mammals may act as umbrella species for smaller mammals (Simberloff 1998). However viability analysis and the carrying capacity over a long-term period, of this forest should complement this result. Monitoring the large mammal density at regular interval in account to the surrounding development activities may provide detailed information on the level of resilience of particular mammal species. Thus, it is worthwhile to encourage the local government to protect the remaining secondary forests, especially lowland dipterocarp forest as a state or even national park in Peninsular Malaysia as the demand for land for development evidently increasing.

Acknowledgements

I would like to thank the Department of Wildlife and National Parks, Peninsular Malaysia, Department of Forestry and FELDA Jerangau Barat Management and settlers for their support for the tiger human conflict (MY0086) project. In addition to this I am also are grateful to all the stakeholders who have participated in this project. We are thankful to En. Mat Salleh, Raleigh International (Malaysian Chapter) and volunteers for their help in the fieldwork. I am grateful to all WWF Malaysia staffs especially Dr. Dionysius S.K. Sharma who has helped and guided throughout the fieldwork. I also would like to thank the two anonymous reviewers for their comments. This project was funded by WWF-UK and WWF Japan and currently being extended by WWF Netherlands.

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