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CAMERA TRAPPING THE INDOCHINESE TIGER, *PANTHERA TIGRIS CORBETTI*, IN A SECONDARY FOREST IN PENINSULAR MALAYSIA

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ABSTRACT. **–** Indochinese tigers (*Panthera tigris corbetti*) are the main mammalian predator in most Asian tropical rainforest ecosystems. However little is known about the distribution of this large carnivore in Peninsular Malaysia. In order to understand tiger-human conflict, we conducted a study to describe the relative abundance of tigers in Jerangau Forest Reserve, Ulu Terengganu, Malaysia, between February 2000 and October 2000. A total of ten individuals, including three cubs, were recorded. The use of camera traps provides detailed information on the abundance, ecology and habits of this cryptic and secretive mammal. The most frequently photographed tiger was an adult male (M1) followed by an adult female (F1) which comprised 66% and 12% of the total tiger individual photographs, respectively. The monthly individual accumulation curve did not show any signs of leveling out, suggesting that additional effort may reveal the presence of other individuals even if the camera sites were maintained. The same individuals were recorded both in isolated and continuous forest suggesting that tigers disperse through degraded forest habitat. As this study concentrated on assessing relative abundance of tigers, additional research will be necessary to understand the population dynamics for conservation of this felid species in secondary forest habitat.

KEY WORDS. **–** Infrared sensored cameras, logged forest, habitat degradation, conservation, wildlife management.

INTRODUCTION

The Indochinese tiger, *Panthera tigris corbetti*, is the most threatened large carnivore in Southeast Asia. It has been used as a flagship species in conservation efforts in many countries in this region to protect a wide diversity of less charismatic species (Lim, 1999) for which it is difficult to gain public and corporate support. Despite this, the principal threats to its sustainability have been rapidly increasing mainly due to habitat destruction (Seidensticker, 1986), decline in prey base caused by overhunting (Karanth, 1991; Rabinowitz, 1991), commercial poaching (Rabinowitz, 1993; Plowden & Bowles, 1997; Shaharuddin, 1999), and poor tiger-human conflict management. Increasing development has resulted in forests becoming fragmented, isolated and reduced in size. In Peninsular Malaysia, many lowland and hill dipterocarp forest have been felled for agriculture and timber particularly, where in 1989, only 1.9 million ha remained as protected forest (Latiff & Zakri, 1998). Oil palm cultivation, which was rapidly adopted in the early 1960s, resulted in extensive deforestation and conversion from rubber to oil palm plantation, most of which are coordinated and managed by the Federal Land Development Authority (FELDA). Currently plantations cover approximately 16% (2.1 million ha.) of the total land area in Peninsular Malaysia (Hai, 2000).

Most of the existing tiger population data in Peninsular Malaysia have been gathered from surveys based on sighting and tracks recorded by the respective State Department of Wildlife and National Parks and largely focused on tiger-human conflict areas and occurrence of tigers at forest fringes (Elagupillay 1983, 1984; Jasmi, 1986, 1998; Khan, 1987; Topani, 1990; Ellagupillay & Shaharuddin, 1999). Track survey or pugmark censuses (Panwar, 1979) have been proven demonstrably failure-prone (Karanth, 1987, 1988, 1993a, b) because estimates based on pugmark census are neither reliable total counts nor statistical samples (Karanth, 1995). A more reliable method of identifying tiger individuals, for population estimates involves their stripe patterns, as each tiger has its own unique coat pattern

(Schaller, 1967). This can be achieved by recording tigers photographically in dorsal or lateral position (Griffiths, 1993, Karanth, 1995). Besides individual identification or population estimation (Karanth 1995), camera trapping can also provide other biologically relevant information such as temporal variations (Laidlaw & Shaharudin, 1999), distance of travel, relative abundance in relation to environmental variables, abundance of prey species (Kawanishi, 2002) and other wildlife in the study area. However, obtaining a total count of tigers using camera traps involves excessive resources and effort and there are possibilities of uncounted tigers (Karanth, 1995). However, undercount can be dealt with if the camera traps are utilized in a mark-recapture framework.

Population censuses are considered to be an important initial step in determining management and protective needs for tigers, which provides a basis for judging the success of tiger management programs. Attempts to conserve tigers may be hindered by a lack of sufficient information to document the species' exact population status, especially outside protected areas. Despite the obvious reasons in monitoring tiger populations, a comprehensive population survey has yet to be implemented in tropical rainforest in Southeast Asia due to lack of resources and expertise.

The overall objective of the project is to determine the possible levels of tiger-human conflict in Peninsular Malaysia where camera-trapping census is utilized to study the relative abundance of tigers. This paper presents the preliminary findings on the results of camera trapping of tigers around human modified habitat, in order to understand the tiger-human conflict in Peninsular Malaysia.

MATERIALS AND METHODS

Study site. **–** The study was conducted at FELDA Jerangau Barat (FJB), which is an oil palm scheme, and Jerangau Forest Reserve (JFR) in the State of Terengganu (N 4°55.5', E 103°05.7') with an approximate area of 140 km^2. These areas lie outside of the Tiger conservation unit 1 (TCU 1) range. The main activity in this scheme is oil palm production and cattle farming. The oil palm scheme with an area of approximately 2200 ha. has been established since 1972, where it is surrounded by JFR to the north and south (Fig. 1). JFR, which receives an average annual rainfall of 2000 mm, consists mainly of hill dipterocarp and lowland dipterocarp forest. The vegetation composition on the above mentioned forest types have been described earlier (Symington, 1974). All the dipterocarp forest around the oil palm scheme except for one compartment (approximately 1 km^2) had been logged in late 1970s and early 1980s. This has resulted in secondary forest habitat type, with dense undergrowth particularly to the south of FJB with mosaic of ferns (*Dicranopteris* sp., *Gleichenia* sp.) where such vegetation types are found in abandoned log yards and old logging roads. The north and south forested areas surrounding the study site are currently being logged. Despite disturbances from past logging operations at JFR, the forest north of FJB still consist of extensive stands of mature dipterocarp trees (*Shorea* sp., *Dryobalanops* sp).

We used commercially made Cam Trakker brand camera trap units (manufactured by Camtrak South, 1050 Industrial Drive, Watkinville, GA 30677. USA). Each unit consists of a plastic casing, camera with built in flash, sensors with selectors and a viewing window. Cam Trakker combines a fully automatic 35 mm, camera with a passive infrared heat-in-motion detector. The heat-in-motion sensor operates on a horizontal plane, thus it is important that it is aimed parallel to the ground. When something that moves and gives off heat, a silent electronic switch engages the camera, which takes a photograph. For obtaining clear photographs of tigers in the dense tropical rainforest, 400 ASA color prints were used. These units are equipped with a delay selector mechanism that precludes the camera from taking a photograph for a set period of time. The time delay between photographs was set to a minimum of three minutes, which eliminates wastage of film on a single situation. All cameras were operational 24 hours a day with no break in monitoring except in instances of malfunction or damage caused by elephants. Time and date were also recorded for each exposure except during camera malfunction or excessive moisture on the film due to high humidity and condensation.

Tigers are reported to regularly use old logging roads and forest trails, communicating through scent markings (Panwar, 1979; Sunquist, 1981, Smith et. al., 1987). In light of this, before choosing locations for the placement of camera traps, we conducted extensive ground surveys for secondary signs of tigers such as tracks, scrapes and scat deposition. When such signs were found, we carefully recorded these and marked the area as a possible site to deploy a camera. Having surveyed a vast area of forests around FJB, we identified 11 suitable locations to use our cameras. They were approximately 1.8 km to 2.2 km apart and surround the entire oil palm estate. This ensured that we would increase our chances of photographing tigers irrespective of which direction they ventured into oil palm estate. All camera units were mounted on trees, at least 2.5 m to 3.5 m from the path or trail, with the infrared beam set approximately 50cm from

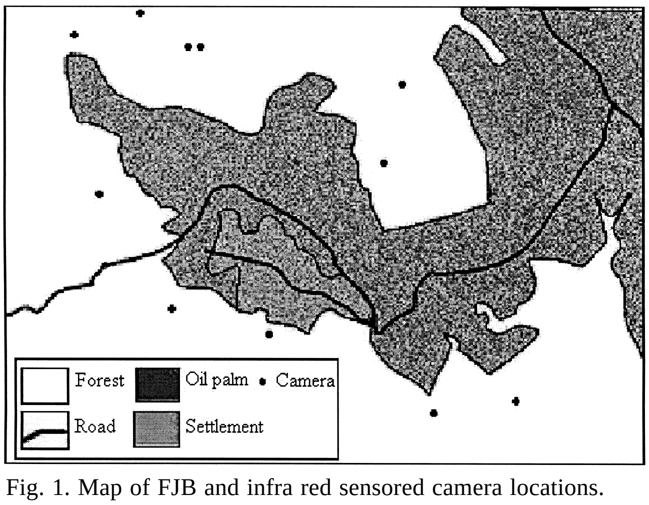

Fig. 1. Map of FJB and infra red sensored camera locations.

Table 1. Description of forest type, area of natural forest, location of the camera traps with respect to forest continuity around FJB.

Camera number	Camera position	Area of Natural Forest	Logging history of forest
1	fringe	Isolated 40 km^2	Logged/secondary forest
2	Central	Isolated 40 km^2	Unlogged/primary forest
3	Central	Isolated 40 km^2	Unlogged/primary forest
4	Fringe	Continuous	Logged/secondary forest
5	Fringe	Isolated 40 km^2	Logged/secondary forest
6	Fringe	Isolated 40 km^2	Logged/secondary forest
7	Central	Isolated 40 km^2	Logged/secondary forest
8	Fringe	Continuous	Logged/secondary forest
9	Fringe	Continuous	Logged/open area
10	Fringe	Continuous	Logged/secondary forest
11	Fringe	Continuous	Logged/secondary forest

Table 2. Sampling effort (number of trap nights) expended for estimating the relative abundance of tigers around FJB in 2000.

Camera Number	Date	No. of days
1	23/2 – 14/10/00	235
2	23/5 – 26/9/00	126
3	24/2-24/5/00	91
4	24/3 – 24/5 ; 24/5 – 22/9/00	183
5	30/5 – 26/9/00	120
6	17/6 – 15/10/00	121
7	18/6 – 24/9/00	99
8	24/6 – 17/8 ; 23/9 – 20/10/00	84
9	24/6 – 16/10/00	115
10	25/6 – 22/10/00	120
11	26/3 – 16/5 ; 18/7 – 22/10/00	149
TOTAL		1443

the ground. Most of the trails and paths consist of old logging roads with thick undergrowth of secondary trees and shrubs. All camera trap sites were marked on a map using a Global Positioning System (GPS) (Ensign, Trimble Navigation).

Camera trap site descriptions are set out in Table 1. Camera locations were maintained throughout the duration of the study, with only minor relocation or repositioning to accommodate changing local conditions such as tree fall, dense undergrowth or inundation by rainwater. The total trapping period was continuous except for climatic and logistical constrains which caused the trapping effort in each camera trap site was not similar. The details of the sampling effort are showed in Table 2.

Tigers were identified and separated as individuals on the basis of stripe pattern (Schaller, 1967; McDougal, 1977; Karanth, 1995, 1999) obvious morphological distinguishing features and basic body dimension (Fig. 3; see also Franklin et al., 1999). Photographs were excluded when an individual tiger could not be distinguished due to the angle of the photograph and poor photo quality. Only the left side of the tiger photo is utilized for identification of individuals.

RESULTS

The total sampling effort accumulated to 1443 trap nights over 9 months (Table 2). A total of 787 photographs of 22 species of wildlife were taken. From a database of 50 tiger photographs, 41 (82%) photographs were confidently utilized for identification of individual animals while the remainder was made up of poor focus and quality photographs that could not be used. More than 5 observers including the authors positively identified seven adult tigers and three cubs. Tiger photo capture success rate per camera is approximately 82% where 9 of the 11 cameras recorded tiger photos (Table 3). Fig. 2 shows the cumulative numbers of individuals tiger encountered in the study site over time. Due to inconsistency of sampling intensity at each camera trap sites, new individual tigers were still encountered, up to end of 9 months of monitoring, and the rate of new encounter showed no decline. One adult male (M1) was photographed 27 times (66% of total tiger individual photos) (Table 3).

The overall sex ratio of the entire sample could not be determined, as the visibility of external genitalia in the remote camera photographs was poor. The gender of only four

Table 3. Captures of individual tigers at the various camera trap locations at FJB.

	Individuals tigers and frequency of captures									
Camera number	M1	M2	M3	F1	U1	U2	U3	C1	C2	C3
1	17			5				1	1	
2	2	1			1	1				1
3	1									
4										
5							1			
6										
7	2									
8										
9	2	1								
10			1							
11	3									
TOTAL	27	2	1	5	1	1	1	1	1	1

individuals was identified. High tiger photo capture rates occur in forest fringes as 73% of the remote cameras are located between oil palm plantation and forest reserve where tiger photographs accumulated to 76% of the total tiger photos.

DISCUSSION

A total of 10 individuals of tigers, including 3 cubs, photographed around FJB, suggest that areas outside protected areas in Peninsular Malaysia hold substantial populations of tigers, even though habitat degradation has produced several patterns of secondary forest and shrub habitat type. The monthly individual accumulation curve showed no signs of leveling out to reach an asymptote, suggesting that additional effort may yield other individuals around the study area. This suggests that the study area would be an open tiger population.

Two tigers (M1 and F1), which were frequently photographed at study site throughout the study period, suggest that their home ranges are located predominantly inside the study site compared to the five other adult tigers

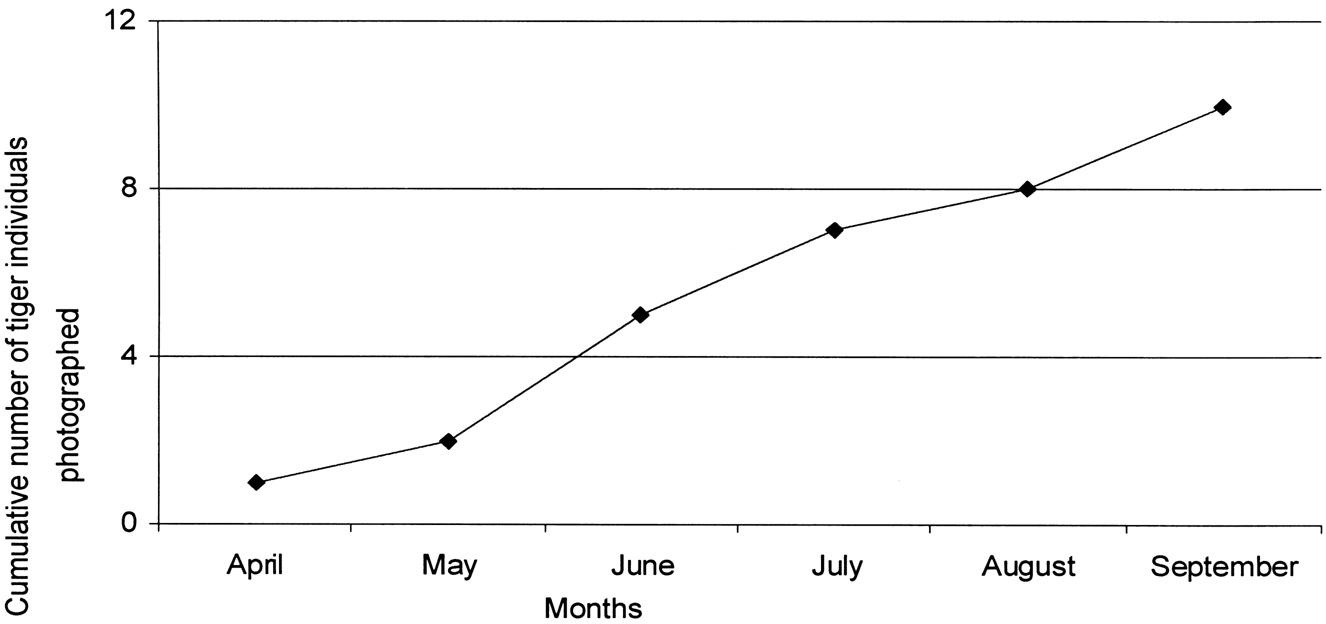

Fig. 2. Cumulative number of individual tiger captured per month around FELDA Jerangau Barat, Terengganu between April 2000 to September 2000.

recorded. These tigers that were photographed occasionally are considered to be individuals that possess home ranges either adjacent or primarily outside of the study site itself. This suggests that they may have little territorial stake within the study site and are referred as non-resident individuals (Franklin et. al., 1999). In addition to this, the possibility of tigers traveling through the study area to locations outside the study site may influence the abundance estimation (Karanth & Nichols, 1988). The non- resident tigers may have been attracted to the study site due to the presence of domesticated animals and wild boars (*Sus scrofa*). This has many times aggravated conflicts with livestock owners, and caused one tiger to be shot in 1998 for killing at least 30 cattle in a single week.

Tiger pugmarks have also been frequently recorded in oil palm estates where in many instances local settlers harvesting oil palm fruit have come into contact with tigers. However, there have been no human fatalities or injuries attributable to tigers within this state since 1980s. As a result of high frequency of contact, local farmers estimated tiger numbers beyond the study area. This anecdotal information is sometimes used by relevant authorities to encourage removal of tigers from the wild during intense tiger-human conflict episodes.

The male tiger (M1) shows a wider distribution with greater concentration of activity pattern compared to the female (F1). This is reflected in Table 3, where M1 was photographed more frequently over a wider geographical range than F1 and other tigers, suggesting that M1 would be the dominant male in the study area. Long term camera monitoring will be required over a wider area in order to establish more accurate details regarding the size and extent of home ranges of the tigers.

Eighty-two percent of the tigers were photographed in the isolated 40 km^2 forest. Settlements, oil palm estates, rubber plantation and asphalt roads surround this forest. Tigers photographed in the isolated forest are also observed in the continuous forest, suggesting tigers cross roads and other types of land use to cover its territory or to locate food sources due to logging land development activities. This suggests that tigers disperse through degraded forest habitat and oil palm plantation under increased stress. Local villagers know of one incident in 2001, in which a tiger was killed as it tried to cross the asphalt road from the isolated forest area to the continuous forest (unpublished data). Immigration of tigers into the study site from external areas is anticipated due to a territorial vacuum created by removed tigers and active habitat reduction pressure in surrounding forested area outside the study site.

Three individuals of cubs (approximately 11-12 months old) that were photographed, on different occasions, in the isolated forest patch, provide evidence of reproduction and

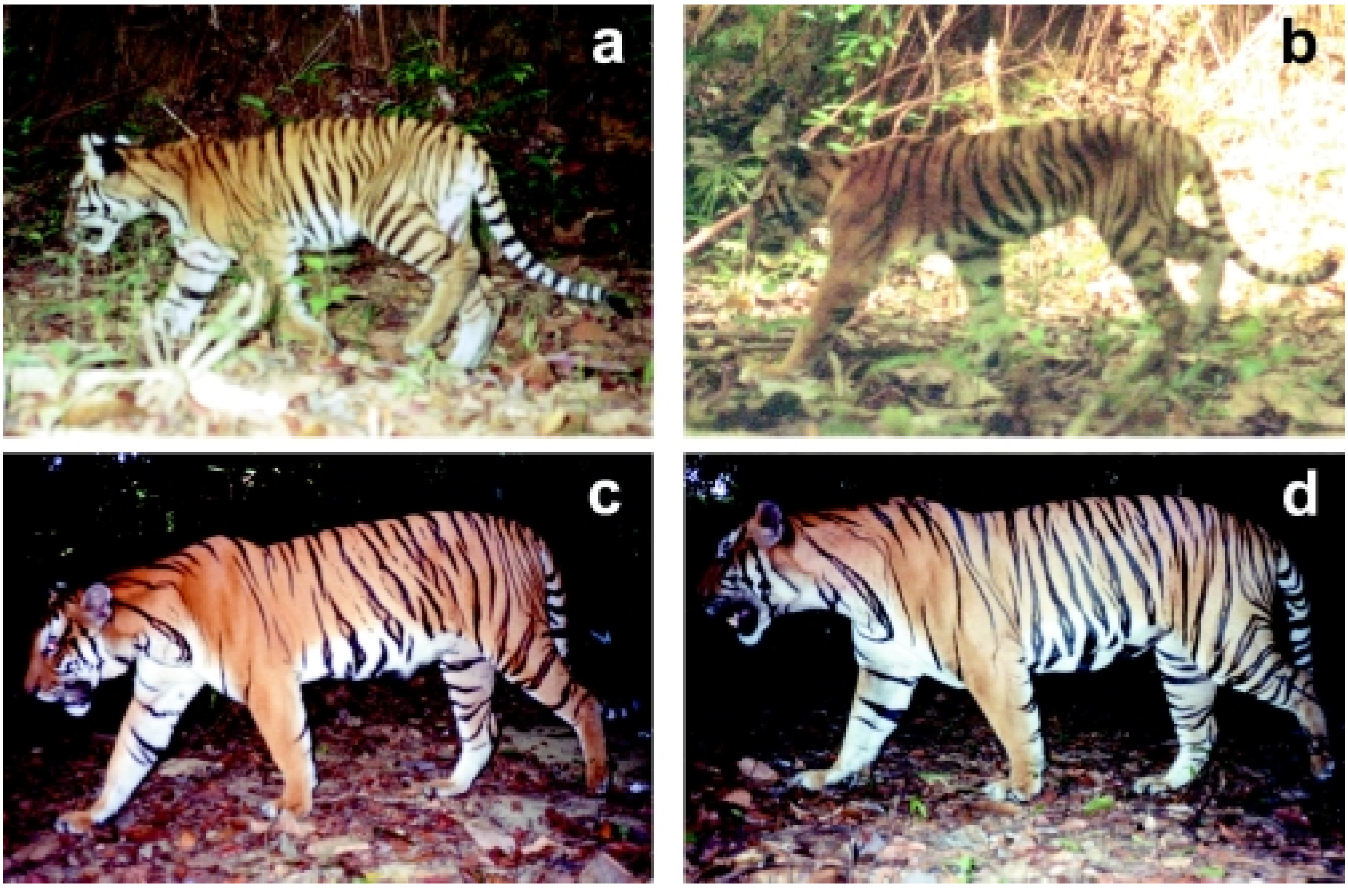

Fig. 3. Identification of tiger individuals from infra-red sensor camera traps. Example of individual identification of tiger cubs (a, b) and adults (c, d) based on stripe patterns.

dispersal despite fragmented and unstable nature of the habitat. These cubs were unaccompanied by adult females in the photos. Tiger cubs populations could be underestimated according to Karanth (1995), where tiger cubs had low capture probabilities due to deliberate avoidance of traps and other behavioral differences between young and adults. The time delay between photographs was set to a minimum of three minutes, where cubs accompanied with adult female tigers in front is unlikely to have been captured in the photo.

Most tiger research has been conducted in protected areas (Sunquist, 1981; Karanth, 1988, 1995; Griffith, 1993; Karanth, 1999; Karanth et.al., 1999; Franklin et al., 1999; Laidlaw & Shaharudin, 1999; Kawanishi, 2002) as these house closed populations and ensure the long-term conservation of this species. The major conservation predicament in Peninsular Malaysia is habitat decline resulting from intended and unpremeditated human actions. The ongoing increase of development in unprotected areas is rapidly increasing the number of insular pockets of tiger habitat. In general, forest fragmentation can isolate small sub-populations from each other and promote inbreeding. Thus small discrete populations are vulnerable to extinction due to unpredictable environmental or land use change, demographic and genetic factors (Jackson & Nowell, 1996).

Reducing the isolation of tiger populations by providing corridors between protected areas to maintain genetic diversity may be critical for long-term tiger conservation strategy in Peninsular Malaysia. Therefore it is important to understand basics of tiger population and dynamics in areas, which have not been protected for future land use planning and wildlife management.

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