POPULATION ECOLOGY OF THE LEOPARD CAT (*PRIONAILURUS BENGALENSIS*) IN THREE COMMERCIAL FOREST RESERVES IN SABAH, MALAYSIA

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INSTITUTE FOR TROPICAL BIOLOGY
AND CONSERVATION
UNIVERSITI MALAYSIA SABAH
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IJAZAH: MASTER OF SCIENCE (CONSERVATION BIOLOGY)

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Tarikh: Julai 2013

DECLARATION

I hereby declare that the material in this thesis is my own except for quotations, excerpts, equations, summaries and references, which have been duly acknowledged.

6 June 2013

AZLAN BIN MOHAMED

PP2008-8065

CERTIFICATION

NAME : **AZLAN BIN MOHAMED**

MATRIC NO : **PP2008-8065**

TITLE : **POPULATION ECOLOGY OF THE LEOPARD CAT (*PRIONAILURUS BENGALENSIS*) IN THREE COMMERCIAL FOREST RESERVES IN SABAH, MALAYSIA.**

DEGREE : **MASTER OF SCIENCE (CONSERVATION BIOLOGY)**

VIVA DATE : **4 JANUARY 2013**

DECLARED BY

Signature

1. SUPERVISOR
Assoc. Prof. Dr. Henry Bernard

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Sincerely,

Azlan Bin Mohamed

6 June 2013

ABSTRACT

POPULATION ECOLOGY OF THE LEOPARD CAT (*PRIONAILURUS BENGALENSIS*) IN THREE COMMERCIAL FOREST RESERVES IN SABAH, MALAYSIA.

The leopard cat (*Prionailurus bengalensis*) is the most common felid species found in Borneo and Southeast Asia. Although often regarded as adapted well to living in disturbed habitat and frequently sighted in secondary forests and plantations, yet little is known about this species in the wild. By using remote digital camera-traps, the present study was conducted on the leopard cat populations located at three commercial forest reserves in South-central of Sabah, Malaysia. The forest reserves (FR), namely Deramakot FR, Tangkulap FR and Segaliud Lokan FR, have been managed under three different logging approaches in the past. The objectives of the study were to investigate the ecology of the leopard cat with specific emphasis on activity pattern, home range and habitat preferences. This study also provides the first densities estimate of leopard cat based on large camera trapping dataset. At Deramakot FR, 23 different individuals were identified during a 4-month trapping period (47 camera stations, 1916 trap-days). At Tangkulap FR, 41 different individuals were identified (64 camera station, 2302 trap-days) and at Segaliud Lokan FR, 60 individuals were identified (55 camera station, 2933 trap-days) during the surveys. At all study sites, male leopard cats were photographed more frequent than females. Males also tended to have larger home range and moved further distance than female. Minimum observed home range estimate for individuals with > 3 captures at different camera locations in Deramakot FR ranged from 1.9 to 12.3 km^2 for five males and 0.4 to 7.5 km^2 for five females. In Tangkulap FR, minimum observed home range estimate for nine males ranged from 1.2 to 26.4 km^2. Whereas in Segaliud Lokan FR, minimum observed home range for 12 males ranged from 0.8 to 11.4 km^2 and 0.3 to 1.9 km^2 for three females. Leopard cats were captured more frequently along logging roads than on the forest trails and at night than during the day, confirming the behaviour that is regularly observed for a nocturnal species. The spatially explicit capture-recapture (SECR) models estimated a higher leopard cat density in the two more disturbed forest reserves; 16.50 ± 2.00 individuals 100 km^{-2} in Segaliud Lokan FR and 12.40 ± 1.61 individuals 100 km^{-2} in Tangkulap FR, than in the sustainably managed forest - 9.56 ± 1.63 individuals 100 km^{-2} in Deramakot FR. The non-spatial model had probably overestimated the leopard cat density because it did not take into account the animal movements and the results were highly influenced by the choice of buffer width (half MMDM or full MMDM). Therefore, the density estimates using SECR models are more reliable and they can be used as baseline data for the leopard cat density in production forests. Using occupancy-based approach, the variables which influenced the occurrence of leopard cat were identified. No single models emerged as the best model but canopy closure, the ratio of climax to pioneer trees and the ratio of large to small trees had a significantly negative impact on the leopard cat occurrences. These results confirm that leopard cat is able to survive in modified landscape and it even appeared to benefit from the opening of forests following logging activities but for other species, the effect might be different.

ABSTRAK

Kucing batu (Prionailurus bengalensis) merupakan spesies kucing yang paling biasa di jumpai di Borneo dan Asia Tenggara. Walaupun sering dianggap sebagai mampu menyesuaikan diri dengan baik untuk hidup di habitat yang terganggu dan seringkali dilihat di hutan-hutan sekunder dan ladang-ladang, tetapi sangat sedikit diketahui berkenaan spesies ini di habitat semulajadinya. Dengan menggunakan kamera perangkap digital, kajian ini dilaksanakan ke atas populasi kucing batu di tiga hutan simpan komersial yang terletak di Selatan-tengah, Sabah, Malaysia. Hutan-hutan simpan (HS) tersebut iaitu Hutan Simpan Deramakot, Hutan Simpan Tangkulap dan Hutan Simpan Segaliud Lokan telah diurus dibawah pendekatan pembalakan yang berbeza di masa lalu. Objektif kajian ini adalah untuk mengetahui ekologi kucing batu dengan penekanan khusus pada corak/pola aktiviti, keluasan kawasan keliarannya (home range) dan keutamaan habitat. Kajian ini juga memberikan anggaran kepadatan kucing batu yang pertama menggunakan sejumlah data yang besar dari perangkap kamera. Di HS Deramakot, sebanyak 23 individu yang berlainan telah dikenalpasti semasa 4 bulan tempoh pemasangan perangkap (47 stesen kamera, 1916 perangkap-hari). Di HS Tangkulap, 41 individu yang berlainan telah dikenal pasti (64 stesen kamera, 2302 perangkap-hari) dan di HS Segaliud Lokan, 60 individu telah dikenal pasti (55 stesen kamera, 2933 perangkap-hari) sewaktu tinjauan dilakukan. Di semua kawasan kajian, kucing batu jantan lebih kerap difotograf berbanding kucing batu betina. Kucing batu jantan juga dilihat mempunyai kawasan keliaran yang lebih luas dan bergerak lebih jauh berbanding betina. Anggaran kawasan keliaran minimum yang diperhatikan untuk individu yang mempunya > 3 tangkapan di lokasi kamera yang berbeza di HS Deramakot adalah dari julat 1.9 hingga 12.3 km^2 bagi lima ekor kucing batu jantan dan 0.4 hingga 7.5 km^2 bagi lima ekor kucing batu betina. Di Tangkulap FR, anggaran minimum kawasan keliaran yang diperhatikan bagi sembilan ekor kucing batu jantan adalah dari julat 1.2 hingga 26.4 km^2. Manakala di HS Segaliud Lokan, minimum kawasan keliaran yang diperhatikan untuk 12 ekor kucing batu jantan adalah dari julat 0.8 hingga 11.4 km^2 dan 0.3 hingga 1.9 km^2 bagi tiga ekor kucing batu betina. Kucing batu difotograf lebih kerap di atas jalan-jalan balak berbanding di denai-denai hutan dan pada waktu malam berbanding siang hari, mengesahkan kelakuan yang biasa diperhatikan pada spesies nokturnal. Model 'spatial explicit capture-recapture' (SECR) menganggarkan kepadatan kucing batu yang lebih tinggi di dua hutan simpan yang lebih terganggu; 16.50 ± 2.00 individu 100 km^{-2} di HS Segaliud Lokan dan 12.40 ± 1.61 individu 100 km^{-2} di HS Tangkulap berbanding di hutan yang diuruskan secara mapan - 9.56 ± 1.63 individu 100 km^{-2} di HS Deramakot. Model 'non-spatial' mungkin memberi anggaran yang berlebihan terhadap kepadatan kucing batu kerana ia tidak mengambil kira pergerakan binatang dan keputusan yang diperolehi sangat dipengaruhi oleh pemilihan keluasan penampan (separuh dari MMDM atau MMDM penuh). Oleh itu, anggaran kepadatan menggunakan model SECR lebih dipercayai and ia boleh diguna sebagai *maklumat rujukan untuk kepadatan kucing batu di hutan pengeluaran. Menggunakan pendekatan berdasarkan kependudukan (occupancy-based approach), faktor-faktor yang mempengaruhi kekerapan kucing batu dikenalpasti. Tiada satu model yang muncul sebagai model terbaik, tetapi litupan kanopi, nisbah pokok klimaks kepada pokok perintis dan nisbah pokok besar kepada pokok kecil mempunyai kesan negatif yang signifikan terhadap kekerapan kucing batu. Keputusan ini mengesahkan yang kucing batu mampu hidup di landskap yang diubahsuai dan ia juga seolah-olah mendapat manfaat daripada pembukaan hutan. Walau bagaimanapun, untuk haiwan lain, kesan ini mungkin berbeza.*

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LIST OF ABBREVIATIONS

AIC	Akaike's Information Criterion
AICc	Correction to Akaike's Information Criterion
ANOVA	Analysis of variance
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora.
ConCaSa	Conservation of Carnivores in Sabah.
CSL	Conventional selective logging.
DBH	Diameter at the breast height.
DFR	Deramakot Forest Reserve.
DNA	Deoxyribonucleic acid.
FR	Forest reserve
FSC	Forest Stewardship Council.
GTZ	German Agency for Technical Cooperation.
ITP	Industrial timber plantation
IUCN	International Union for Conservation of Nature.
IZW	Leibniz Institute for Zoo and Wildlife Research.
MCP	Minimum convex polygon.
MCMC	Markoc Chain Monte Carlo
MMDM	Mean maximum distance moved
MTCS	Malaysia Timber Certification Scheme.
rCP	Ratio of climax trees to pioneer trees
rDBH	Ratio of large trees to small trees
RIL	Reduced impact logging.
SECR	Spatially explicit capture-recapture.
SFD	Sabah Forestry Department.
SLFR	Segaliud Lokan Forest Reserve.
TFR	Tangkulap Forest Reserve.
Tukey's HSD	Tukey's Honestly significant differenced
USA	United States of America
UTM	Universal transverse Mercator.
WR	Wildlife Reserve.

WS	Wildlife Sanctuary.

LIST OF SYMBOLS

>	Greater than
<	Less than
≥	Greater than or equal to
≤	Less than or equal to
±	Plus or minus
Σ	Capital letter sigma
Ψ	Psi
	Estimate of psi (estimate of occupancy)
Λ	Lamda
ρ	Rho
	Estimate of rho (detection probability)
σ	Small letter sigma
%	Percentage
^{o}C	Degree Celsius
^{o}N	Degree North
^{o}S	Degree South
^{o}E	Degree East
^{o}W	Degree West
'	Minutes
ΔAICc	Delta of correction to Akaike's Information Criterion
A(W)	Effective trapping area
cm	Centimeter
D	Density
ha	Hectares
K	Number of parameters
km	Kilometer
km^2	Kilometer square
kg	Kilogram
m	Meter
m^3	Cubic meter

mm	Millimeter
n	Sample size
N	Population size
r	radius
RM	Malaysian Ringgit
tn	Trap night
TS	Trap success
US$	United States Dollar

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CHAPTER 1

INTRODUCTION

1.1 General introduction

The high value of tropical timber trees and the high demand of palm oil based products (Bateman *et al.,* 2010) has led to the conversion of large tracts of previously almost untouched forests to mainly oil palm plantations (Wilcove and Koh, 2010). The remaining forests are often fragmented and too small to harbour stable wildlife populations. Currently in Sabah, over 50% of the area is still covered by forests, however only about 15% of its forests are classified as totally protected include non-national park (McMorrow and Abdul Talip, 2001). The major remaining areas are classified as commercial forest reserves which are mainly for timber production. Although the importance of protected areas for wildlife conservation is undeniable, protected area systems alone cannot be considered as sole solution to guarantee the survival of wildlife because there are always limiting factors such as size, shape and placement of protected area as well as connectivity between protected areas (Fimbel *et al.,* 2001).

In Sabah, most of the protected areas are in mountainous regions in which lowland species cannot be found. The Tabin Wildlife Reserve and Kinabatangan Wildlife Sanctuary are the only protected lowland forest areas but both are now surrounded by oil palm plantations. The plantations could potentially limit the movement of animal, consequently putting more pressure on the survival of wildlife. For these reasons, the survival of many species in Sabah largely depends on the long-term sustainable management of the large commercial forest reserves. Therefore, an assessment of the extent to which wildlife can cope with anthropogenic changes to their habitat is of special interest. These forest reserves also provide connectivity to core protected areas which allow animals, especially large mammals such as elephant to move and travel from one protected area to forest reserves. This is essential for viable population size, gene flow and dispersal of individuals.

Malaysia is blessed with diverse carnivore species and they have an extremely important role in helping to maintaining the ecological balance of the forest. Due to their diet and spatial requirement, carnivores required large home ranges which result in low population densities (Sillero-Zubiri and Laurenson 2001). They are among the animal groups that are greatly affected when their pristine habitats are changed or altered by human activities (Sillero-Zubiri and Laurenson 2001), yet very little information is available on their survival in disturbed forests. Currently, the studies of carnivores in disturbed forests such as in logging areas mostly focus on the tiger (Linkie *et al.,* 2008; Rayan and Wan Mohamad, 2009) thus, leaving a noticeable gap in knowledge on other species, especially small carnivores. The main reason for this knowledge gap is that almost all species have a restricted distribution in tropical rainforests which, together with their secretive behaviour, makes them extremely difficult to monitor.

Small carnivores play significant roles within their habitats as predators and seed dispersers (Mudappa *et al.*, 2007). They also perform important tasks such as a controlling numbers of rodents and other small mammal communities. Thus, disturbance or alteration of small carnivore communities due to habitat disturbance can negatively impact ecosystem dynamics (Redford, 1992; Crook and Soule, 1999). Some small carnivores, particularly habitat generalist species such as civets and mongoose, are found to adapt well in moderately disturbed habitat (McShea *et al.* 2009). From the family Felidae, the leopard cat, *Prionailurus bengalensis,* is probably the only species that is found to be able to adapt to various habitat disturbance and lives in broad range of habitat types (Payne *et al.,* 1985; Lim, 1999). They are the most common felid species found in Asia and have a wide geographical distribution. Other than primary and secondary forests, leopard cats are also known to occur within agricultural plantations particularly oil palm and rubber estates (Lim and Omar, 1961; Rajaratnam *et al.,* 2007), in areas of shifting cultivation and villages (Santiapillai and Suprahman 1985), and in orchard plantations (Lim, 1999). However, in areas where habitat destruction or conversion is occurring, the population of all wild felids, including leopard cats is declining (Khan, 1986).

Despite the fact that they are very common species, only few studies that specifically focus on the leopard cat have been conducted. This is not surprising as smaller cats are less charismatic than the big cats and thus often receive little attention. Although there have been a number of behavioural and dietary studies carried out on leopard cats in captivity (Lim and Omar 1961; Lim, 1999), only one detailed field ecology study (Rajaratnam, 2000) has been conducted on leopard cat in the wild in Malaysia. Hence, there is still very little known about the leopard cat although it is a common species. The long-term threat of large scale habitat modifications is difficult to assess as occurrence and abundance of the species in the modified habitat remains unknown. In addition, information on population size, habitat preference, reproduction, home range, breeding behaviour and social organisation is among the most important, basic information needed to understand a particular species before sufficient effort to conserve them effectively can be made.

In this study, some of those basic parameters such as population size, habitat preference, home range and activity pattern were explored using camera-trapping method and data was analysed using the latest statistical analysis approach which is more robust compared to conventional method. More importantly, this study was carried out in commercial forest reserves which are or were managed under different forest management systems. Although many studies on logging effects on wildlife were published (Meijaard *et al.,* 2005; Meijaard and Sheil, 2008) but up to the present time, no detailed study on leopard cats has ever focussed in commercial forest reserves which are set aside for timber production. This is particularly important as a large proportion of forests in Sabah, and Borneo generally is production forests. This study will provide some insight into how leopard cats endure in disturbed forests and explores the potential of production forests as conservation areas for wildlife. It is expected that leopard cats are able to tolerate to moderate habitat disturbance level but it is still unknown how they will react to the more severe habitat disturbance.