



***LARGE SIZE MAMMAL SPECIES OF NORTH SELANGOR PEAT
SWAMP FOREST AND THEIR RESPONSE TO HABITAT QUALITY AND
ANTHROPOGENIC DISTURBANCES***

NURFATIN ADILA BINTI MD RASHID

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By

NURFATIN ADILA BINTI MD RASHID

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfillment of the Requirements for the Degree of
Master of Science**

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in
fulfilment of the requirement for the degree of Master of Science

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Malaysia's peat swamp forest is now disappearing at alarming rate due to deforestation. Tropical peat swamp forests of Peninsular Malaysia are one of the unique ecosystems that are currently being threatened primarily for agricultural expansion. Oil palm is the most demanding commercial crop in Southeast Asia especially in developing countries such as Malaysia. To determine the mammal species richness and the response toward its richness, a camera trap survey was conducted in the North Selangor Peat Swamp Forest (NSPSF), the last remaining peat swamp ecosystem on the western coast of Peninsular Malaysia. The research was initiated in May 2013 and ended in October 2014. I measured a total of 13 attributes of local level factors and landscape level factors to investigate the relationships between these factors and mammal species recorded by camera traps. Eight local level factors were accounted for the habitat quality measurement. These were number of saplings, number of trees (DBH: less than 45cm and more than 45cm), number of palmae species, number of fallen trees (DBH: less than 45cm and more than 45cm), canopy cover and canopy height. Meanwhile, five landscape level factors were the distances to river, road, oil palm land area, forest area and compositional heterogeneity. Throughout 45 camera traps deployed randomly in the forest area, 16 species of mammal were recorded in the NSPSF. The species obtained were classified according to feeding guilds and then analyzed in response to local and landscape level factors using Generalize Linear Models (GLMs). From 2565 trap nights, a total of 5046 photos were recorded excluding the blurry and out of focus photos. Asian Tapir (*Tapirus indicus*) recorded in this study was listed as

Endangered species under IUCN Red List. This study also documented the discovery of the Bearded Pig (*Sus Barbatus*) in the west coast region of Peninsular Malaysia in contrast to prior distribution studies of them. Result obtained for richness model explained the overall species richness increased significantly with areas located to the main road, palm oil plantation and areas with trees exceeding 45cm in diameter at breast height (DBH). These models also demonstrated a negative relationship with variables such as canopy height, number of sapling and distance to the river. The results also showed that the richness model according to the feeding guild has responded contrarily to local and landscape level factors. The current pressure on the NSPSF compelled the wildlife to survive on shrinking habitat that is already on the brink of extinction. The finding of the research also concludes that the existing wildlife may have adapted to the existing anthropogenic elements. However, it is crucial to monitor forest clearance and devise a mitigation plan such as forest gazettelement or creating an environment-friendly area for adjacent lands. It is vital to consistently monitor the forest biodiversity through long-term researches.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**MAMALIA BERSAIZ BESAR DI HUTAN PAYA GAMBUT UTARA
SELANGOR SERTA RESPON TERHADAP KUALITI HABITAT DAN
GANGGUAN ANTROPOGEN**

Oleh

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Hutan paya gambut di Malaysia semakin berkurangan pada tahap yang membimbangkan disebabkan oleh penebangan hutan. Hutan paya gambut tropika adalah salah satu ekosistem yang unik di mana ianya semakin diancam oleh pengembangan pertanian. Kelapa sawit kini adalah merupakan tanaman komersial yang paling mendapat permintaan yang tinggi di Asia Tenggara terutamanya di negara-negara yang membangun seperti Malaysia. Untuk menentukan kepelbagaian spesis mamalia berserta respon terhadapnya, satu kajian perangkap kamera di Hutan Paya Gambut Utara Selangor (NSPSF) dijalankan di mana hutan ini adalah ekosistem paya gambut terakhir yang terletak di persisiran timur Semenanjung Malaysia. Kajian ini bermula pada bulan Mei 2013 sehingga Oktober 2014. Sebanyak 13 atribut faktor setempat dan faktor landskap diambil kira untuk menyiasat hubungan antara faktor-faktor berikut dengan spesis mamalia yang direkod oleh perangkap kamera. Sebanyak lapan faktor-faktor setempat diambil kira meliputi pengukuran kualiti habitat yang ada. Ianya adalah seperti bilangan anak pokok, bilangan pokok (terbahagi kepada DBH : kurang dari 45cm dan lebih dari 45cm), litupan kanopi dan tinggi kanopi. Manakala bagi faktor-faktor landskap pula adalah seperti jarak ke sungai, jarak ke jalan, keluasan kawasan sawit berdekatan, litupan kawasan hutan dan juga komposisi heterogeiniti. Dari 45 perangkap kamera yang dipasang secara rawak di dalam kawasan hutan tersebut, sebanyak 16 spesis mamalia direkodkan di dalam NSPSF. Spesis yang berjaya diperolehi diklasifikasikan mengikut cara pemakanan dan dianalisa kepada hasil tindakbalasnya terhadap faktor-faktor setempat dan landskap menggunakan

Generalize Linear Models (GLMs). Dari 2565 malam perangkap, sebanyak 5046 foto-foto mamalia dicatatkan kecuali foto-foto kabur dan juga tidak lengkap. Tapir (*Tapirus indicus*) yang direkodkan di dalam kajian ini merupakan haiwan yang tersenarai sebagai spesis Terancam di bawah IUCN *Red List*. Kajian ini juga berjaya mendokumentasi penemuan babi janggut (*Sus barbatus*) di bahagian pantai barat semenanjung Malaysia yang mana berbeza dari taburan asal yang pernah dicatatkan. Kepelbagaian spesis didapati meningkat dengan ketara apabila kawasan kajian berdekatan dengan jalan dan kawasan penanaman kelapa sawit serta mempunyai pokok-pokok yang berdiameter melebihi 45cm (DBH) lebih besar. Keputusan yang menunjukkan hubungan negatif adalah ketinggian kanopi, bilangan anak pokok dan juga jarak ke sungai. Bagi pengelasan mengikut cara pemakanan, ianya memberi keputusan yang berlainan kepada faktor-faktor setempat dan landskap. Hasil dari kajian ini menyatakan bahawa hidupan liar dapat mengadaptasi kepada elemen-elemen anthropogenik yang ada. Bagi pengelasan mengikut cara pemakanan, ianya memberi respon yang berbeza kepada faktor-faktor setempat dan landskap. Tekanan semasa terhadap NSPSF memaksa haiwan-haiwan liar untuk hidup di dalam habitat yang kian mengecil di mana ianya sudah diancam kepupusan. Hasil dari kajian ini menyatakan bahawa hidupan liar dapat mengadaptasi kepada elemen-elemen anthropogenik yang ada. Namun begitu, adalah sangat penting untuk mengawasi pembukaan hutan yang berlaku dan juga menyediakan pelan tindakan bagi mengurangkan kesan selepas tempoh pembukaan hutan atau pengezatan kawasan hutan. Pada ketika ini, adalah menjadi satu kepentingan untuk memantau biodiversiti hutan secara konsisten melalui kajian yang berterusan.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

AIC	Akaike's Information Criterion
DBH	Diameter at Breast Height
<i>E. guineensis</i>	<i>Elaeis guineensis</i> . A palm species or known as African oil palm. It is a major source of oil for food and secondary industrial uses.
IUCN	International Union for Conservation of Nature
NSPSF	North Selangor Peat Swamp Forest
NGOs	Non-governmental Organization
RSPO	Roundtable on Sustainable Palm Oil

CHAPTER 1

INTRODUCTION

1.1 General Overview

Tropical rainforests sustain high diversity of flora and fauna species compared to other forest types in the world (Whitmore, 1990; Butler, 2006). It is home for nearly half of existing flora and fauna species in the world (Butler, 2006; Alonso et al., 2011). Rainforest supports high organism diversity and scientists are still discovering new species on an almost daily basis (Leete, 2006; Wetlands International, 2010; Posa et al., 2011; Alonso et al., 2011). These areas receive high amount of rainfall annually (Larsen and Simon, 1993; Jacobs, 2012) and experience hot and wet weather condition throughout the year (Walsh and Newberry, 1999; McKnight and Hess, 2000; Butler, 2006). Malaysia is listed as one of the mega biodiversity countries with these complex ecosystems and this has attracted many scientists to the country (Mittermeier et al., 1997; Mittermeier et al., 1999; Myers et al., 2000; Leete, 2006). From an ecological perspective, tropical rainforests in Malaysia can be classified into lowland dipterocarp forest, hill dipterocarp forest, upper hill dipterocarp forest, heath forest, montane forest, mangrove forest and peat swamp forest (WWF, n.d). Due to the complex structure of the rainforests, scientists believe that there are more species to be discovered in the tropical rainforests around the world (Leete, 2006; Wetlands International, 2010).

Located close to the equator with vast array of flora and fauna species, Malaysia listed as top 12 biodiversity country in the globe (Mcneely et al., 1990; Myers, 1990; Gaston et al., 1995; Mittermeier et al., 1998; Butler, 2006; Mace et al., 2010). Known as a mega biodiversity country, Malaysia has over 15000 species of flowering plants, 1500 species of terrestrial vertebrates and about 150,000 species of invertebrates which were estimated to cover about 20% of the world's animal species (Myers et al., 2000; Brooks et al., 2002; WWF, n.d). Regarded as a developing nation with increasing human population, deforestation takes part as one of the country's major problems. Land modification such as residential developments, agricultural activities and other land conversion activities critically affected the rate of forest loss (Koh and Wilcove, 2008). These cause damages contributing a major source for the forest loss and fragmentation, which then affecting the biodiversity (Primack, 2001; Kerr and Deguise, 2004).

Since listed as a megabiodiversity region, Malaysia was facing rapid forest loss by 1980's (Archard et al., 2002; Brooks et al., 2002; Sodhi et al., 2004). Prior to deforestation for agricultural expansion, logging was the primary factor for forest disturbances in most of Malaysia's forest landscape. To date, most of state governments seized logging activities and restructured their administrative frameworks to control forest loss from these activities (Currey et al., 2001; Wilcove et al., 2013). Many logged forests declared as protected areas as they play an important role to the indigenous people and also serves as tourism hotspots (Nepal, 2002). In recent years, Tilman et al. (2001) predicted agriculture-based expansion poses a serious threat to forest and other natural ecosystems in the next 50 years. These are related to the rise of food industry and biodiesel, a cheaper alternative to diesel (Fulton et al., 2004; Laurance, 2007b; Koh and Ghazoul, 2008; Laurance et al., 2009). Oil palm cultivation continue to expand everyday despite this activity is being considered as a serious threat to the tropical biodiversity (Rudel et al., 2009; Sodhi et al., 2004; Sodhi and Brook, 2006; Koh and Wilcove, 2007) and it has become a key driver of tropical peat swamp forest clearance (Carlson et al., 2012).

Peat swamp forest plays a fundamental role in reducing carbon dioxide emission globally and carbon dioxide stability are often associated with climate change (Page et al., 2004; Jeanicke et al., 2008; Gorte and Sheikh, 2010). Described as one of the largest terrestrial carbon stores on Earth, it has been a focal point for researchers to conduct studies on the importance of peat swamp (Jauhiainen et al., 2005; Rydin and Jeglum, 2006; Posa et al., 2011). Apart from these carbon storage functions, tropical peat swamp forest comprises a wide variety of flora and fauna that need to be studied in depth, despite the unfavorable terrain condition (Gorte and Sheikh, 2010; Posa et al., 2011). The timber and non-timber products in the peat swamp forest were claimed to be valuable natural resources to the country as there are demands, locally and globally (Posa et al., 2011; Parish et al., 2014). Peat swamp forest has high soil acidity and low rate of bacterial activities in decomposing forest litter (Andriessse, 1988; Yule and Gomez, 2008) thus adding the uniqueness of peat swamps. The production of food, pulp and biofuels further exploits the vulnerability of targeted areas for cultivation (Wetlands International, 2010; Posa et al., 2011). Most cases involving peat swamps were considered non-arguable as peat components were perceived as being problematic and less profitable (Andriessse, 1998). This has led to the large scale forest conversion for oil palm cultivation in line to the rising demands for palm oil related products (Butler and Laurance, 2009; Koh et al., 2009; Wetlands International, 2010). As the peat area is considered as low value forest, it has become more vulnerable to be converted to the other land uses such as residential development (Rijksen and Peerson, 1991; Wetlands International, 2010; Posa et al., 2011).

1.2 Justification

The world biodiversity is currently facing a great threat on its forests where deforestation and forest degradation causes severe effects on biodiversity (Kinnaird et al., 2003; Sodhi et al., 2004; Laurance, 2007a; Fitzberbert et al., 2008; Wilcove and Koh, 2010; Savilaakso et al., 2014). With an annual deforestation of 2 million hectares per year from 2000-2010 (FAO, 2010), existence of many plant and animal species are endangered (Wilcove et al., 2013).

The North Selangor Peat Swamp Forest (NSPSF) is in a crucial state as the forest is being threatened by aggressive oil palm expansion, logging, forest fire and road construction (Page et al., 2009; Posa et al., 2011; Azhar et al., 2011; Parish, 2014). The NSPSF encompasses the suitable land to grow oil palm (*Elaeis guineensis*) solely due to the demand of local agencies for the purpose of oil palm-related profits (Basiron, 2007; Koh et al., 2009; Koh et al., 2011). The NSPSF forested area had been logged before and the activities ceased early 1980's (Parish et al., 2014; Selangor Forestry Department, 2014). Despite the logging moratorium, there are still parts of the forest area being cleared for oil palm cultivation (Parish et al., 2014).

In Southeast Asia, the tropical peat swamp areas are now facing the most extreme and vicious forest fires, according to weather patterns (Van der Werf, 2010; Posa et al., 2011; Miettinen et al., 2011; Gunawan et al., 2012; Parish et al., 2014). In addition, wind disturbance lead the rapid spreading of fire causing severe air pollution (Gunawan et al., 2012). In the NSPSF, there was series of slash and burn agriculture practices occur among settlements and villages adjacent to the forest area (Parish et al., 2014). The fire resulted serious smoke-haze which has a huge impact on public health and economy (Hirano et al., 2012; Parish et al., 2014; Selangor Forestry Department, 2014). Besides the fire threat, NSPSF is also jeopardized by new road construction such as the highway from Ijok to Teluk Intan which located near the forest area (Selangor Forestry Department, 2014). Over the years, habitat fragmentation and shrinkage have degraded the remaining forest to a level where it can no longer support viable population of threatened species (Sodhi et al., 2009; Posa et al., 2011; Gibson et al., 2011; Wilcove et al., 2013; Newbold et al., 2015).

The NSPSF was once being logged over for its valuable timber such as the Ramin tree (*Gonystylus bancanus*) (Yule, 2009; Posa et al., 2011; Parish et al., 2014). The previous intensive logging activities signified the low opportunities of discovering Ramin tree nowadays (Posa et al., 2011). Following intensive deforestation, scientists highlighted the importance of NSPSF encompassing

rare species of flora and fauna species located as an isolated forest of the Westcoast of Peninsular Malaysia (Parish et al., 2014). The forest also has not been fully explored and its biodiversity data has not been updated due to the lack of research interest. For an example, black water fish studies showed that NSPSF is the home of rare species of certain endemic fishes but there is no follow-up study to this matter (Ng et al., 1992).

1.3 Research Aims and Objectives

This study aimed to determine mammal species richness in the NSPSF and to investigate the influence of anthropogenic factors such as logging and oil palm expansion on species richness. Our objectives in this study were:

- a) To determine mammal species richness in the NSPSF using camera trapping method.
- b) To examine the relationships between local and landscape level factors with mammals species richness in the NSPSF.

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