

**RELATIVE ABUNDANCE, ACTIVITY
PATTERNS AND HABITAT USE OF THE ASIAN
ELEPHANTS IN THE BELUM-TEMENGOR
FOREST COMPLEX, PERAK**

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FOREST COMPLEX, PERAK**

by

ELANGKUMARAN A/L SAGTIA SIWAN

**Thesis submitted for the fulfilment of the requirements
for the degree of
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TABLE OF CONTENTS

ACKNOWLEDGEMENT.....	ii
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF PLATES	xi
LIST OF SYMBOLS AND ABBREVIATIONS.....	xii
ABSTRAK	xiv
ABSTRACT	xvi
CHAPTER 1 – INTRODUCTION	1
1.1 Asian elephant.....	1
1.2 Rational of study	3
1.3 Aim of the study.....	6
1.4 Objectives	6
1.5 Expected results	6

1.6	Flow Chart	8
1.7	Assumptions and challenges	9
CHAPTER 2 – LITERATURE REVIEW		11
2.1	Asian elephant: Taxonomy and Morphology	11
2.2	Ecological significance of Asian elephant	14
2.3	Global distribution of Asian elephant	15
2.4	Global population of Asian elephant	20
2.5	Global threats to Asian elephant	20
2.6	Distribution in Peninsular Malaysia.....	22
2.7	Population in Peninsular Malaysia.....	26
2.8	Threats in Peninsular Malaysia	29
2.9	Conservation efforts in Peninsular Malaysia	30
2.10	Asian elephant habitat use	32
	2.10.1 Definition: Habitat use and modelling	32
	2.10.2 Analytical method from similar studies	33

2.10.3 Application in conservation.....	41
CHAPTER 3 - METHODOLOGY	46
3.1 Study area.....	46
3.2 Study design.....	52
3.2.1 Sign survey.....	56
3.2.2 Camera-trapping.....	58
3.3 Data organisation	59
3.3.1 Sign survey data organisation	59
3.3.2 Camera trap data organisation.....	60
3.3.3 Habitat covariates.....	62
3.3.4 Sampling effort covariates	64
3.3.5 Datasheet for analysis	65
3.4 Predicted habitat use map	67
3.5 Develop conservation recommendations	69

CHAPTER 4 – RESULTS	70
4.1 General results	70
4.2 Relative Abundance Index	71
4.3 Activity patterns and class	71
4.3.1 Activity patterns	71
4.3.2 Activity class	73
4.4 Habitat use	74
4.4.1 First step: Detection probability	74
4.4.2 Second step: Probability of habitat use	75
4.5 Predicted habitat use map	76
4.6 Explore conservation recommendations	79
CHAPTER 5 – DISCUSSION	81
5.1 Relative abundance in BTFC	82
5.2 Activity patterns and class	86
5.3 Asian elephant habitat use	89

5.4	Synthesis from habitat use studies	92
5.5	Explored aspects of conservation recommendations	100
5.5.1	Limitations and future study recommendations.....	100
5.5.2	Habitat management for Asian elephants	100
5.5.3	Protection of Asian elephants.....	102
CHAPTER 6 – CONCLUSION AND RECOMMENDATIONS		105
6.1	Conclusion	105
6.2	Recommendations.....	107
6.3	Succinct conservation recommendations.....	114
REFERENCES		115
APPENDICES		

LIST OF TABLES

	Page
Table 2.1 Population estimates of Asian elephants in Peninsular Malaysia from previous studies.	28
Table 4.1 Summary of sampling period and efforts for Asian elephant habitat use using sign survey and camera trapping	70
Table 4.2 Relative abundance Index values generated from camera trap	71
Table 4.3 BTFC Asian elephant detection probability (p)	74
Table 4.4 Models with less than two delta AICc value	76
Table 5.1 Summary of camera trapping studies used for comparison in terms of RAI.	85

LIST OF FIGURES

	Page
Figure 1.1 Flow of research	9
Figure 3.1 Location of Belum-Temengor Forest Complex and forest blocks within it	47
Figure 3.2 Location of study blocks and camera traps in both TFR and RBSP	54
Figure 4.1 Activity class of Asian elephants in TFR and RBSP shows cathemeral class	73
Figure 4.2 Predicted habitat use intensity of Asian elephant within BTFC	78
Figure 6.1 Proposed riparian buffer zone for Asian elephant protection	109
Figure 6.2 Proposed locations for roadblocks	112

LIST OF PLATES

	Page
Plate 2.1 Death elephant found at Rancangan Penempatan Semula Air Banun, Gerik, within Belum-Temengor Forest Complex	30
Plate 3.1 A bull sighted along Sg. Perak in RBSP	56

LIST OF SYMBOLS AND ABBREVIATIONS

km	kilometer
p	p-value
km ²	kilometer square
RBSP	Royal Belum State Park
TFR	Temengor Forest Reserve
HEC	Human Elephant Conflict
NECAP	National Elephant Conservation Action Plan
DWNP	Department of Wildlife and National Park
DNA	Deoxyribonucleic acid
BTFC	Belum-Temengor Forest Complex
BFR	Banding Forest Reserve
AFR	Amanjaya Forest Reserve
m	meter
a.s.l.	above sea level
MNS	Malaysian Nature Society
WCS	Wildlife Conservation Society
WWF	World Wildlife Fund for Nature
cm	centimeter
RAI	Relative Abundance Index
%	Percentage
p.	page

pp.	paper presentation
GPS	Global Positioning System
NDVI	Normalized Difference Vegetation Index
Dist	Distance trekked
TN	Trap Night
GIS	Geographic Information System
ψ	Probability of occupancy/use
\hat{c}	c-hat
hrs	hours
AIC	Akaike Information Criteria
AICc	Akaike Information Criteria small sample correction
ΔAIC	Delta Akaike Information Criteria
e.g.	example give
i.e	that is

**KELIMPAHAN RELATIF, CORAK AKTIVITI DAN PENGGUNAAN
HABITAT OLEH GAJAH ASIA DI KOMPLEKS HUTAN BELUM-
TEMENGOR, PERAK**

ABSTRAK

Ekologi gajah Asia (*Elephas maximus*) di hutan tropika Semenanjung Malaysia tidak dikaji secukupnya walaupun ia merupakan spesis “flagship” yang ikonik di rantau ini. Diklasifikasi sebagai terancam di bawah *IUCN Red List of Threatened Species*, sebanyak 1,223-1,677 gajah Asia liar dianggarkan di Semenanjung Malaysia, yang menghadapi pelbagai ancaman dari fragmentasi, degradasi and penukaran habitat serta konflik gajah manusia, kemalangan jalan raya dan pemburuan haram. Kamera perangkap (21, 263 malam perangkap) and survey kesan tidak langsung (2665 km jarak) telah digunakan untuk menilai kelimpahan relatif, corak aktiviti dan penggunaan habitat oleh gajah Asia di kawasan keutamaan pemuliharaan gajah di Semenanjung Malaysia; Kompleks Hutan Belum-Temengor. Kelimpahan relatif keseluruhan menunjukkan nilai 2.13 ± 0.48 . Corak aktiviti gajah Asia didapati “cathemeral” dan berbeza secara ketara ($W=44.50$, $p=0.040$) pada waktu siang di antara dua kawasan di dalam kompleks hutan; Taman Negeri Royal Belum (hutan primer) dan Hutan Simpan Kekal Temengor (hutan sekunder). Penggunaan habitat oleh gajah Asia secara umumnya menunjukkan kepentingan kesan bergabung oleh sungai dan kawasan hutan yang kurang kepadatan tutupan vegetasi. Secara am, kesan bergabung ini kemungkinan besar mencerminkan habitat riparian. Ciri ini lebih ketara di hutan yang

sudah dibalak akibat tumbuhan sekunder yang tumbuh di sepanjang rangkaian sungai seperti yang divisualkan dalam jangkaan penggunaan habitat oleh gajah Asia di Kompleks Hutan Belum-Temengor. Oleh itu, habitat riparian dan hutan yang telah dibalak tidak patut ditukar kepada guna tanah yang lain tanpa mengambil kira impak terhadap taburan gajah Asia di lanskap tersebut.

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ABSTRACT

The ecology of Asian elephants (*Elephas maximus*) in the tropical forests of Peninsular Malaysia inadequately studied, even though it is an iconic flagship species for the region. Classified as endangered under the IUCN Red List of Threatened Species, a total of 1,223-1,677 wild Asian elephants estimated in Peninsular Malaysia, which are facing various threats from habitat fragmentation, degradation and conversion as well as human elephant conflict, roadkill and poaching. Camera trapping (21, 263 trap nights) and sign survey (2665 km distant) were used to assess relative abundance, activity patterns and habitat use of Asian elephants within priority area for elephant conservation in Peninsular Malaysia; Belum-Temengor Forest Complex. The overall relative abundance index found to be 2.13 ± 0.48 . The activity patterns of the Asian elephants was found to be cathemeral and significantly different ($W=44.50$, $p=0.040$) only during the daytime between two sites within the forest complex; Royal Belum State Park (a primary forest) and Temengor Forest Reserve (a secondary forest). The habitat use of Asian elephants broadly indicates the importance of the combined effect of rivers and patches of forest that are less dense in vegetative cover. In general, this combined effect is likely to reflect riparian habitats. This feature likely becomes predominant in logged-over forests due to the secondary

growth along networks of rivers as visualized by predicted habitat use of Asian elephants in Belum-Temengor Forest Complex. Therefore, crucial recommendation from this study is to gazette riparian habitats in Belum Temengor Forest Complex for protection from any other land use with a buffer of 1.5 km on each side of the main rivers. The study also recommends that the logged over forest should not be converted to other land uses without taking into account its impact on Asian elephants distribution within this landscape.

CHAPTER 1

INTRODUCTION

1.1 Asian elephant

Listed as Endangered under the IUCN Red List (Choudhury et al., 2008), the Asian elephant (*Elephas maximus*) is one of the few animals celebrated in the Asian region as a cultural symbol among Asian people (Varma, 2006) and has an important historical role in religion throughout the region (Santiapillai & Jackson, 1990). Vedic religions such as Hinduism and Buddhism hold elephant as one of the important figure in their belief system. It is also been given enormous respect in Indo-China region, primarily because of Hindu-Buddhist influence.

In Burmese astrology method *Mahabote*, elephant considered as one of the zodiac. In this zodiac, it has details pertaining tusked and tuskless elephants according to planetary influence (Htin, 1962). This shows the importance of elephants in Burmese culture. Asian elephants are also an important arsenal in wars (Glaize, 2003). The use of war elephants been described in many historical and mythological records.

Thailand celebrates Royal Thai Armed Forces day on January 18th to commemorate the victory of King Naresuan the Great in battle against the vice-king of Burma in 1593. In this battle, both party used war elephants. (“The History,” December 2014).

The Asian elephant has been recognized in the conservation field as an umbrella, keystone, and flagship species due to their large ranging areas, importance in ecological roles and their impact on the environment (Choudhury et al., 2008). Smaller than its African counterpart, the Asian elephant is taxonomically divided into three subspecies; *Elephas maximus indicus*, *Elephas maximus maximus*, and *Elephas maximus sumatranus* (Shoshani & Eisenberg, 1982). Interestingly, Lydekker mentioned *Elephas maximus hirsutus* to be a subspecies unique to Peninsular Malaysia (Lydekker, 1914). This designation was based on morphological characteristic alone. However, this has not been accepted and applied in mainstream Asian elephant publications.

In recent years, the Asian elephant population in Borneo has been classified as a separate evolutionary significant unit based on their mitochondrial DNA (Fernando et al., 2003). Thus, with the addition of this new subspecies (*Elephas maximus borneensis*), a total of four subspecies currently exists in Asia (Alfred et al., 2010). For the purpose of this research, elephants found in Peninsular Malaysia are referred to as *Elephas maximus indicus*.

Asian elephants were once distributed from West Asia to East and South East Asia covering over 9 million km² (Sukumar, 2003), but currently only occur across 13 countries (Kemf & Santiapillai, 2000; Sukumar, 2003; Blake & Hedges, 2004) covering 878,639 km² (Hedges et al., 2009). A decade ago, a global population of 41,410-52,345 Asian elephants has been estimated (Sukumar, 2003).

However, Blakes and Hedges (2004) as well as Hedges (2006) argued that these estimates are no more than a rough guess. Even the likely distribution and the very existence of the Asian elephant's range in some of the areas are still questionable. Recent studies using dung count surveys have revealed Malaysia could be the country that has the largest known population of pachyderms among the South East Asian countries (Wildlife Conservation Society, 2009).

1.2 Rational of study

Globally reduced by distribution and numbers, there is an urge for conservation action for this species. In general, there is a lack of ecological information from robust scientific study on the distribution and the population for Asian elephants in Peninsular Malaysia, largely due to lack of resources to conduct rigorous survey. (Khan, 1991; Salman et al., 2011; DWNP, 2013). Under the new National Elephant Conservation

Action Plan (NECAP) three main landscape been identified as priority area for Asian elephant conservation (Belum-Temengor Forest Complex, Taman Negara, Endau-Rompin Complex).

With some ecological studies on Asian elephants had taken place in Taman Negara and Endau Rompin National Park (DWNP, 2013), there is a clear need to get ecological information on this large mammal in Belum-Temengor Forest Complex. Recent studies from Management and Ecology of Malaysian Elephant (MEME) attempts to obtain ecological information such as elephant's impact on the forest structure and biodiversity, effect of translocation on wild elephants, translocated elephant movement (Ning et al., 2016), farmer's perception and attitude towards government's mitigation pertaining elephant via electric fencing (Ponnusamy et al., 2016) have contributed towards improving knowledge towards Asia elephant conservation.

The most relatable occupancy framework based study was on historic elephant distribution that address human dominated areas (Tan, 2017). However, the habitat use of Asian elephants in two of the largest forest blocks within this landscape remain uninvestigated. As a developing nation, competition for agricultural use of land have resulted in Human Elephant Conflict (HEC). Many conflict elephants translocated to forested areas far away from human-dominated landscapes in order to resolve HEC.

One such area is Royal Belum State Park (RBSP), which is part of the Belum-Temengor Forest Complex (Salman & Nasharuddin, 2006). With the current issues of habitat degradation, forest conversion and HEC, the knowledge of Asian elephant ecology in Belum-Temengor Forest Complex becomes extremely crucial for its conservation.

The future of Asian elephant conservation relies on different ecological studies, one of which is resource and habitat utilization (Fernando et al., 2004), which is lacking in Belum-Temengor Forest Complex. In the absence of spatial occurrence and the habitat use of Asian elephants within Belum-Temengor Forest Complex, a comprehensive study on these ecological parameters will not only add to the crucial information about the species for its conservation, it could also be useful in the mitigation of HEC by applying good land use planning.

Apart from that, this study will be in line with fulfilling activities under the NECAP as well as to highlight the conservation value of this landscape. Ultimately, this study aim to predict habitat use for Asian elephants in Belum-Temengor Forest Complex which will help in identification of potential habitat sites that need to be protected.

1.3 Aim of the study

The aim of this study is to increase the ecological knowledge on Asian elephants in order to aid the conservation of the species in Peninsular Malaysia, particularly within Belum-Temengor Forest Complex.

1.4 Objectives

1. To investigate on the relative abundance, activity patterns of Asian elephants.
2. To investigate factors that influence the habitat use of Asian elephants within TFR and RBSP.
3. To identify critical areas for Asian elephant within the Belum-Temengor Forest Complex by creating a habitat suitability map.
4. To explore conservation recommendations to reduce threats to Asian elephants within Belum-Temengor Forest Complex.

1.5 Expected results

The relative abundance of Asian elephant in Temengor Forest Reserve and Royal Belum State Park expected to be different between RBSP and TFR. This is due to the logging activities and subsequent human disturbance to the habitat. Asian elephants reported to be cathemeral hence similar result expected to be observed in the study area.

The habitat use of Asian elephants is likely to be different in the two study sites due to the nature of the forest stand; consisting of primary forest (in Royal Belum State Park) and secondary forest (in Temengor Forest Reserve). Disturbance of natural forests due to logging would create secondary undergrowth that could also be used by elephant for browsing. According to Weerakon *et al.*, (2004), disturbed habitat was said to be a preferred habitat for elephants in Sri Lanka.

Observations from DWNP also support this finding (Salman & Nasharuddin, 2006). This scenario is likely to be seen in Temengor Forest Reserve (TFR) since it is a logged-over forest and logging is still active and was during the study. On the other hand, it is known that elephants prefer lowlands (Alfred *et al.*, 2006; Salman & Nasharuddin, 2006; Gopala, *et al.*, 2013) and gentle hills (Alfred *et al.*, 2006; Gopala, *et al.*, 2013) and these features are more prominent in Royal Belum State Park (RBSP) compared to TFR.

In Sabah, elephants were found to be more frequently present in lowland forest with flat ground or gentle slopes, below 400 m a.s.l., most of which is secondary forest (Alfred et al., 2006). Hence, a combination of availability of lower land and gentle hills coupled with disturbed vegetation are expected to be the likely factors that would influence the habitat use of Asian elephant in Belum-Temengor Forest Complex. Conservation recommendations expected to be focused on management of areas highly used by Asian elephants.

1.6 Flow Chart

The aim of the study is to promote elephant conservation in the Belum-Temengor Forest Complex based on scientifically derived conservation recommendations. The prime ecological factor targeted to be assessed in this study is the habitat use Asian elephant via occupancy framework whereby presence or absence (presence-absence) of the species in the sampling units laid across the study block to investigate against habitat features in order to find out what ecological factors affect utilization of an area by the Asian elephants.

In order to achieve this, rigorous sampling carried out to obtain presence-absence data for Asian elephants over a period of 17 months covering 560 km² area via camera trapping and sign surveys. Presence-absence of the species in a sampling unit tested for any relationship with ecological factors via statistical modelling. Best available habitat use model were further explored for conservation recommendations.

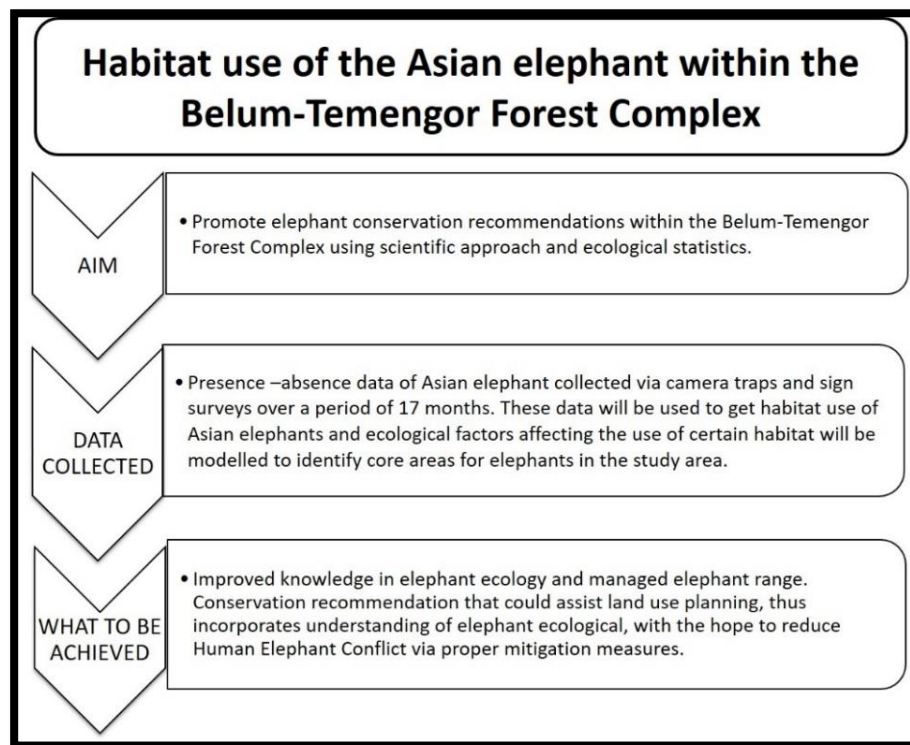


Figure 1.1 Flow of research

1.7 Assumptions and challenges

The assumptions in the framework of occupancy study is that there are no misidentification of Asian elephants especially no false presence in a sampling unit. The detections are also assumed to be independent from one sampling unit to another. This study have closure assumptions whereby occupancy status of a species does not change over the survey season. The individual animal may go in and out of the area of interest. Another assumption is that the probability of occupancy is constant across the sites and differences (if any) modelled using covariates. There is no unmodelled heterogeneity for default model (Mackenzie et al., 2006a).

Among the challenges in this study is to ensure signs of elephants collected were not more than about 1 month old. This is especially a challenge for elephant tracks which may last very long in the forest. Another challenge is spatial independence of a detection in a sampling unit in relation to its adjacent sampling units. Other challenges includes logistics and resource constraints, which result in extended stay in the forest to complete sampling.

CHAPTER 2

LITERATURE REVIEW

2.1 Asian elephant: Taxonomy and Morphology

Taxonomically Asian elephant falls under the Order Proboscidea and there are only two extant species under this order i.e. *Elephas* sp. and *Loxodonta* sp.. Formerly, these groups of large mammals were more diverse but many extinct during and since the Pleistocene period (Corbett & Hill, 1992). Asian elephant placed under Family Elephantidae, under the Genus *Elephas* (Francis, 2008). Originally described as *Elephas maximus* (Linnaeus, 1758), this Asian elephant were subjected to many suggestions by Blumenbach, (1797), Cuvier (1798), and Temminck (1847) (Shoshani & Eisenberg, 1982).

However, the original description i.e. *Elephas maximus* Linnaeus, 1758 have been largely accepted. Under *Elephas maximus*, three subspecies were recognized by Shoshani and Eisenberg (1982). This recognition was based on Chasen (1940) which concluded that elephant subspecies named as *Elephas maximus indicus* Cuvier, 1798,

Elephas maximus maximus Linnaeus, 1758, and *Elephas maximus sumtranus* Temminck, 1847 (Shoshani & Eisenberg, 1982). The long debated elephant subspecies of Borneo have been finally resolved via genetic analysis and accepted as the fourth subspecies (*Elephas maximus borneensis*) making altogether four subspecies listed under *Elephas maximus* (Fernando *et. al.*, 2003; Alfred *et al.*, 2010). This study deals with the mainland Asian elephant that is *Elephas maximus indicus*.

Morphologically, elephants are the largest terrestrial mammal that still exist on this planet weighing more than 1,000 kg (Owen-Smith, 1988). These mega herbivores divided into two groups: African elephant and Asian elephant. The main distinguishing character between these two are their size whereby Asian elephants are smaller than African (DWNP, 2013).

The Asian elephant shoulder height is about 1.5 to 3.0 m and weigh up to 5000kg (Francis, 2008). However, there are records of elephant with the height of 3.43 m (Shoshani & Eisenberg, 1982). A large bull in Sri Lanka reported to weigh 5400 kg (Shoshani & Eisenberg, 1982). Although the height and weight may vary, generally male elephants are larger than the females.

In terms of dentation, Asian elephants have two types of teeth. These are the cheek teeth and the iconic tusks. The tusks can be as long as two meters, usually only half of it are visible (Francis, 2008) and weigh up to 50 kg each but such records are hard to observe in recent days (DWNP, 2013). This feature of bearing tusks observed only in male Asian elephants. The females however have tushes, barely protrude beyond the jaw and usually not visible (Linnaeus, 1758; Medway, 1969; Francis, 2008; DWNP, 2013). Record of the tallest bull from early studies on elephants in Peninsular Malaysia comes from a 55 years old bull measured at three meters tall (Khan, 2012). The heaviest of all was a tuskless male, 6133 kg (Khan, 1991).

The tuskless male, are called *makhnas* in Tamil language (Biniwale, Jan 2015; Frontline, October 2015), and they are often bigger than the one with tusks (Kemf & Santiapillai, 2000). Elephant's trunk is a combination of nose and upper lip. This structure allow them to breath, locate scents, drink, and handle objects to extreme delicate and accuracy. Together with tusk, the elephant trunk also used in battles among them (Linnaeus, 1758). Their sense of smell and hearing are acute as oppose to the limited vision capacity. Elephants known to communicate using subsonic sound, which is beyond human hearing. This sound communicated as far as five kilometer in the forest (Jackson, 1990; Kemf & Santiapillai, 2000).

2.2 Ecological significance of Asian elephant

Ecological perspective of Asian elephant identifies the species' crucial role in maintaining the delicate ecosystem (Hazarika et al., 2008). Asian elephants are perfect example of umbrella species. The main criteria of such species is to have a large home range. Asian elephant home ranges are variable, depending on couple of environmental factors such as forest stand, human disturbance level, availability of food and water, sex (Alfred et al., 2012; DWNP, 2013) and in some places it is affected by seasonal change (Shoshani & Eisenberg, 1982; Sukumar 1989).

As an umbrella species, conservation of Asian elephant provides a larger benefit to many other wildlife and the habitat that they depend on (Choudhury et al., 2008). Asian elephant also serves as a flagship species, a charismatic species with high influence and huge fame, this species attain easy attention. Such criteria enables the species to be used for fund raising to aid conservation works. The ecology of Asian elephant is such that is often regarded as keystone species.

By definition, keystone species are that have effect disproportionately that its biomass (Paine, 1995). However, Fernando (2011) mentioned that there is a little evidence to show that Asian elephant serves as a keystone species in seasonally dry tropical forest. Asian elephants are deemed as gardeners in tropical rainforest (Campos-Arceiz et al., 2011) without equal match of existing mega-herbivores in Peninsular Malaysia for seed dispersal of megafaunal-syndrome plants (Campos-Arceiz et al., 2012).

This findings on Asian elephant in parallel to African forest elephant's role in seed dispersal, helping forest health and regeneration (Chapman et al, 1992; White et al., 1993; Blake, 2002). Based on these points, the conservation of Asian elephant is indeed significant for the ecology of many ecosystems, thus ensuring the survival of many species that depend on it, including human race.

2.3 Global distribution of Asian elephant

According to Olivier (1978), the historic range of Asian elephant stretched from the Tigris and Euphrates (45° East) in the west, east through Asia south of Himalaya and north into China at least as far as the Yangste Kiang (30° North) and probably further, covering an area more than nine million km² (Sukumar, 2003). Asian

elephant have been wiped out almost 90% from their historic range, leaving only 10% (DWNP, 2013) with which they are spread across 13 countries (Kemf & Santiapillai, 2000; Sukumar, 2003; Blake & Hedges, 2004).

According to Choudhury et al., 2008, the 13 countries are Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Sri Lanka, Thailand and Vietnam. In Bangladesh, Asian elephants are restricted to southeast and periodically presence in northeast of the country. The population from the northeast actually shares the neighbouring country India. Most of these areas spared to become elephant habitat due to some level of inaccessibility to human (Choudhury et al., 2008).

In Bhutan, the only area that the species roam are along the Bhutan-India border. The previous movement of the species between Bhutan and India blocked due to habitat loss and fragmentation (DWNP, 2013). In Cambodia, mountains of the southwest; Mondulkiri and Ratanakiri Provinces are stronghold for the species (Pollard et al., 2007). The rest of the Asian elephants in Cambodia exist in small and scattered populations (DWNP, 2013).

In China, this species suffered great extirpation, almost entirely wiped out from this vast land (Kemf & Santiapillai, 2000). This once widespread species in China now restricted to Yunnan Province only. Similar situation observed in India, except that the Asian elephant in India are now restricted to generally four large areas. These areas are the northeast, the central, the northwest and the southern of India. Although the species occur in four large areas, due to human pressure, the Asian elephants in India subjected to fragmented habitat, which leads to isolated population within these four large areas (Sukumar, 1989; DWNP, 2013).

Indonesian elephants are distributed in two different islands of Sumatra and Kalimantan. Sumatra houses *Elephas maximus sumatranus*, which have highly fragmented population, scattered throughout the island (Sukumar, 1989). Some places in Sumatra, the elephants are threatened by habitat loss, poaching due to human elephant conflict (Santiapillai & Jackson, 1990, Hedges et al., 2005).

Bukit Barisan Selatan located in the southern Sumatra identified as highly important area for Asian elephant conservation (DNWP, 2013). Pygmy elephant, *Elephas maximus borneensis* in the Indonesian part of Borneo Island mostly found in northeast Kalimantan. They are recorded to be found in the upper Sembakung river, under Tindung District (Sukumar, 1989; DWNP, 2013).

Laos formerly known as “Lane Xang” literally means the land of a million elephants (Olivier, 1978). Although the species is now widely spread over Laos People’s Democratic Republic, they are only sporadically distributed over the forest along the border of this country, ranging from highland to lowland (Sukumar, 1989; Kmf & Santiapillai, 2000; DWNP, 2013).

The distribution of Asian elephants in Myanmar are poorly known (DWNP, 2013). The species speculated to be widespread in Myanmar based on the forest cover, which is roughly 50% of the country (Kmf & Santiapillai, 2000). The highly fragmented distribution Asian elephants in Myanmar is attributed to five main areas for which are largely at the north and west hill ranges, central, east and the south of the country (Choudhury et al., 2008).

In Nepal, previously Asian elephants found in lowland Terai. In recent years, the distribution are reduced, and they are more likely to be found in the national parks and wildlife reserves of Nepal that borders India (Choudhury et al., 2008). In Sri Lanka, Asian elephant was once widespread. Now, the species are mostly restricted to dry zones of the country.

These are north, south, east, northwest, north central, and southeast of Sri Lanka. The only two wet zones housing Asian elephant in Sri Lanka are the Peak Wilderness Area and Sinharaja Area (Sukumar, 1989; DWNP, 2013). Progress in agriculture in lowlands led to isolation of elephant habitat, termed as “pocketed-herd” phenomenon (Olivier, 1977).

In Thailand, Asian elephants are abundant in mountains bordering Myanmar. The species also found in the southern forest complex bordering Malaysia. Several forest complexes and protected areas in the east and northeast of Thailand also house Asian elephants (Choudhury et al., 2008; DWNP, 2013). In Vietnam, very limited number of Asian elephant populations are sustaining.

In the past, the species distributed nearly throughout the borders of Vietnam with Laos People’s Democratic Republic and Cambodia. Drastic decrease in forest cover have resulted in reduction of the species’ range (Kemf & Santiapillai, 2000). Asian elephants are no longer present in the north of Vietnam, but this area occasionally receives wanderers from neighbouring country such as Lao People’s Democratic Republic Currently Asian elephants distributed in very small-isolated central and southern parts of Vietnam (Choudhury et al., 2008; DWNP, 2013).

2.4 Global population of Asian elephant

Previous global population estimate of Asian elephant subjected to multiple changes. This is largely due to lack thorough scientific research across the distribution of Asian elephants. Olivier estimated a total 28,000 – 42,000 of Asian elephants to exist in late 1970s (Olivier, 1978). In the 21st century a total of 41,410 – 52,345 Asian elephants were estimated (Sukumar, 2003) and this figures which has been regarded as a crude guess is in use for about 25 years (Blake & Hedges, 2004; Hedges, 2006).

Current estimate of Asian elephants are based recent findings from almost all 13 elephant range countries, except Thailand. The result shows that 39,463 – 47,427 Asian elephant to be found in their range (Fernando & Pastorini, 2011). Although the drop for the lower range is only 1,947 individuals since 2003, this recent findings suggest the population trend is indeed declining as what postulated in IUCN Red List for Asian elephants.

2.5 Global threats to Asian elephant

A common set of factors adversely affecting the population of elephants have been known throughout its range. These factors are habitat loss, degradation and fragmentation (Leimgruber et al., 2003; Sukumar, 2003; Hedges, 2006). These factors either singly or in combination have also been known to cause a cascading effect, which often leads to Human Elephant Conflict (HEC). Overall, these threats have isolated them within smaller provinces across Asian countries, likely to affect their long-term survival.

In addition to this, poaching also identified as another major threat to this species (Kemf & Santiapillai, 2000; Dublin et al., 2006; Choudhury et al., 2008). In recent years, major declines in population numbers have mainly been attributed to illegal killing of elephants due to either demand for ivory and body parts (Sukumar et al., 1998; Milliken, 2005) or through retaliatory killing via HEC cases (Sukumar, 1992, 2003; Hedges 2006).

General assumption on Asian elephant is that poaching is not a serious threat in relative to its African counterpart since the ivory trade strongly involves the African elephants. However, poaching on Asian elephant are not entirely to cater ivory market, but also other use such as bushmeat consumption, leather and traditional medicine. Asian elephant population could be more prone to effects due to ivory poaching since only male elephants have tusks. Continuous poaching on male tusker will result in

skewed population sex ratio with more female than male elephants. Such scenario have been recorded in different parts of elephant range such as India, Cambodia and Vietnam (Kemf & Santiapillai, 2000; Choudhury et al., 2008). Cases of Asian elephant skin turned into ornamental beads deemed crisis that could affect the species (Akpan, 2018).

2.6 Distribution in Peninsular Malaysia

Based on the literatures, it can be concluded that the distribution of Asian elephant throughout its range have been greatly reduced by human pressure. Similar case observed in Malaysia as well. In Malaysia, there are two species of Asian elephants. These are the mainland population in Peninsular Malaysia (*Elephas maximus indicus*) and the Bornean population in Sabah (*Elephas maximus borneensis*). In Sabah, Bornean elephants occurs in five key managed elephant ranges namely Tabin, Kinabatangan, Central Forest, North Kinabatangan and Ulu Kalumpang (Alfred et al., 2011). The Bornean elephant population estimated to be within the range of 1,184 to 3,652 individuals (Alfred et al., 2010). Central Forest range said to support more than 1,000 individuals whilst the other 4 ranges have less than 1,000 individuals (Alfred et al., 2011).

Literatures reviewed here are mostly from Peninsular Malaysia since this thesis is about the mainland population *Elephas maximus indicus*. Occasionally scientific findings from Bornean population are also included in later part of this thesis. There were no nationwide robust scientific assessment on Asian elephant distribution and many accounts derived from HEC records. Such reliance on HEC records as a proxy to report the species distribution data in official documents would lead to false indication of Asian elephant distribution (DWNP, 2013). Nevertheless, the distribution of the Asian elephant in Peninsular Malaysia reported to reduce over time, in tandem with the loss of their habitat.

According to Flower (1900), Asian elephants were once common everywhere in Peninsular Malaysia except in Penang (Olivier, 1978). Prehistoric Peninsular Malaysia fully covered by few types of natural forest (Salman et al., 2011) and ninety percent of forest was still dominating Peninsular Malaysia in early 1950s (FDTCP, 2007). In less than 60 years, forest cover in Peninsular Malaysia have been reduced to just 37.7% (Miettinen et al., 2011). Expansion of large agricultural scheme driven by the government economic policy has taken vast lowland forests from its existence. These lowland forests, which were once prime habitat for Asian elephants (Fernando, 1989), now replaced with oil palms and rubber trees (Wan, 1985).

A very large chunk of forest have disappeared from Peninsular Malaysia due to large agriculture land scheme. For instance, the oil palm plantations have expended to area more than 21,870 km² (Abdullah, 2003), an area larger than the Main Range: the hilly and mountainous forest that stretch from Malaysia-Thailand border to south, covering over five states in Peninsular Malaysia (DWNP, 2008).

This continuous permanent removal of Asian elephant habitat at an alarming rate of 400 km² annually (Blair, 1980) which lead by Federal Land Development Agency (FELDA) (Fernando, 1989) have undeniably reduced the distribution of Asian elephant in Peninsular Malaysia.

In a report compiled by Santiapillai and Jackson (1990) for the IUCN/SSC Elephant Conservation Action Plan, a reduction in the distribution of the Asian elephant highlighted. Among the main reason for their reduction is habitat loss, degradation as well as fragmentation (Santiapillai & Jackson, 1990)

According to this report, Asian elephants were recorded in nine states, namely Johor, Kedah, Kelantan, Negeri Sembilan, Pahang, Perak, Perlis, Selangor and Terengganu and absent in the state of Melaka. In 2006, the DWNP management plan for elephants in Peninsular Malaysia reported that elephants were absent in two more