The Republic of the Union of Myanmar

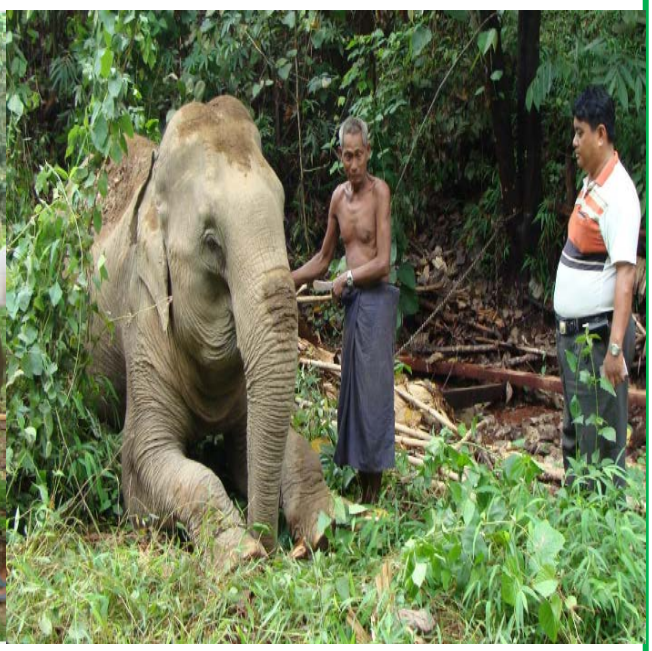
Ministry of Forestry

Forest Department

Taninthayi Nature Reserve Project

A Study on

Wild Elephant Density, Distribution, Its Correlated Ecological Factors and Threats in TNR



Submitted by

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ABSTRACT

The aims of this study were to determine the population density, distribution and its ecological factors of wild elephants in the Taninthayi Nature Reserve (TNR). With the rich natural resources, the domain habitat of wild elephants in TNR is still very good despite the loss of some fringe habitat area of the elephants due to deforestation and shifting cultivation.

The methods for estimation of the wild elephants were used as questionnaire surveys and also the methods of Dawson, 1991 and Rabinowitz, 1997. The results of present study show that four captive elephants the average defecation rate was 13.3 per 24 hour and the decay rate was 0.012 based on trial of 10 dung piles. The remaining wild elephants numbers were about minimum 45 to maximum 64 in 1601.30 km^2 (94.19%) of TNR area and its density and distribution of elephants from TNR was 0.087/ km^2 in high density strata (HDS), 0.029/ km^2in medium density strata (MDS) and 0.004/ km^2 in low density strata (LDS).

Wild elephants were not found in the more than 30% slope and above 1500 feet mountainous area where 98.70 km^2 (5.81%) total area of TNR. Most of the elephants are wandering in the steep sided valley as domain habitat which is between above sea level 220 to 650 feet of TNR in the dry season. Results indicated that the traditional or seasonal migration of wild elephants was from South Eastern to North Western direction in the dry season**.**

This study also found that 35 plant species were consumed by elephants as their food that preferred fodder are Banana (*Musa bakeri*), Wazun (*Neohauzeaua dulloa*), Gonnyinnwe (*Entada pursaetha*), Kadat U (*Diocorea sativa*) and Damyetsii Grass (*Triticum spp*) in the dry season. Moreover, the hot and warm mineral spring saltlicks were very important components of wild life conservation especially wild elephant health in TNR. The pitfall and keddah elephant capture method have high mortality level, minimum 35% to maximum 75% based on questionnaire interviews.

From the study, it is suggested that the major problem facing the wild elephant in TNR is uncontrolled increase of commercial hunting, illegal logging and poaching by local and foreign hunters. The capture of wild elephants for domestic use has become a threat to wild elephant populations where their numbers have been seriously reduced. The majority of people who capture these wild elephants in TNR are the Karen tribe. Wild elephants are not directly related to deforestation activities; however all domesticated elephants are causative factors of deforestation in TNR as logging was banned in TNR since 2005. Nowadays, there are no distinctive Human Elephant Conflict (HEC) cases in TNR. These facts can be integrated in the Operational Management plan in future.

This study concluded that the remaining wild elephants in TNR is at a critically low level compared to its habitat area and is declining gradually throughout most of their ranges. A total population of 45 - 64 wild elephants is present in 1601.30 km^2 in TNR. Consequently, there is an urgent need to conserve these numbers in TNR as a Trans-boundary issue is being enthusiastically negotiated with Thailand.

KEYWORDS: WILD ELEPHANT/ DENSITY/ DISTRIBUTION/ ELEPHANT FODDERS/ SALTLICKS/ POACHING/ SEASONAL MOVEMENT/ TANINTHAYI NATURE RESERVE (TNRP)

84 pages

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Hla Myo Aung

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LIST OF ABBREVIATIONS

Abbreviation or symbol	
AKNP	Alaungdaw Kathapa National Park
ASL	Above Sea Level
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
FD	Forest Department
GPS	Global Positioning System
HDS	High Density Stratum
HEC	Human Elephant Conflict
HWS	Htamanthi Wildlife Sanctuary
IUCN	International Union for Conservation of Nature
LDS	Low Density Stratum
LOUs	Local Operating Units
MDS	Medium Density Stratum
MGTC	Mottama Gas Transportation Company
MIKE	Mitigation of Illegal Killing Elephant
MOF	Ministry of Forestry
MSS	Myanmar Selection System
MTE	Myanma Timber Enterprise
OMP	Operational Management Plan
PAS	Protected Area System
RSLT	Reconnaissance Survey Line Transect
RS & GIS	Remote sensing and Global Information System
TEPM	Total E & P Myanmar
TPC	Tanintharyi Pipeline Company
TNR	Tanintharyi Nature Reserve
TNRP	Tanintharyi Nature Reserve Project
WWF	World wildlife Fund
WEFCOM	Western Forest Complex

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CHAPTER I
INTRODUCTION

1.1 Background

The Republic of The Union of Myanmar possesses flora and fauna of rich diversity and the country is facing with the loss of biodiversity primarily due to the socio-economic pressure. The general trend of wild animal protection seems to be apparently decreasing compared with their relative abundance over the past two or three decades ago.

However, conservation of soil, water, wildlife, biodiversity and the entire environment have been implemented in accordance with Myanmar Forest Policy, 1995, 36 Protected Area and 7 proposed Protected Area, constituting about 6.67% of the total area of the country have been established as Protected Areas System (PAS) (FD, 2010).

In order to create significant addition to both Myanmar's PAS and the regional protected areas network in Myanmar, the Mottama Gas Transportation Company (MGTC) and Taninthayi Pipeline Company (TPC) support funding for the establishment of long term operation of the Taninthayi Nature Reserve (TNR) by using the funds derived from the operation of MGTC and TPC gas production facilities. The main objective of the TNR, most likely as a Managed Nature Reserve is considered an essential part of Myanmar's PAS with planned, established and managed, using recognized international best practices, appropriately adapted to the Myanmar situations. The project also make sure the active participation and development of local people within and adjacent to the TNR with a funding period of 30 years (Project Document-TNRP, 2001).

In this context, the TNR has been legally declared in 2005 as a managed Nature Reserve to conserve pristine tropical rain forests and their constituent biodiversity in the Taninthayi region of the southern Myanmar. TNR is situated in Yebyu Township,

Dawei District in Tanintharyi Region, and includes part of Heinze-Kaleinaung forest (857.27 km^2) and Luwaing forest (842.72 km^2) (TNRP, 2007).

Myanmar has been acceded as a party to the Convention on International Trade in Endangered Species of World Fauna and Flora (CITES) since 1997. Myanmar also has the second largest population of world's remaining wild Asian elephants after India and the largest continuous area of natural habitat. One salient fact is that Myanmar is the only country using a large number of elephants in timber extraction and the Asian elephant is listed as Endangered under the International Union for Conservation of Nature (IUCN) Red List. The most well known among the wild animals of Myanmar is probably the elephant. The elephant is deeply interlinked with man in Myanmar not only due to the religious and cultural heritage but also play a key role in economic sector of the country's timber industry (Forest Department, 2005).

The wild elephant population was less than 4,000, widely distributed throughout 87 Townships in the whole country, except for the Dry Zone area (Myint Aung, 1994). At the same time the Nature and Wildlife Conservation Division in 1990-1991 had estimated the population as 4,639 which excluded Kayah State. Its major inhabit areas are Northern hills, the Yakhine Yoma, the Bago Yoma, the Taninthayi Yoma and Shan State of Myanmar (U Uga, 2000). In Myanmar, the elephant census was carried out at Alaungdaw Kathapa National Park (AKNP) in 1993 give number of elephants and the birth rate of captive elephants by means of artificial insemination by Washington Zoo in 1995 for their conservation. In addition to that, the conservation and management of elephant populations in AKNP and Htamanthi Wildlife Sanctuary (HWS) were surveyed by Smithsonian's National Zoo in 2001, while Monitoring the Illegal Killing of Elephants (MIKE) patrolling program in AKNP was carried out in 2006. Moreover, the first Elephant Sanctuary has already established in Yakhine Yoma 2000 and wild elephant population was estimated using DNA testing technology by Smithsonian Institute in 2006. Results with regard to distribution, wild elephants are found throughout Myanmar (Tun Aung & Thaung Nyunt, 2001). However accurate data on population distribution and abundance is difficult to find due to seasonal migration for forage and fodder during the changing seasons. Yet there are very rare appropriate studies being carried out and the data with

regard to wild elephant population distribution and abundance is not reliable (Henning, 2002).

In order to ensure reliable data and provide estimates on distribution of wild elephants in TNRP particularly for improvement of management plan in future, a short initial biological research was done in TNRP during the first week of March to end of June, 2011 so as to gain some initial information, pertaining to their density and distribution and correlated ecological survey in the TNR.

1.2 Statement of research

This year 2011, is the second four-year plan period for the management of the reserve. During the first four years period of TNRP, a considerable baseline data were collected on the biodiversity of TNR, at least for mammals, birds and plants. At the end of the first plan period, five species were listed as endangered and five as critically endangered. The endangered mammals include elephants, tigers, tapirs, gibbons, Asiatic black bears including sun bears (TNRP, 2010). The initial studies indicated that the status and current condition of globally threatened species at TNR need to be recorded and conserved systematically in order to determine key habitats, especially in the population size and information on periodic movement of large mammals along the trans-border of Thailand and Myanmar.

The problem facing the elephant and its ecosystem in the TNR is uncontrolled increase of human population and the demand on the natural resources for the needs of the population such as commercial hunting and plantations, shifting cultivation and illegal logging. Undue human population increase is threatening the abundance and distribution of crucial wild elephant and its habitats, disruption of traditional migratory routes and the practice of shifting cultivation have devastated habitats in the vicinity of TNR. Therefore the abovementioned facts depicted that, due to lack of reliable data on elephant population in TNR, research on population abundance and distribution of elephant and its ecology for elephant management is urgently needed.

1.3 Objectives of the study

The main purpose of the study is to study elephant abundance, distribution and ecology survey in the TNRP and to make recommendations for improvement where this is appropriate.

1. To determine the population abundance, distribution and ecology of wild elephants in the Taninthayi Nature Reserve (TNR).
2. To assist the long term management of the wild elephant population within TNR.
3. To provide reliable data of wild elephant to the TNR Project so as to assist future revisions of Operational Management Plan.
4. To make recommendations for future biological surveys of wild elephants in Myanmar.

1.4 Research area

1.4.1 Location, topography and climate

Tanintharyi Nature Reserve (TNR) lies between the Dawei river and Myanmar-Thailand international borders within the latitudinal range of N 14°20′50″ to 14°57′55″ and the longitudinal range of E 98° 5′10″ to 98° 31′32″. It is located under the jurisdictional boundaries of Yebyu Townships, Dawei District of the Tanintharyi Division, southern Myanmar (Anon., RS & GIS- FD, 2007).

The location of Tanintharyi Nature Reserve (TNR) with a total area of about 1700 km^2 was notified as a Nature Reserve in 2005. It stretches over some fractions of two Reserved Forests, namely, the Heinze-Kaleinaung and Luwaing Reserve. Most area around and inside TNR is undulating, ranging from 15 m to 1400 m above sea level at the ridge of Thailand border (RS & GIS-FD, 2007).

The mountain range is running from north to south while the slope rises almost west to east climbing to the ridge top and is oriented to the western aspect. The steep slope in most parts of the area is greater than 37%.The Dawei River flows from north to south more or less parallel with the western boundaries of TNR. Almost all eastern tributaries of the river originate in TNR. Ye-Dawei road, the main access road in the

area, runs in the narrow strip of plain along the river. It can be used almost all seasons, with some difficulties in the rainy season. At the northern parts of the area, the road runs in the west side but it passes through the river near Kaleinaung, and then runs on the east bank parallel again with the river in the south (TNRP, 2009).

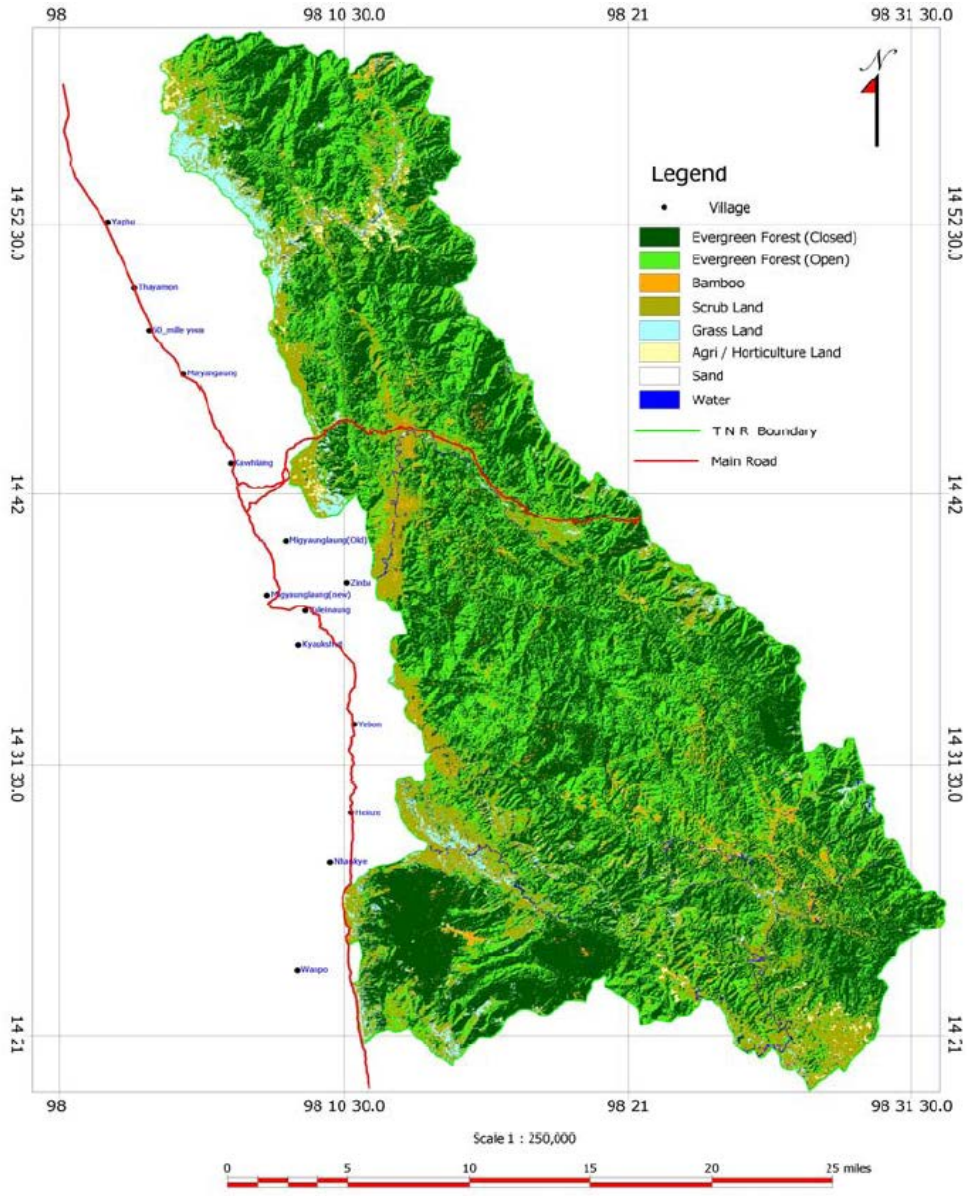

Figure 1.1 Location of Thaninthayi Nature Reserve Project Area

The areas around TNR have the seasonal and tropical monsoon climate with most abundant rainfall. According to the meteorological records of Dawei District, the average annual rainfall from 2001 to 2008 is 6,674 mm with about 145 rainy days

from May to October. The average annual temperature ranges between 25-28°C with the hottest month in March and the coldest in January (TNRP, 2009).

The soil type in the study site falls into the "yellow" at the high elevation and "red brown" in low land (Smith, 1926).

1.4.2 Demography

There is a long history of settlement around TNR and four ethnic groups (Kayin, Dawei, Mon and Bama) have now settled in the area. Kayin and Dawei tribes seem to be forerunners in the known history of settlement for more than 200 years. At present, Dawei are the most dominant ethnicity, representing about 40% of the people residing in the area. Villages inhabitants varied widely ranging from a maximum of 1078 (Yaphu) to a minimum of 326 (Heinze). The average household size (members/ household) of the area seems to be not very large, ranging from 3.7 (Heinze) to 6.4 (Yepon). People of the area are devoted to two main religions: Buddhism and Christianity. Buddhism tends to be more influential in the area since more than 80% of the people are Buddhists (Min Thant Zin, 2009).

1.4.3 Biodiversity in TNR

Ecosystem balancing and environmental stability plays a very crucial role in conducting the activities of biodiversity conservation in Myanmar. From the biodiversity conservation point of view, U Uga (2006) stated that TNR is nationally important, regionally significant and globally outstanding which lies within Bio-unit 5. The area has been identified by World Wildlife Fund (WWF) as one of the threatened terrestrial ecosystem of the world and particularly as their area is connected to the Western Forest Complex of Thailand, it will be of significance for one of the important trans-border protected area in Asia.

There are 277 tree species of which 5 species are critically endangered and other 5 species are endangered (Hla Maung Thein, 2007). 67 mammal species are present in TNR and the endangered species are Elephant, Tiger, Tapir, Serow, Gibbons, Gaur and Bears (Ye Htut *et al.* 2008). 244 bird species are also found in

TNR of which 10 species are threatened and 3 are vulnerable species (Nay Myo Shwe *et al.* 2008). 82 amphibian and reptile are also present (Myint Hlaing *et al.* 2010) in TNR.

1.4.4 Status of vegetation

The natural vegetation of TNR is mostly tropical rainforest which are occupied especially in high ridge mountainous area while lowlands are associated with mixed deciduous and bamboo forest. Generally, western slope of the mountain is Semi-Evergreen Forest and eastern and northern sides are Tropical Evergreen Forest type (Smith, 1926; RS & GIS 2007). There are 8 land use classes such as evergreen (closed), evergreen (open), agriculture and horticulture land etc. in TNR area (RS & GIS 2007).

1.4.5 Land cover and land use

Eight land cover categories are allocated for TNR which include evergreen forest (closed), evergreen forest (open), scrub, grass land, bamboo, agriculture / horticulture land, sand and water (TNRP, 2009).

Table 1.1 Land cover and land use of TNR in 2006

Sr.	Land use	Acre	Hectare	%
1	Closed evergreen	256,492	103,983	61.17
2	Open evergreen	70,241	28,426	16.72
3	Scrubland	50,994	20,637	12.14
4	Bamboo	33,156	13,418	7.89
5	Grass land	4,690	1,898	1.12
6	Agri/horticulture land	3,034	1,228	0.72
7	Sand	27	11	0.01
8	Water body	986	399	0.23

1.5 Expected outcomes of the study

The outcome of elephant density, distribution, abundance, seasonal movement and forage habitat monitoring will play a key role in future revisions of the Operational Management Plan (OMP) with particular emphasis on addressing key threats to biodiversity, especially the wild elephants in TNR for effective sustainable

management. Moreover, it is one of the components of biodiversity assessment in TNR and it also will lead toward the long term development of OMP at TNR site.

1.6 Conceptual framework of the study

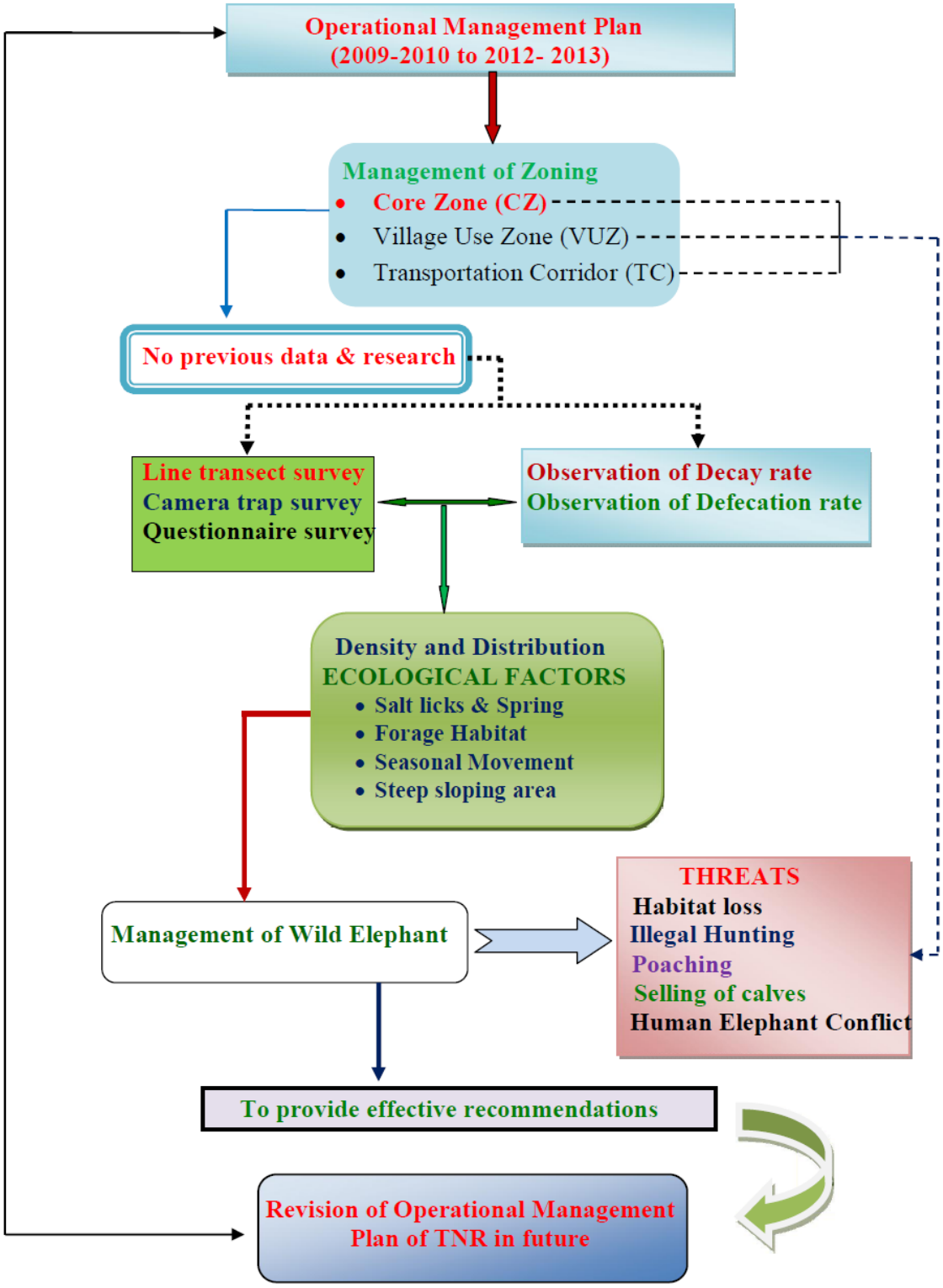

Figure 1.2 Conceptual framework of the study

CHAPTER II
LITERATURE REVIEW

2.1 Introduction

This chapter covers four main literature related with this research. The main literature review involves forest types of TNR, biological concepts and population census theories, habitat and ecology of wild elephants and their seasonal movement, status of Myanmar's wild and captive elephants, and definitions related to subjects of elephant density, distribution and abundance.

2.2 Concept of Protected Area

This protected area category refers to those areas that receive the least amount of human impact. They are defined by IUCN as "*strictly protected areas set aside to protect biodiversity and also possibly geological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values*".

Particularly, conservation is a point along the continuum, which must be fixed by setting a balance between environmental requirement (long term goal) and societal requirement (immediate needs). Consequently, conservation essentially means to represent rational use of natural resources- no more than the combination of two principles: the need to plan resource management on the basis of accurate inventory and the need to take protective measures to ensure that recourses do not become exhausted (Min Thant Zin, 2009).

2.2.1 Elephant capture methods in Myanmar

Capture of elephants is controlled by the Forest Department through the elephant control scheme. Licenses are issued yearly to the prospective capture teams of good reputation. The capture limit is determined each year. In Myanmar, there are

three methods available for the capture of wild elephants. These are: (1) chemical immobilization (still practiced in Myanmar); (2) Kedah and (3) Melar Shikar methods used by private elephant catchers. However, the two latter methods have been stopped since 1982 on account of the high mortality involved. In 1991 in order to provide recruits to the pool of elephants used in timber extraction, the Forest Department once again allowed the private elephant catchers to capture elephant using the Keddah method (Myint Aung, 1994).

2.2.2 Domesticated elephants

It is normally accepted that domesticated elephants were put into the service of man almost 2000 years ago in Myanmar. Historical depictions of war elephants date back to the time of King Anawrahta of Bagan in the year 1044 AD and who conquered Thaton dynasty, a flourishing seaport at that time, and after subduing it, brought back to Bagan city (together with other sacred relics of Lord Buddha) thirty sets of Tripitaka placed on the backs of thirty two white elephants that had been the property of King Manuha of Thaton (U Toke Gale, 1974).

Tun Aung & Thaung Nyunt, (2001) revealed that the total number of elephants owned by the Timber Industry of Myanmar was about 10,000 and 6,500 of these were full grown, 2,500 were trained calves between the ages of five and eighteen and about 1,000 were calves before 1942.

By the end of the Second World War in 1945, only about 2,500 full grown elephants, less than one half of the pre-war amount, were available for the extraction of timber (U Toke Gale, 1974).

2.3 Managing wild populations

In 2001, scientists from the Smithsonian's National Zoo began a cooperative project with Myanmar's Nature and Wildlife Conservation Division of the Forest Department. The project, titled “Managing Two Critical Elephant Ranges in Myanmar”, focused on the conservation and management of elephant populations in AKNP and HWS in Myanmar. These parks lie within the country's once-extensive

elephant range. Project staff monitored elephant populations throughout the two areas, conducted attitude surveys of 69 villages in the surrounding areas, and assessed community needs. Radio-tracking of a female elephant, collared with a satellite-Global Positioning System (GPS) transmitter, generated information on habitat use in AKNP over an 18-month period.

Results from the elephant surveys indicate populations are declining, and are highly vulnerable to local extinction (Surveying Elephants through Dung Counts). The primary threats to elephants are organized poaching for ivory and meat and live capture for domestic use. Secondary threats to elephants are indirect and include disturbance and modifications to habitat.

Curbing primary and secondary threats will require expansion of the protected areas and their buffer zones, increased law enforcement in the park, stronger regional controls through CITES enforcement, and close work with local communities. The management plan addresses both biological and park management issues necessary for the conservation of elephants, and treats several topics covered in traditional park management plans. The recommendations to the Forest Department deal with general park management, law enforcement, community relations, small-population and genetic management, habitat conservation, population monitoring, and ways and means of supporting expanded and future park activities (Tun Aung & Thaung Nyunt, 2001).

2.4 Trans-boundary elephant populations in Myanmar

Shepherd, (2002) concluded that most of the remaining large elephant populations are in Myanmar's forested hill regions stretching along the country's borders with Bangladesh, India, China, and Thailand. Where there is sufficient habitat on both sides of this border, the populations are likely to be contiguous and their long-term conservation and management needs to be addressed on both sides. Myanmar’s elephant experts were able to identify several trans-boundary elephant populations that may need to be considered in regional conservation planning. These were located

within Kachin State to China; Sagaing Region to India; Rakhine State to Bangladesh; and Kayah State and Mon State/Tanintharyi Region to Thailand.

2.5 Methods of wild elephant census

The dropping count method is widely used to estimate elephant densities (Barnes and Jensen, 1987). It provides relatively good results for its cost (Jachmann, 1991), but there are several potential sources of error related to deriving the index of abundance and turning this index into an estimate of elephant numbers (Barnes, 1993; Tchamba, 1992).

Reliable and consistent results can be obtained so long as some straightforward precautions are taken. It covers large area quickly and economically and is the only method for censuring in areas where access on the ground is difficult or impossible. Its use becomes limited when the vegetation is so thick that the animals cannot be seen from the air, or the animals concerned are too small (Craig, 1993).

2.5.1 Dung count based line transect

Information on elephant abundance and factors that affect abundance over time is essential to manage wild elephant populations effectively (Laing *et al*. 2003). There is a wide variety of techniques available to obtain estimates of elephant numbers including methods that exist for direct surveys of animals in general (Laing *et al*. 2003, Norton-Griffiths, 1978).

A new indirect sample counting technique has recently been introduced for estimating the size of elephant populations in forests (Eggert *et al.* 2003). At the same time, dung counts remain the most common type of indirect census method for counting elephants (Eggert *et al.* 2003; Barnes & Dunn, 2002) and it produces population estimates as accurate and precise as those obtained using other methods for a wide range of species (Barnes, 2001; 2002). Dung counts relate elephant number to a count of dung piles detected along line transects, corrected for variables such as rainfall in the 2 months before the count, rate of deposition of dung piles and rate of dung decay (Barnes & Dunn, 2002).

2.5.2 Questionnaire interview

Questionnaires can be a useful tool to interview and gather survey information from a large number of people. A questionnaire can be fact or opinion-based and may be answered by choosing from a list of options or writing out responses by hand. There are several advantages to using a questionnaire format. It's cost-effective, easy to analyze, reduces bias and is less intrusive than other survey methods like focus groups or interviews [www.wikipedia Access in 22/4/2011].

2.5.3 The method of Dawson, (1990) and Rabinowitz, (1997)

The one assumption for this calculation is that the proportion of fresh dung-piles deposited each day is equal to the proportion of old dung piles disappearing each day (the environment is in a steady state with regard to dung piles). However, since elephant defecation and dung decay rates may change between seasons (changing weather conditions) and between habitat (changing food quality and quantity), it is important that this study state assumption only be made within the same season and habitat type (Rabinowitz, 1997).

A variation of this technique is often used with forest elephant censuses. The following three parameters are necessary at the estimation of elephant density.

a) Dung density (D), or number of piles/ km^2 are obtained by line transects.
b) Daily dung decay rate (R), or the ratio of dung piles disappearing per day.
c) Defecation rate (Y), or the number of dung piles produced / elephant/ day.

Dung decay and defecation rates were obtained through observation experiments at the study site and during the same season as the elephant estimation.

2.5.4 Camera trapping

Camera trapping is not a new tool in wildlife science. It was invented in the late 1890s, before being first used in the field in 1913 (Trolle, 2005). In recent decades, it has been widely used throughout the world, with an annual increment of 50%. The results of these studies have been published in internationally recognized journals (Rowcliffe & Carbone, 2008).

In dense tropical rainforest, camera traps are useful to detect cryptic species, estimating abundances using individual recognition and, recently, without individual recognition. A good image from the camera trap is undisputable, as to the presence of a certain species, when compared to interview or conventional survey methods. The utilization of camera traps has revealed the presence of secretive rainforest dwelling species, which have been overlooked by the application of the conventional applied, transect surveys (Mohd-Azlard, 2006).

2.6 Ecological factors correlating wild elephant population

2.6.1 Seasonal movement

Asian elephants migrate and generally follow the same migratory routes annually its distances vary considerably depending on environmental conditions. Asian elephants usually migrate at the beginning of the dry season, between February and March; heading toward more hospitable locations near rivers, streams and water sources that are not prone to drying. When the rainy season arrives, usually from May to July, wild elephant herds return to native regions to feed on the abundant, green vegetation the rains helped regenerate. Wild elephant migration allows time for the re-growth of vegetation in exhausted grazing areas (Joshi & Singh, 2008a).

Joshi & Singh (2009) stated that movements in large mammals are considered to be one of the most important ecological factors, which influence the distribution of other small herbivores. Elephants travel long distance as part of their migration activities and at the same time they stay within different forest habitats those are enriched with water and fodder species. Migration within large mammals also influenced due to water availability as during the dry period elephants required tremendous amount of water and at that time their local movements is quite frequent near to riparian corridors. Thus the home range studies are better options for wildlife management as these highlights the preferred habitats of any animal and the rate of fragmentation of habitat.

Joshi & Singh (2009) also found that elephants use whole of the park area as their natural habitat but mostly they leave some of the areas having less vegetation

cover and water for few months and move towards other ranges richer in fodder species and natural water. Although at that time few of them (mostly solitary bulls) use the same feeding grounds or move frequently in all the forest beats of the park as a general rule of migration of any species.

2.6.2 Saltlicks and spring saltlick

Salt and minerals are crucial in the diet of mammal and wildlife for their health. A salt lick is a salt deposit that animals regularly lick. In an ecosystem, salt / mineral licks often occur naturally, providing the sodium, calcium, iron, phosphorus and zinc required in the springtime for bone, muscle and other growth in wildlife. Herbivores in nutrient poor ecosystems may be able to overcome deficiencies in essential elements by using natural mineral licks (Kurlansky, 2002).

Jones (1970) mentioned that one type is formed when natural springs with a high content of various minerals seep out from the ground and form shallow pools of water within a general area. Minerals from this type of saltlick are ingested by animals when they drink the mineral-soaked water. Hot spring saltlicks are formed by thermal springs forming shallow and hot mineral pools. Natural saltlicks, including mineral hot spring saltlicks, are undoubtedly very important to the survival of mammals and other wildlife. The study by Jones (1970) revealed that saltlicks have comparatively high contents of sodium, potassium, fluorine, chlorine and the carbonate radical (including bicarbonate).

2.6.3 Availability of fodder and water resource

Elephants are generalist of intermediate feeders that feed on grasses and browse, consuming a large numbers of plant species (Sukumar *et al.* 1987; Sukumar, 1989). The total number of 124 plant species are consumed by the elephants in the Okkan Reserve Forest exceed the numbers mentioned in the literature and 112 plant species eaten by Asian elephants in the deciduous forest of southern India (Sukumar, 1989), with most of three species belonging to very few families, such as *Arecaceae*, *Leguminaceae*, *Malvaceae* and *Graminaceae* (Sukumar *et al.* 1987). In another study

from southern India, only 25 plant species accounted for 85 % of the elephant total uptake (Sukumar, 1987) and the home range size of an elephant group depends on the availability of food (Wan Htun, 2006).

Consumption of tree species (74%) was highest as compared to grasses (14%) and shrub (8%) but their diet was mainly depend on availability of seasonal food round the year and on their migration(Joshi & Singh, 2008b).

The consumption of bark for example helps to cover the calcium needs of elephants, and may consequently serve more than just for satisfying hunger (Sukumar, 1989). The climber *Tinospora nudiflora* (*Menispermaceae*) that was consumed by five elephants in his study is known as a very efficient medicine in Myanmar.

Elephant eats a variety of species vegetation. They prefer grasses, but they also consume bark, roots, leaves and stem of trees, vines and shrubs. Most of an adult's activities involve moving and eating food. They eat in the morning, evening, and night but rest during the hottest part of the day. Average day's intake is 150 kg of vegetation of which only about 44 % is actually digested (with the aid of symbiotic gut bacteria) (Hedges & Lawson, 2006).

An adult consume 150 kg of vegetation (wet weight) per day with an average intake of 7 kg per hour. Given food preferences and needs, grass is always a major component. Elephant also need large quantities of water; an elephant drinks over 100 liters at a time up to 25 liter in a day (Henning, 2002).

Joshi & Singh (2008a) conclude that the animals are directly affected by water availability and availability of fodder species in the Protected Nature Reserve Area.

CHAPTER III
METHODOLOGY

3.1 Introduction

The objective of this chapter is to describe the methodology and research design. It also describes the data analysis techniques and interpretation of information gathered from estimation of wild elephant's population, distribution and abundance by using dung count base line transects method in the study area.

3.2 Pilot survey

To estimate the total length of line transects, a pilot survey is necessary to conduct transect walks in the study area (Buckland *et al.* 2001). Recce Survey Line Transects (RSLT) method was adopted to use for the pilot survey using all previous collected data such as previous mammal survey conducted in TNR area during the first phase of the project.

The main objectives of a pilot survey are

(1) to collect data on wild elephant density and distribution by collecting data on dung-pile encounter rate

(2) to allow the survey team to become familiar with the survey site and equipments

(3) to access any logistical problem and the feasibility of access to different areas.

In order to grasp the three crucial objectives, 24 Recce Survey Line Transects 1 km in length as a pilot survey was carried out in the upstream and downstream area of Kyauklonegyi, Zinba, Maeke, Khotama and its valleys and three ridges of H3, 1500 point and H6 hills to achieve basic data for the improvement of formal dung count base line transects survey. Particularly, 42 fresh dung-piles (S1 & S2) were found and recorded with GPS points for monitoring dung pile decay rate on RSLTs prior to the formal survey.

3.3 Data collection

Data collection involved both primary and secondary sources. Primary data collection consists of counting of dung piles on line transects.

Primary data had been collected using questionnaire surveys in order to know the major experiences from owners of captive elephant, mahout and hunters such as hunting, poaching, and wildlife trade. Counting of dung piles on line transects and observations of dung decay and defecation rate and identification of captured pictures with 15 camera traps were implemented. Secondary data collection consists of published and unpublished reports from the Forest Department, previous researches and project reports and from internet related to elephant surveys.

3.4 Line transects and it's sampling size:

Line transect sampling is a common method used for obtaining estimates of wildlife distribution and it require very little equipment (Rabinowitz, 1997).

There are 20 lines transects in High Density Strata (HDS), 20 lines transect in Medium Density Strata (MDS), and 20 lines transect in Low Density Strata (LDS) based on expected elephant density in order to improve precision. The total areas of line transect are 95.91 km in length or 3.8 square kilometers or 0.22 % of total area of TNR. The line transects were 1-2 kilometer in length, 40 m in width and the numbers of line transects are 60 in which walking rate is about 500m/ hour.

3.5 Survey design

This survey focuses on estimation of wild elephant's population, distribution and abundance by using dung counts on 60 line-transects in three strata (High, Medium and Low). Transects were laid across the forest areas covering three strata based on elephant density which varies with distance from human disturbance. The area of sample size could not cover to the whole area of TNR as some unsecure areas in which security cannot be provided and some area are excluded from the survey area.

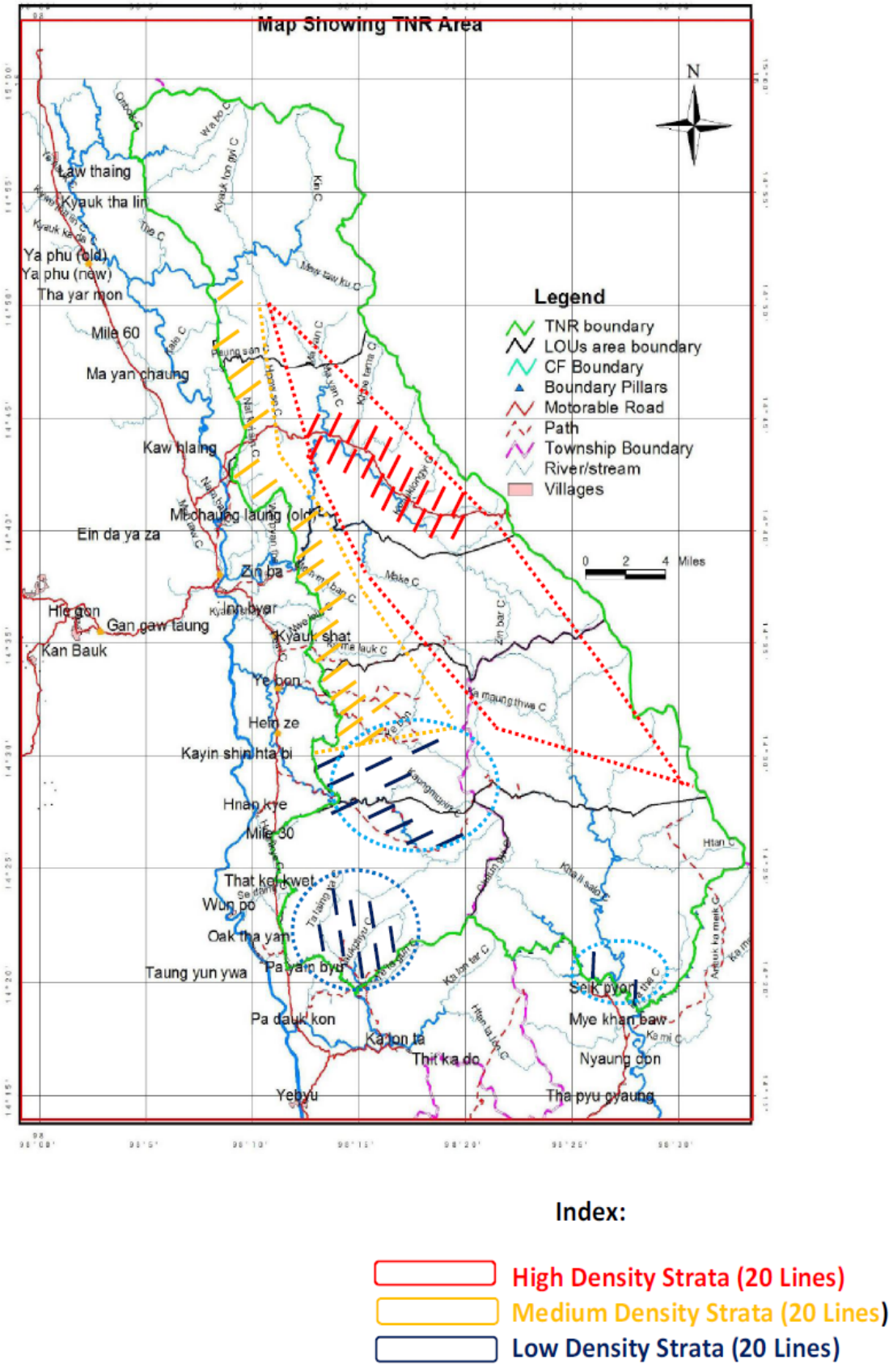

Figure 3.1 Survey design for 60 lines-transect in high, medium and low strata

3.6 Classification of elephant's dung-pile

The following dung-pile classification was used in this research which is cited from Hedges & Lawson (2006). Elephant dung-piles were recorded as belonging to stage S1, S2, S3, S4 or S5 as appropriate during data collection.

Table 3.1 Classification of dung-pile of elephant

Stage	Definition
S1	All dung are intact (see notes below)
S2	One or more dung (but not all) are intact
S3	No dung are intact, but coherent fragments remain (fibers are held together by fecal material, see notes below)
S4	No dung are intact; only traces (e.g. plant fibers) remain; no coherent fragments are present (but fibers may be held together by mud, see notes below)
S5	No fecal material (including plant fibers) is present

Source: Hedges & Lawson (2006).

3.7 Observation of elephant's defecation rate

To estimate elephant population density from dung-pile density requires defecation rates (dung production rates) as well as dung decay rates. Defecation rate data for elephants, however, are scarce (Hedges & Lawson, 2006).

However, four cases of study on defecation rates within six days were accomplished with four captive elephants in the Laukthine, Yarphu, Kaukhlaing and Kalonehtar villages at the vicinity of TNR.

3.8 Monitoring of dung-pile decay rates

Although many elephant researchers have not assessed decay rate at their sites, instead they have used data from other sites, often many hundreds of kilometers from where they were working (Hedges & Lawson, 2006). Fortunately, for dung decay rate estimation, 62 dung piles were marked during the second week of March, 2011. However, 10 fresh dung-piles dropped within the previous 48 hours (Stage S1) were located, classified and marked with GPS for successive observations during the next visits for mean decay rate.

3.9 Estimation of elephant population and density

As nature reserve possesses dense evergreen forest in the high land and steep slope area coupled with inaccessibility to certain areas, direct count method is inappropriate and the indirect-dung count method must be used in this area (Barnes & Jenson, 1987).

Indirect technique involves correlating animal sign with numbers of individuals. This is often difficult to do, but is possible when data on a species' fecal deposition rate is combined with counts of the animal's feces in the field. The method developed by Dawson, (1991) and Rabinowitz, (1997) method was used in this study to estimate wild elephant population, distribution and abundance.

3.10 Observation on distribution with camera traps

To evaluate the application of camera trap technology in population dynamics study of Asian Elephants, indigenously designed, cost effective, infrared triggered camera traps were used (Varma *et al.* 2006).

Camera traps are powerful tools for inventorying elusive and rare species and very useful to obtain ecological data for plans that involve wildlife conservation. Camera traps have been used successfully in numerous studies of mammals, and potential applications of this field technique in wildlife studies are increasing. Camera traps, however, are not dependent on the environment and the photographs allow an accurate identification of animals (Trolle, 2005).

Camera traps were used to estimate the density and documenting existing wild elephant's presence. Fifteen camera traps were installed at the saltlicks with different GPS positions.

3.11 Identification of wild elephant habitat and their forage

The vegetation factors are directly affecting elephant's density and population. The value of elephant habitats is strongly linked to the type and variety of existing trees and plant communities (Sukumar *et al.* 1987).

One or two days after the elephants had left their feeding ground, various fodder plants and trees were collected for identification. Vegetation of the browsed areas was enumerated in 5 (10m x 10 m) plots. All plants including small trees, shrub, herbs, grasses and climbers were enumerated and identified either through the nomenclature on list of tree shrub and principles climbers (Hundley and Chit Ko Ko, 1986) or with the help of staff from Local Operating Units (LOUs). Some trees and plants were well known to us.

3.12 Observation of the elephant's seasonal movement

An animal's range of movement increases with greater body size and energy requirement (Mc Nab, 1963). Long distance travel during seasonal movement offers clear ecological advantages to elephants (Sikes, 1971). Availability of food, water, seasonal movement, spatial distribution, and diversity in habitat types may influence the home range size. Although elephants have no seasonally distinct ranges, they move widely to find food patches that are sufficiently rich with habitat resources to support them (Olivier, 1978).

Elephant's traditional or seasonal movement tracks along with feeding grounds have been searched and observed directly using their footprint and dropped dung-piles positions based on different forest types of TNR.

CHAPTER IV
RESULTS AND DISCUSSION

4.1 Outcome of pilot survey

There were 43 fresh dung-piles found in 24 Recce Survey Line Transects (RSLT) and recorded with GPS points. The outcome of the pilot survey indicated that these results could be used as a basis for formal survey.

4.2 Results of line transects

A total of 96 dung piles (S1 and S2) in 20 line transects was found in High Density Strata (HSD). Next 39 dung piles (S1, S2 and S3) were in 20 line transect of Medium Density Strata (MDS) while 7 dung piles (only S2 and S3) were found in 20 line transect of Low Density Strata (LDS). (Detailed findings are attached in Appendices).

Figure 4.1 Foot print of elephant

Figure 4.2 Measuring of dung boli

4.3 Finding of defecation rate

Defecation rate was studied with the help of four captive elephant owners from Kawhlaing, Yarphu and Lawthaing village during 17th and 18th May, 2011 and 20th June to 25th June, 2011 near the fringe area of TNR in which the climate does not

show marked variations. In this trial, four captive elephants were allowed to forage naturally in the bamboo and scrubland forest during the day and were chained during the night. The result of this trail showed that the average defecation rate of captive elephant is 13.3 per 24 hours among elephants.

Table 4.1 Rate of defecation 6 days trial on 4 captive Asian elephants

Sr.	Time	Trial on defecation rate			
		Kyayzushin	***Naw Kay Kaw***	***Naw Moe Bwar***	***Phar Maung Than***
Owner's name		Saw Phoe Pree	U Myint Aung	U Phee Raw	U Mya Tun
Bull/ cow		Bull	Cow	Cow	Bull
Name of village		Kaukhline	Laukthine	Yarphyu	Laukthine
Trial Period		6 days	6 Days	6 days	6 days
Season		Rainy season	Rainy season	Rainy season	Rainy season
1	6:00-07:00 am	6	5	4	3
2	7:01-08:00 am	0	2	3	3
3	8:01-09:00 am	4	4	4	3
4	9:01-10:00 am	6	3	4	4
5	10:01-11:00 am	0	3	4	3
6	11:01-12:00 am	2	2	3	4
7	12:01-1:00 pm	4	2	4	3
8	1:01-2:00 pm	2	3	2	3
9	2:01-3:00 pm	4	4	3	4
10	3:01-4:00 pm	6	4	4	4
11	4:01-5:00 pm	4	4	4	3
12	5:01-6:00 pm	6	4	4	4
		44/6	**40/6**	**43/6**	**41/6**
13	6:00-07:00 am	2	4	3	4
14	7:01-08:00 am	4	4	3	4
15	8:01-09:00 am	4	3	4	3
16	9:01-10:00 am	4	4	5	3
17	10:01-11:00 am	4	3	3	4
18	11:01-12:00 am	2	3	4	4
19	12:01-1:00 pm	4	2	4	3
20	1:01-2:00 pm	4	3	3	2
21	2:01-3:00 pm	4	4	3	4
22	3:01-4:00 pm	2	3	4	3
23	4:01-5:00 pm	0 (sleeping)	0 (sleeping)	0 (sleeping)	0 (sleeping)
24	5:01-6:00 am	4	4	4	3
	Total rate/day	**38/6**	**37/6**	**40/6**	**36/6**
Defecation rate		**13.7**	**12.9**	**13.9**	**12.9**
Average Def. rate		**53.2/4 = 13.3**			

4.4 Result of dung-pile decay rates

There were 43 fresh dung piles marked and mean decay rate was estimated during 8th March to 24th June, 2011. Out of 43 fresh dung-piles dropped within the previous 48 hours (stage S1) in (8-3-2011) 10 dung piles close to the service track were marked and their locations recorded with GPS. All 10 fresh dung-piles were monitored and reclassified into different stages (S1-S5) during the five visits.

Table 4.2 shows that all 10 dung piles were changed from Stage 1 to Stage 2 within 10 to 14 days. The change from Stage 2 to Stage 4 was within 61 days during the testing period of dung decay rate. Dung decay rates may vary widely depending on deferring nature of the prevailing estimate in which rainfall plays a major role in determining dung decay rates. The finding of the study shows that 9 out of 10 dung piles were decayed within 75 days. According to Table 4.2, during the dung-pile monitoring experiment, all elephant dung-piles were decayed completely within 108 days.

The results of this study also showed that the decay rate is 0.012 based on 10 dung piles near the service track of MGTC in TNR.

Table 4.2 Analysis of decay rate of wild elephant's dung piles in TNR

Dung No	Date	No of pellet	Location UTM/GPS	Vegetation type/ slope	Information to be record				
					Visit 1	Visit 2	Visit 3	Visit 4	Visit 5
1	8-3-11	5	N 14 41 07.1 E 98 17 18.0	Closed forest	S1 8/3/11 (S)	S2, 21/3/11 (S)	S5 24/5/11 (R)	S5 10/6/11 (R)	Destroy 24/6/11 (R)
2	8-3-11	2	N 14 41 34.6 E 98 16 43.4	Bamboo Scrub forest	S1 8/3	S2 21/3	S5 24/5	S5 10/6	No 24/6
3	8-3-11	5	N 14 43 41.0 E 98 15 00.2	Khotama Camp	S1 8/3	S2 21/3	S4 24/5	S4 10/6	Destroy 24/6
4	8-3-11	4	N 14 42 45.8 E 98 15 54.9	Damyetsi Scrub land	S1 8/3	S2 21/3	S5 24/5	S5 10/6	No 24/6
5	8-3-11	4	N 14 42 17.0 E 98 16 13.6	Beside of service track	S1 8/3	S2 21/3	S5 24/5	S5 10/6	Earth 24/6
6	8-3-11	5	N 14 43 40.8 E 98 14 52.0	Semi evergreen	S1 8/3	S2 21/3	S5 24/5	S5 10/6	No 24/6
7	8-3-11	4	N 14 43 28.0 E 98 15 16.6	Bamboo forest	S1 8/3	S2 21/3	S5 24/5	S5 10/6	Earth 24/6
8	8-3-11	5	N 14 42 18.7 E 98 16 12.1	Banana & valley	S1 8/3	S2 21/3	S4 24/5	S4 10/6	S5 24/6
9	8-3-11	4	N 14 43 26.9 E 98 17 23.6	Banana & valley	S1 8/3	S2 21/3	S5 24/5	S5 10/6	No 24/6
10	8-3-11	3	N 14 43 26.2 E 98 15 34.6	Beside of service track	S1 8/3	S2 21/3	S5 24/5	S5 10/6	Earth 24/6
Time consuming period					**-**	**13**	**77**	**94**	**108**

The total finding of decay rate survey indicated that decay rate of summer (S) season is slower than rainy season (R) in the TNR area. Dung piles were directly affected by rain, but more importantly, moisture also enhanced the activity of microbes, insects and other causative factors of decay.

The finding of elephant dung decay rate specify in TNR are as follows:

After 75 days, 9 of 10 dung piles were transformed from stage 1 to stage 5.

Hence, decay rate per day = 1/75 x 9/10 dung-piles = 0.012 / day

4.5 Estimation of wild elephant density in TNR

4.5.1 Identification of abundant area in the estimated strata

The following figure 4.3 shows that the extent of the High Density Strata, Medium Density Strata, Low Density Strata and No Wild Elephant Area of TNR based on matrix which was formulated by elevation and slope percentages indicators (Source: Myat Su Mon, GIS, FD, 2011). These indicators are identified after conducted line transects and observation of wild elephant ecological habitat in TNR.

The area extents of HDS, MDS and LDS were delineated by indicators of less than 30% slope and Above Sea Level (ASL) less than 500 ft, 501- 1500 ft and greater than 1500 ft respectively. Moreover, No Wild Elephant Area (NWEA) was demarcated by indicators of greater than 30 % slope and Above Sea Level (ASL) less than 500 ft, 501- 1500 ft and greater than 1500 ft correspondingly.

Table 4.3 The area extent of wild elephant estimation strata

Elevation / Slope %	<500 ft	501-1500 ft	>1500 ft	Total	% of Total Area
	HDS	MDS	LDS		
< 30 %	252.92	713.30	635.09	1601.30	94.19
> 30%	1.13	37.89	59.68	98.70	5.81
Grand Total	**254.05**	**751.19**	**694.77**	**1700.00**	**100.00**

The Table 4.3 shows that the area extent of HDS, MDS, LDS and No Wild Elephant Area are 252.92 km^2, 713.30 km^2, 635.09 km^2 and 98.70 km^2 respectively of the total area of TNR. This Table 4.3 also explains that 94.19% were containing wild elephants and 5.81 % of total TNR area are lacking of wild elephants.

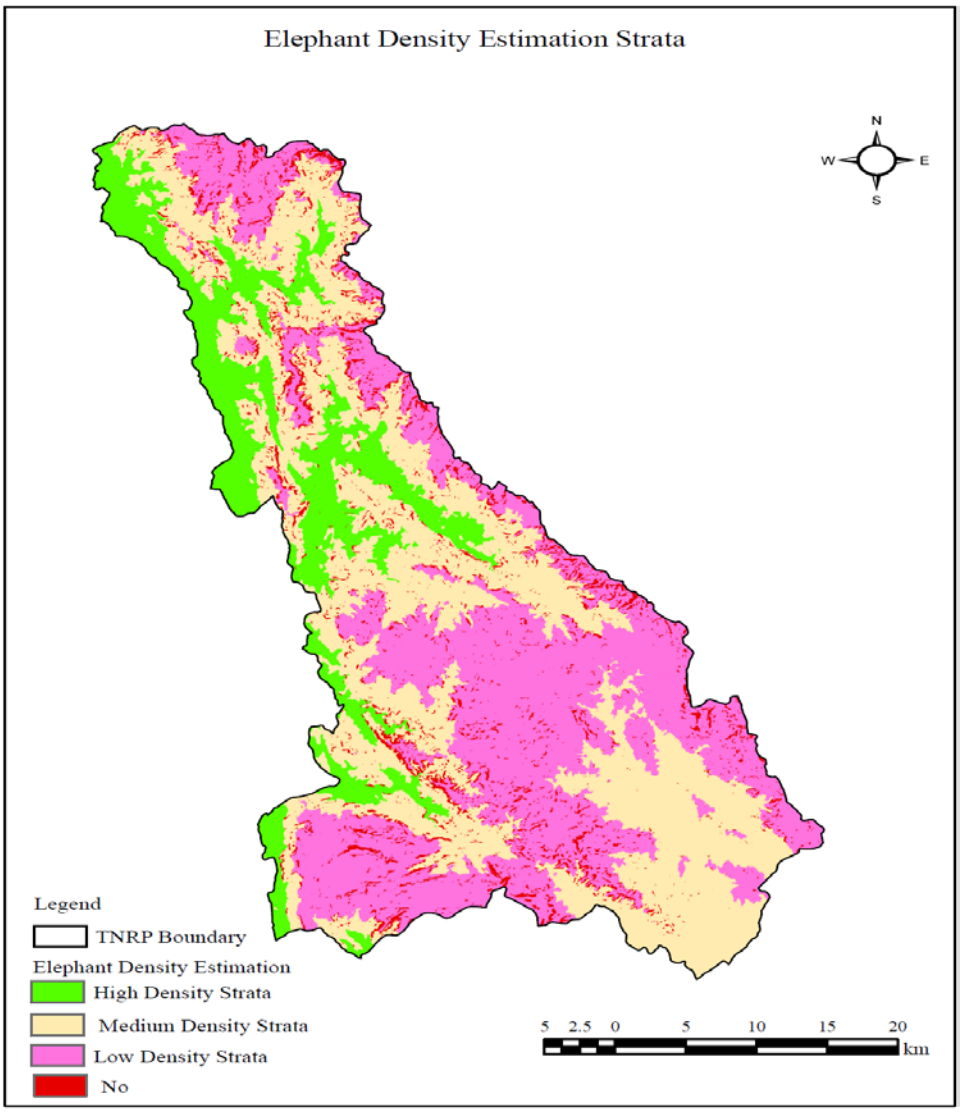

Figure 4.3 Elephant Density Estimation Strata

4.5.2 Dawson, S. (1991) and Rabinowitz, A. (1997) method

The following three parameters are necessary in estimating the density of wild elephants.

a) Dung density (D), or number of piles/ km^2 are obtained by line transects.

b) Daily dung decay rate (R), or the ratio of dung piles disappearing per day.

c) Defecation rate (Y), or the number of dung piles produced / elephant/ day.

Dung decay and defecation rates were obtained through observation of experiments at the study site.

A total of 96 dung piles in high strata, 39 in medium strata and 7 in low strata were encountered in 60 line transects during project period**.** Dung-piles were found in

the total area 3.83 km^2 of line transects. When worked out for the line transect of dung piles /1 km^2 the results are as follows:

In HDS, 96 of 137 dung-piles are representing 1 km^2 of HDS,

In MDS, 32 of 39 dung-piles are representing 1 km^2 of MDS, and

Also in LDS, 5 of 7 dung-piles are in place of 1 km^2 of LDS.

The elephant density of HDS, MDS and LDS can be calculated as follows (Dawson, 1991& Rabinowitz, 1997):

Elephant density = Dung density x Daily Dung Decay rate/ Defecation rate

where,

a) Dung density (D), or number of piles/ km^2 are obtained by line transects.
b) Daily dung decay rate (R), or the ratio of dung piles disappearing per day.
c) Defecation rate (Y), or the number of dung piles produced / elephant/ day.

1. High Density Strata (within valley, <500 ft and <30% slope)

A total of 137 dung piles were found within 1.4321 km^2 of 20 line transects in HDS of TNR during the survey period. For 1 km^2 there will be 96 dung piles were represented in HDS (detailed numbers of dung piles area attached in appendices).

Elephant density of 1 km^2 in HDS = 96 x 0.012 / 13.3

Elephant density of 1 km^2 in HDS = 0.087/km^2

Sample size area of HDS = 252.92 km^2 (Using of data delineated by GIS)

Elephant density of 1 km^2 in HDS = 0.087 x 252.92 km^2 = **22.00**

2. Medium Density Strata (elevation 501 ft - 1500 ft and< 30 % slope)

In MDS, a total of 39 dung piles are counted within 1.1824 km^2 of 20 lines transects in MDS. For 1 km^2, there will be 32 dung piles in MDS (detailed numbers of dung piles area attached in appendices).

Elephant density of 1 km^2 MDS = 32 x 0.012 / 13.3

Elephant density of 1 km^2 in MDS = 0.029 /km^2

Sample size area of MDS = 712.30 km^2 (Using of data delineated by GIS)

Elephant density of 1 km^2 in MDS = 0.029 x 712.30 km^2 = **20.65**

3. Low strata (elevation >1500 ft and < 30% slope)

Likewise, a total of 7 dung piles are enumerated within 1.2228 km^2 of 20 lines transects in MDS. For 1 km^2, there will be 5 dung piles are located in MDS (detailed numbers of dung piles area attached in appendices).

Elephant density of 1 km^2 LDS = 5 x 0.012/ 13.3

Elephant density in 1 km^2 of LDS = 0.004/ km^2

Sample size area of LDS= 635.09 km^2 (Using of data delineated by GIS)

Elephant density in 1 km^2 of LDS = 0.004 x 635.09 km^2 = **2.54**

4. No Wild Elephant Area (>30% slope & elevation<500 ft,501-1500 ft & >1500ft

This study shows that there was no finding of wild elephants in the greater than 30% steep slope and above 1500 ft (ASL) areas where occupy 98.70 km^2 (5.81%) total area of TNR based on aforementioned Figure 4.3.

5. Total density and distribution of wild elephants in TNR

Here, when calculate on 3 results of 3 strata-

Total sample size area (3 strata) of survey = 252.92 km^2 (HDS) +713.30 km^2 (MDS) +635.09 km^2 (LDS) = 1601.30 km^2 (94.19%) of total TNR area

Total distribution of wild elephant (D) = **22.00**+ **20.65** + **2.54** = **45.19** (Normal distribution) are existing in 1601.30 km^2 (94.19%) of total area 1700 km^2 while 98.70 km^2 (5.81%) are lacking of wild elephants in TNR.

When three results of density in three strata were added,

0.087 + 0.029 + 0.004 = 0.12, Total average density = 0.12/3 = 0.04/km^2

Total distribution = Total Average Density x Wild Elephant Existing Area

= 0.04/km^2 x 1601.30 km^2 = **64.04** (Highest distribution)

Table 4.4 Total density and distribution of wild elephants in TNR

Strata	HDS	MDS	LDS	NWEA	Total
Area (km^2)	252.92	712.30	635.09	98.70	1700
Density (/km^2)	0.087	0.029	0.004	0	Avg. density 0.04
Distribution	22.00	20.65	2.54	0	45.19- 64.04

4.5.3 Review on previous estimated data

Win Maung (2003) stated in his mammal survey report that the wild elephant population size is estimated to be over 500 in Tanintharyi Division and he also assumed that about 40 to 100 elephants are moving around the present studied Yadana pipeline area and the proposed Taninthayi Nature Reserve (TNR).

Ye Htut *et al*. 2008 also stated that in TNR the encounter rate of wild elephant was 0.3 / km^2 and its estimated populations were 21 sightings in 70.4 meter in distance. The wild elephants have been seen almost everywhere of the TNR. Their survey track and sign method indicated that elephants are one of the most relatively abundant species and widely distributed species. Moreover, wild elephants occasionally visited the mineral hot water spring and probably avoid staying in the steep sloping ridges in the monsoon period, because of the danger of potential landslides. There were about 19 landslides which occurred along the service track in 2007 and 2008 (pers.comm, MGTC, 2011).

There are inhabited by wild elephant is about 115,600 km^2. It is estimated that a total of over 4000 wild elephant still survive in fragmented populations across Myanmar (Myint Aung, 1994). He estimated that 100 wild elephants are remaining in Taninthayi region particularly in Yephyu, Dawei, Tayetchaung, Taninthat, Myeit (East) and Botebyin Townships.

The detail findings of this study showed that distribution and abundance of elephants from TNR is 0.087/ km^2 in high density strata (HDS), 0.029/ km^2 in medium density strata (MDS) and 0.004/ km^2 in low density strata (LDS) within TNR. The mean density of wild elephants is about 45 to 64 in 1601.30 km^2 of total TNR area. Moreover, the remaining populations of wild elephants are at a critically low level and declining gradually throughout the TNR area. Wild elephants move to valleys by passing steep slopes and very high ridges when fodder and availability of water is scarce in summer period, indicating that steep sided valleys are more secure fodder and water for them. One or two wild elephant can be found in the vicinity area and some parts of Luwine Reserve with the migratory behavior at the beginning of the dry season.

4.5.4 Results of questionnaire interviews

A total of 115 respondents were interview during the observation period. The interviewees are 36 hunters, 28 elephant owner, 20 mahouts, 13 elephant catchers from 22 villages, 6 soldiers from 3 military base camp and 12 Forest Department staffs. The estimated numbers of wild elephants by questionnaire interviews (please see in the following Figure 4.4) were the minimum numbers of 46 elephants to the maximum numbers of 50 elephants inhabit in TNR area especially in steep sided valley between Ban I Taung, Zimba and Mekhe ridges ahead to near upstream area of Khamaungthwe. List of interviewees are attached in the appendix -2.

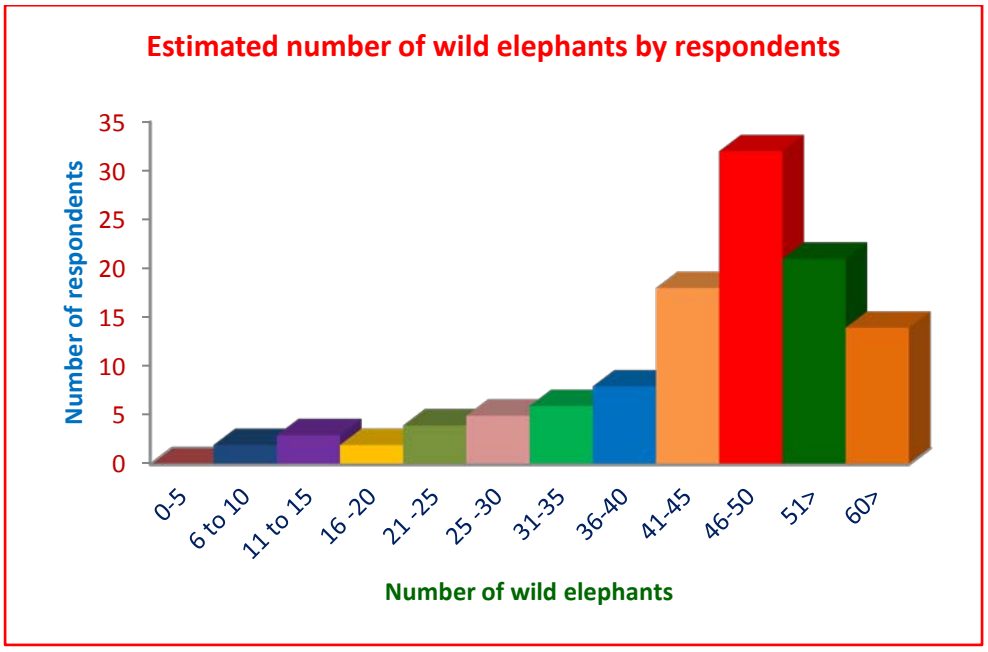

Figure 4.4 Estimated numbers of wild elephants by respondents

4.5.5 Method of analysis by DISTANCE 6.0

Although DISTANCE 6.0 software is intended to be used in this survey for estimating elephant density, the sample size of survey is not sufficient enough for running the program. The minimum total line length of greater than 250 km is required to use DISTANCE software program properly (User Guide Distance 6.0 Release 2, 2009). This required length 250 km will take 125 days (2 km in one day) in

order to walk completely. However, the coverage of this study is only 95.91 km length along with 60 lines transects (total of line transect area 3. 8364 km^2) during 4 months period due to steep terrain with dense evergreen forests and security constraint. The total length covered in this study was not long enough to operate DISTANCE 6.0 program. In this context, the final statistical results are quite fluctuated as unreliable output after operating the program with inadequate field data. Finally, this program software had been abandoned after trying several times by researcher. As this software is endorsed by MIKE, IUCN for estimating elephant population, further research should be attempted if duration of research period is adequate for researchers for effective results.

4.6 Verification of captured photos by camera Trap

Fifteen automatic infrared camera traps were installed along the fifteen GPS locations and some elephant images were documented indicating their presence and seasonal movement directions of wild elephants in TNR area.

Figure 4.5 Tuskless in camera trap

Figure 4.6 Tusker elephant in camera trap

Out of fifteen camera traps, five camera traps were installed in the following five GPS positions and 16 wild elephant images were documented at the end of summer period at the following elevations and forest types of Table 4.5.

Table 4.5 Location of camera trap in the study area

No	Camera Trap No.	Location	GPS Position	Elevation/ forest type	No. of days in service
1	88	Alongside of Gas pipeline, near KPR 61	N 14 42 45.8 E 098 15 54.9	273 ft Grassland	14
2	89	Access No. 22 which lied on the service track	N 14 43 16.8 E 098 15 36.2	257 ft Bamboo	2
3	90	Waterhole or salt lick of Yebote, Yebon village area	N 14 31 47.1 E 098 16 17.3	553 ft Open evergreen	31
4	91	U Kyaing Mine Road	N 14 39 48.8 E 098 19 46.6	960 ft Scrubland	62
5	92	U Kyaing Mine Road	N 14 39 19.6 E 098 19 57.3	588 ft Scrubland	62

No pictures of wild elephants were captured from the remaining 10 camera traps at the following locations, elevation and forest types. The following Table 4.6 shows that there are no inhabitations of wild elephants at the height above sea level of 121 feet to 1086 feet during rainy season in TNR. It shows that most elephants inhabit on secured ridges of mountains of TNR in the rainy season.

Table 4.6 Location of camera traps in the study area (No elephant photo captured)

No	Camera Trap No.	Location	GPS Position	Elevation/ forest type	No. of days in service
6	93	Maw Ka Pe stream to Make stream	N 14 39 53.0 E 098 14 10.1	121 ft Open evergreen	29
7	94	Byet Ka than saltlick (Meke stream)	N 14 39 47.4 E 098 16 34.0	480 ft Close evergreen	29
8	95	Byet Ka than saltlick (Meke stream)	N 14 39 47.1 E 098 16 40.0	480 ft Close evergreen	29
9	96	Byet Ka than saltlick (Meke stream)	N 14 39 52.5 E 098 16 33.3	480 ft Close evergreen	29
10	97	Byet Ka than saltlick (Meke stream)	N 14 40 7.51 E 098 16 17.3	480 ft Close evergreen	29
11	98	Byet Ka than saltlick (Meke stream)	N 14 40 03.3 E 098 16 46.4	1086 ft Close evergreen	29
12	99	Kyauklonegyi mountain ridge	N 14 40 13.3 E 098 17 17.2	912 ft Open evergreen	29
13	100	U Kyaing Mine abandoned Road	N 14 38 49.8 E 098 20 28.4	790 ft Scrubland	34
14	101	U Kyaing Mine abandoned Road	N 14 37 37.5 E 098 21 16.2	649 ft Scrubland	34
15	102	U Kyaing Mine abandoned Road	N 14 38 23.8 E 098 21 04.8	825 ft Scrubland	34

The relative abundance indices of elephant, capture rate per trap-night from camera trapping survey fully support the maneuver of wild elephants in TNR (see Appendix 11).

A total of 67 elephant pictures with 447 trap nights were captured from camera trapping. Each species of capture rate per trap nights was calculated by dividing the numbers of pictures captured of that particular species by total trap nights. According to the following figure capture rate per trap night as relative abundance indices of elephants were fairly consistent. This result of camera trapping capture rate per trap night in the following Figure 4.7 show that sambar and wild boar are the most abundant compared to elephant species in TNR.

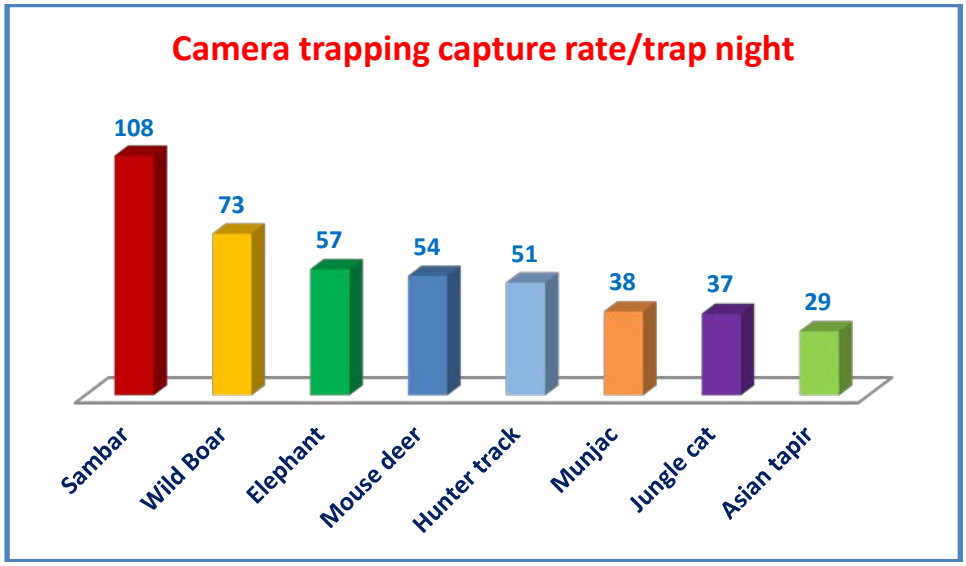

Figure 4.7 Camera trapping capture rate/ trap night

4.7 Ecological factors correlated wild elephant population

4.7.1 Identification of wild elephant habitat and their food

Wild elephants were found never to roam far from stream water, and usually travel great distance along or across the service track in TNR area. Determination of elephant food species is commonly determined by leftovers of forage along the animals' tracks and signs rather than direct observations, particularly in forested habitat. As direct observation was impossible; indirect evidences like feeding sign,

debarkation, digging roots and rhizomes, browsing on shrubs and soft trees were recorded indirectly.

Five blocks of elephant's habitat (10m x 10 m) in 3 different strata were chosen for measuring of elephant's feeding habit by using total block count method. After that, all plants with vernacular names were enumerated and identified either through the nomenclature on list of trees, shrubs and principle climbers (Hundley and Chit Ko Ko, 1986) or with the help of staffs from Local Operating Units (LOUs). Moreover, some unknown species of weeds and grasses were noted with local and common names. This study found that the most abundant crops in this valley are banana (perennial: *Musa bakeri*) and various bamboo species as elephant fodder species. Banana trees are available all year round with no seasonal fluctuations, where as bamboo shoots and leaves and other annual crops show marked seasonal fluctuations in availability.

During the dry season, wild elephants prefer to move to the areas in which fresh banana trees are prevalent near the streams such as Khotama, Mayan, Mekel, Sinswe and Kyauklonegyi.

Figure 4.8 Setting of sample plot

Figure 4.9 Identification of elephant fodder

A total of 35 plant species were recorded, which were favorite fodder species for wild elephant, which include 10 species of trees, 3 shrubs and 2 herbs, 5 climbers, 5 grasses, 1 tuber and 9 species of bamboos were found to be consumed by wild elephants in the dry season of TNR. While feeding on trees, herbs, and shrubs, both leaves and twigs were preferred. Elephants sometimes were found to take a long period of time to feed on some plants especially Banana tree (*Musa*, *bakeri*) according

to the signs of feeding. Wild elephant feed on bark of certain species such as ***Gonnyin nwe*** *(Entada pursactha)*, in the different forest types of TNR.

This list has been compiled from identification of the leaves and fruits taken from those plants that had signs of elephant feeding with the basis of their vernacular and local name. The plant species eaten by elephant are listed in the following Table 4. 7.

Table 4.7 Elephant food plant species, their life form and the plant parts eaten in the TNR

Sr.	Vernacular Name	Scientific Name	Family	Life forms	Parts eaten
1	Waba (Waya)	*Oxytenathera nigrociliata*	Poaceae	Bamboo	Shoot & leaves
2	Wabowa	*Dendrocalamus Brandisii*	Poaceae	Bamboo	Shoot & leaves
3	Wathabut (Wanwe)	*Neohouzeaua helferi*	Poaceae	Bamboo	Shoot & leaves
4	Wame	*Gigantochloa macrostachya*	Poaceae	Bamboo	Shoot & leaves
5	Hmyinbyu	*Dendrocalmus membranaceus*	Poaceae	Bamboo	Shoot & leaves
6	Wagok	*Oxytenanthera albo-ciliata*	Poaceae	Bamboo	Shoot & leaves
7	Wazun	*Neohauzeaua dulloa*	Poaceae	Bamboo	Shoot & leaves
8	Watho	*Bambosa polymorpha*	Poaceae	Bamboo	Shoot & leaves
9	Tabindaing wa	*Dendrocalamus longispathus*	Poaceae	Bamboo	Shoot & leaves
10	Damyetsi	*Triticum spp.*	Gramineae	Grass	Leaves
11	Myaukkyan	*Dioscorea pyrifolia* Kunth.	Dioscoreaceae	Grass	Whole parts
12	Hmaw (Minbaw)	*Pothos angustifolius* Presl.	Araceae	Grass	Whole parts
13	Kywetalinkyein	*Calamus spp.*	Arecaceae	Climber	Climber
14	Gon-nyin-nwe (sinsa)	*Entada pursaetha*	Mimosaceae	Climber	Climber
15	Sindon-Ma-Nwe	*Stephania reticulate (Tvy)*	Menispermaceae	Climber	Climber
16	Kyein Ni	*Calamus guruba*	Arecaceae	Climber	Climber
17	Kabaung kyein	*Calamus longiaetus Griff.*	Arecaceae	Climber	Climber
18	Tawthayet	*Magnifera indica*	Anacadiceae	Tree	Fruit
19	Taungbein	*Artocarpus calophylla*	Moraceae	Tree	Fruit
20	Yay-tha-phan	*Ficus glomerta* Roxb.	Moraceae	Tree	Fruit, leave
21	Zinbyun	*Dillenia scasbrella*	Dilleniaceae	Tree	Fruit
22	Kamaung/Kadat	*Ficus hispida L.*	Moraceae	Tree	Bark
23	Taw-gwe	*Eriolobus hookeriana Dene.*	Rosaceae	Tree	Fruit
24	Nyaung-tha-byay	*Ficus indica* Linn.	Moraceae	Tree	Fruit, bark
25	Tawkyetmauk	*Cnestis raniflora*	Connaraceae	Tree	Fruit
26	Kadut	*Ficus hispida*	Moraceae	Tree	Fruit
27	Kanazo	*Baccaurea sapida*	Euphobiaceae	Tree	Fruit
28	Sin koe si ywet	*Cinnamomum parthenoxylon*	Lauraceae	Herb	Leaf
29	Taw nget-pyaw	*Musa bakeri*	Musaceae	Herb	whole
30	Kadat eu	*Diocorea sativa* Linn.	Dioscoreaceae	Tuber	Tuber
31	Thinbaung	*Phoenix raparia (Tvy)*	Arecaceae	Shrub	Leaves
32	Taw-kun-thi	*Aerocomia triandra* Roxb.	Arecaceae	Shrub	Fruit
33	Nwe hmine	Unidentified yet	Unidentified yet	Shrub	Whole parts
34	Hmoe (Le)	Unidentified yet	Unidentified yet	Grass	Leaves
35	Yit phat	Unidentified yet	Unidentified yet	Herb	Leaves

The results of this study further indicated that wild elephant density is correlating with vegetation type and availability of food and water in TNR. The findings show that wild elephant prefer fodders which are Banana (*Musa bakeri*), Wazun (*Neohauzeaua dulloa*), Gonnyinnwe (*Entada pursaetha*), Kadat U (*Diocorea sativa*) and Damyetsii Grass (*Triticum spp*).

The amount of Elephant fodder is quite enough. The home range of wild elephant depends on the availability of food, water in TNR area. The results of this study shows that among the 35 species documented, the following families, such as *Poaceae, Aracaceae,* and *Moraceae* are dominating the other fodder species for wild elephants in TNR (see Figure 4. 10).

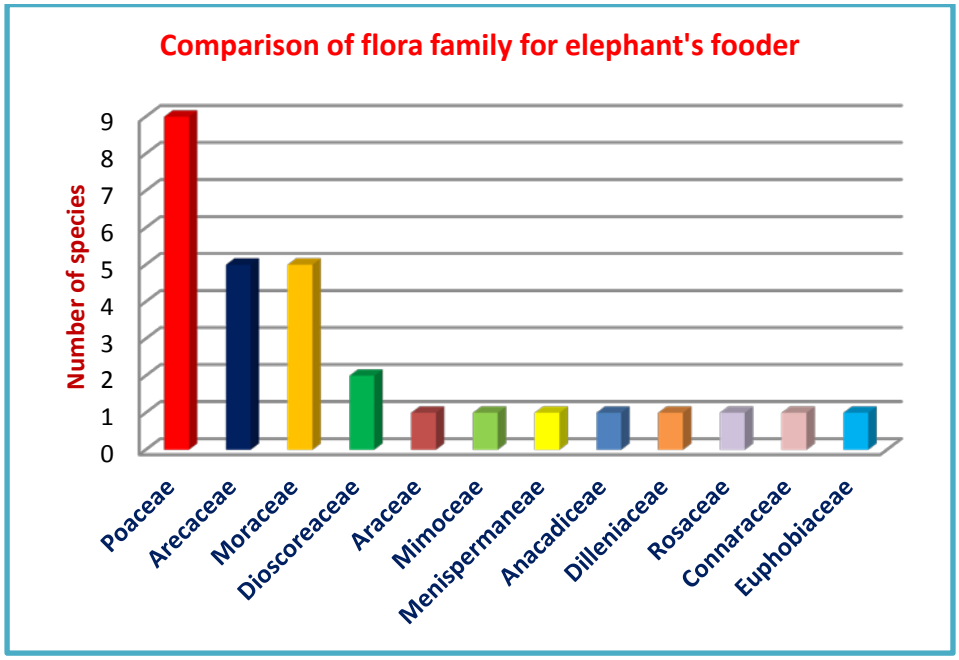

Figure 4.10 Comparison of flora family for fodder species of wild elephants

4.7.2 Importance of saltlick with hot spring

A salt lick is a deposit of mineral salts used regularly by animals including wild elephants to supplement their nutrition, ensuring that they get enough minerals in their diets. Saltlicks influence distribution, abundance and possible seasonal movement of the wild elephants (www.wekipedia).

The significant harsh weather and various topographic positions of Taninthayi Region form salty mineral deposits and several warm and hot springs (*Yebote* as a local name in Karen tribe) that attract wild elephants from miles away for a taste of essential nutrients.

Figure 4.11 A warm mineral spring (Yebone)

Figure 4.12 A hot mineral spring (Yepugyi)

This study found that hot and warm spring saltlicks are generally found in some plain area such as Yebon (name of village) *yebote* or *Byetkathan* (a kind of scent tree eaten by wild elephant) and Yaypugyi *yebote* of Yarphu village in TNR area. The largest distinctive saltlicks at TNR are Yaypugyi, Meke saltlick and Khotama saltlick Yebon saltlick or *Byetkathan yebote* which has a combination of a saltlick (also called *yebote* as a local name in Karen tribe) and warm and hot water springs.

Grasslands and open forests including herbs such as banana (*Musa bakeri*) and small or soft trees and climbers in the TNR could not provide enough minerals for the wild elephant. Therefore they must supplement their diet from saltlicks. Wild elephants inhabit single or in herds within the Yebon *yebote* in TNR, sometimes foot prints of elephants are frequently spotted at saltlicks.

4.7.3 Findings of wild elephant's seasonal movement

Elephants seasonally migrated to low elevation during the dry season, followed by dispersal into the forested hills during the rains. Elephants have the ability to move long distances when necessary due to food or water requirements under seasonal migration pattern (Henning, 2002).

Asian elephants live in seasonal environments and almost all populations move between wet and dry season that differ in availability of food, water and nutrient quality (Sukumar, 1992).

During the time of heavy rain, all streams flow very fast with high level of water. In such a case, wild elephants prefer moving to the area in the eastern gentle slopes of Meke and Zimba mountain range as refuge. According to the findings of elephant's foot prints in this study, they always keep away from steep slopes and areas consisting of abundant big trees from fear of being smashed by fallen trees or broken branches due to the strong wind at the beginning of rainy season. Sometimes, they use some gentle ridge as a trespassing way to move to another secure area in order to refrain from threats of natural disaster when heavy rains are started.

Figure 4.13 Elephant's footprint

Figure 4.14 Elephant's feeding sign

Elephant travel long distance as part of their migration activities. At the same time they stay within different forest habitats where enriched water and fodder species are prevalent. Besides, many of the herds and solitary bulls wander inside all types of forest the whole year. Wild elephants normally live in the lowland and valley of TNR during the dry season. Generally, forage, availability of water and shade of dense forests are correlated to influence the seasonal movement of wild elephants.

This study also found that seasonal movement of wild elephants are heading the direction from South Western towards North Eastern in the summer season based on elephant's foot prints encountered during the vegetation type survey (See Figure 4.15.

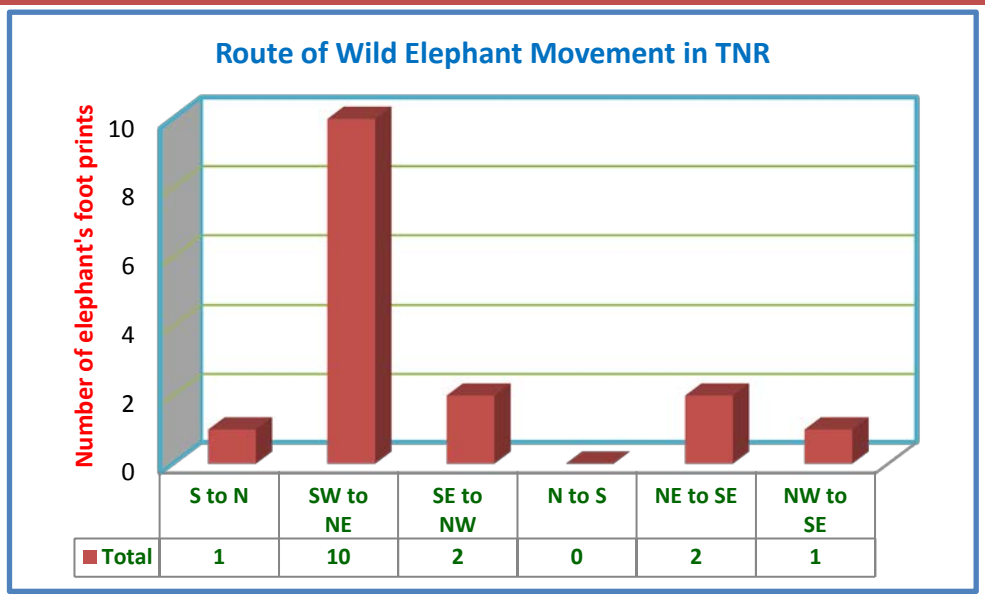

Figure 4.15 Route of wild elephant movement in the summer of TNR

4.8 Threats to wild elephant population in TNR

4.8.1 Finding of wild elephant capture methods by Karen

In Myanmar, there were 3 methods available for the capture of wild elephants. These are: (i) chemical immobilization (still practices in Myanmar); (ii) Kedah and (iii) Mela Shikar methods used by private elephant catchers. Though these three methods were endorsed by the Forest Department, some Karen tribes had used illegal "pit fall" elephant capture methods since 1982 within the area and fringe areas of TNR.

The study found that wild elephant captured method using pitfalls results in heavy casualties and becoming the main problem resulting in the decline of wild elephant population, distribution and abundance in TNR. Most of elephants are also being poached for timber extraction and for marketing them to Thailand through border pass.

Sample of 6 pitfalls found prevalent near the waterholes, mineral licks and shallow and muddy water ponds are shown in the Table 4.8. In the past 20 to 30 years, wild elephants were said to be abundant in the evergreen and semi-evergreen forests of TNR. They were captured with 'Pitfall method' in large numbers and domesticated for use in logging operations by Karen tribe who are still living in the fringe areas of TNR.

Table 4.8 Observation of elephant Pit Fall and their location and elevation

No. of Pit fall	Location (GPS position)	Elevation	Size of pit(ft)	Cubic feet
1	N 14° 31' 52.0" E 098° 16' 10.6"	667	12 x 6 x 8	576
2	N 14° 31' 51.8" E 098° 16' 10.9"	560	12 x 7 x 6	504
3	N 14° 31' 48.2" E 098° 16' 15.6"	559	12 x 7x 7	588
4	N 14° 31' 48.4" E 098° 18' 16.2"	559	11 x 7 x 7	539
5	N 14° 49' 51.0" E 098° 08' 25.9"	102	12 x 6 x 8	576
6	N 14° 51' 16.4" E 098° 08' 34.5"	121	12 x 6 x 8	576

Elephant captured by the pitfall method, during the months of January to April, which coincides with the summer period. Elephant herds, normally travel in search of water holes, salt licks and fodder, form regular paths or walks, in the forests. The Karen traditional pit falls were arranged in sets, where a set consisted of three pits, arranged in a triangle pattern. The dimensions of the pit falls were measured by survey team as follows:

Distance between each pit, in a set – 21 feet. (7 – 8 m)

Depth of each pit – 8 feet (2.7 m) , Length of each pit – 12 feet (4 m)

Diameter of each pit – 6 to 7 feet (2 m or 2.5 m)

Diameter of each pit – 6 to 7 feet (2 m or 2.5 m)

Figure 4.16 Measuring of pit fall depth

Figure 4.17 Measuring of pit fall dimension

4.8.2 Comparison of four elephant capture method

The study indicated that majority of the people who capture these wild elephants are Karen ethnic groups whereas Mon, Dawei and Burmese ethnic groups who also reside in the surrounding area of TNR are not interested to own live elephants. Most of calves are poached for export to Thailand by using illegal trade routes.

This study found that Pit snare with twitch system and Mela shikar is more popular than pitfall and Hlaung (Keddah) method in the border areas of Myanmar and Thailand. Keddah and pitfall methods involve very large expenditure of investment and time consuming for taming and can be organized only near a water hole and saltlick or a known migratory path.

The mortality rate in the Keddah capture method is about 30% which is higher than the death rates incurred in the other two methods (Myint Aung, 1994). This following Table 4.9 show that the mortality rate of pitfall capture method is about 75%, whereas Hlaung or Keddah method is about 50% and Mela Shikar method is 35% respectively.

Table 4.9 Comparison of four elephant capture methods in TNR

Sr.	Capture Method	Investment cost	Taming cost	Mortality rate
1	Pitfall	500,000	500,000	75%
2	Me lar Shikar	300,000	500,000	35%
3	Hlaung (keddah)	1,000,000	500,000	50%
4	Pit snare with twitch	150,000-250,000	500,000	25%

This study indicates that success rate of pit fall is very low as compared to Mela shikar, Hlaung (Keddah) and pit snare with twitch methods. Among these methods, pit snare with twitch system is traditionally preferred by the Karen tribe due to its very low mortality rate and lesser costs. Mela Shikar is relatively cheaper and offers much more liberty regarding the area of operation; however it is not suitable for capturing elephants of bigger sizes (height above 7.5 feet). Mela Shikar involves considerable risk for the Sin Ooze, mahout. There is also a chance of the captive wild elephants getting suffocated if the knot of the noose is too tight for each elephant caught. Nowadays, Karen people in the fringe and surrounding areas of TNR adopted

the Mela shikar method from Thai people and the Karen use this method for illegal wild elephant capture in the southern part of TNR.

4.8.3 Observation of captive elephant numbers in and around of TNR area

According to the following Figure 4.18, there are 23 and 59 domesticated elephants registered in line with wildlife law of Forest Department by owners of Karen ethnic groups as private owned elephants in the Yayphu and Dawei Township, Taninthayi Region.

This study shows that all captive elephants were transformed from wild elephants within the area of Forest Reserves in Taninthayi Region, including TNR. The following Figure 4.18 also shows that there are no working elephants in this region owned by Myanmar Timber Enterprise (MTE). All of captive elephants are owned by private sector only. Although wild elephants are not correlated directly to deforestation, captive elephants are totally related to deforestation of TNR because all captive elephants are being used in illegal logging in this area.

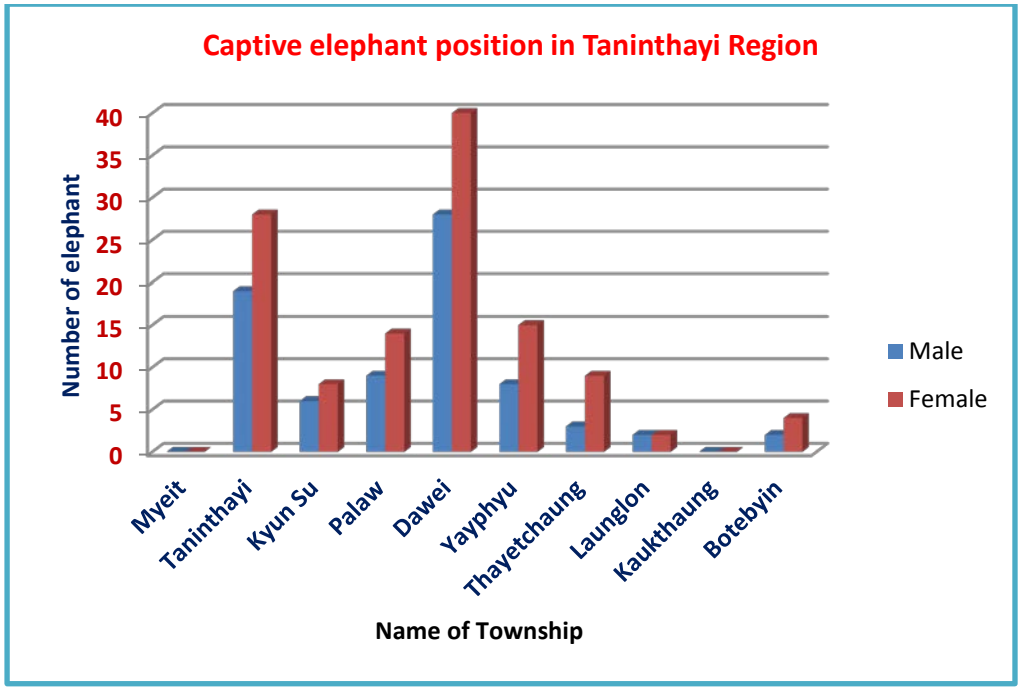

Figure 4.18 Captive elephant position in Taninthayi Region

4.8.4 Habitat loss and deforestation in TNR

Deforestation and the resulting loss of wild elephant habitat is a major threats to the survival of viable populations wild elephants in TNR.

It is also quite apparent that the extent of deforestation inside 10 km buffer is in the reverse order; almost double the quantity of evergreen forest are deforested as there seems to be fewer areas left available for expansion of agri / horticultural lands in 2006 when compared to 2000 (TNRP, 2009).

According to the results from this study, extension of agricultural land, shifting cultural practices and extension of oil palm and rubber plantation, particularly in the vicinity areas, has resulted in substantial permanent conversion from forest land to agricultural land. Although legal logging concessionaires are not allowed by the Forest Department, some illegal timber activities are presently done by local villagers in and around the TNR area.

4.8.5 Human Elephant Conflicts (HEC) in TNR

In general, the population growth of humans, aggravated by settlements, encourages increase in Human Elephant Conflict (HEC). Habitat loss also increases the incidence of conflict with humans (Begley, 2006).

Figure 4.19 Human Elephant Conflict

Figure 4.20 Human Elephant Conflict in TNR

According to the questionnaire interview, there are a few cases of conflict between Human and Elephant in and surrounding area of TNR. Half of the cases were involved through soldiers using automatic guns in self defense against the wild elephants attack on them. The other half of the cases were due to the destruction of

cultivated crops such as paddy and maize fields invaded by wild elephant while foraging for food. Additionally, wild elephants annually move outside of TNR boundary at the beginning of winter season (*thadingyut and tazaungmone*) when the cultivated paddy fields have ripened and also during their visits to saltlicks.

The following Table 4.10 indicates the size of household and population of local ethnic groups in the fringe area of TNR. The biggest number of inhabitants is observed in Michaunglaung (old) village 1,038 and the least amount in Heinze 183. Other villages have inhabitants within a range of 300 to 733. The average household size of those villages appear to be not very large, ranging from 2.5 (Kyaukshut) to 9.5 (Michaunglaug-old). However, the population and family sizes of 12 village tracts locating in surrounding area of TNR are low. The existing human population about 16,000 in 2010, so far will not be a serious threat for suddenly damaging the entire habitat area of wild elephants. In fact, the domain habitat of wild elephants in TNR is still in very good shape and amount of fodder is also very plentiful which indicate that the availability of fodder of wild elephants may influence reduction of Human Elephant Conflict in TNR. This study found that there is no habitat loss at the valley of TNR despite some deforestation in the vicinity of the area.

Table 4.10 Household and population of villages profile in the vicinity area of TNR

Sr.	Name of village	Household	Population	Average HH size
1	Yarphu	70	336	4.8
2	Tharyarmon	105	448	4.2
3	60 mile	48	250	5.2
4	Kawhlaing	73	300	4.1
5	Mayanchaung	100	506	5.06
6	Michaunglaung (old)	109	1038	9.5
7	Michaunglaung (new)	77	470	6.1
8	Zinba	146	733	5.02
9	Kyaukshut	162	411	2.5
10	Yebone	106	608	5.7
11	Heinze	30	183	6.1
12	Hnankye	98	640	6.5
	Total	1124	5923	5.2

Source: Village profile: TNRP 2010

This study concludes that there are very rare Human Elephant Conflict (HEC) cases in and surrounding area of TNR. However, the remaining population is affected

by threats of local and foreign hunters within TNR and also from threats well outside the administrative boundary of the TNR.

4.8.6 Poaching

Poaching using snares, poisoned spears and arrows, drop spears, guns, pitfalls, hunting dogs, and insecticides are common (Henning, 2002). Hunting and capture of elephants in TNR is mainly to satisfy the demand for ivory and live elephants in TNR (Shepherd, 2008). Moreover, hunting and trapping for subsistence requirements is still in practice among all the villages in the vicinity of TNR (Min Thant Zin, 2009).

However, the capture and sale of live elephants for use in the tourism industry, especially in neighboring Thailand, also constitutes a major threat to Myanmar's elephants. In the past, live elephants were often smuggled into Thailand for use in the logging industry (Liar, 1997). However, since Thailand banned logging in 1990, market preferences have caused a shift in the age composition of the live elephants taken out of Myanmar, with calves and juveniles now being targeted and sold into the tourism industry (Liar, 1997; Shepherd, 2002). The calves were purchased for between THB 125,000 – 150,000 (US$ 5 – 6000, 1997 conversion rate) with the specific intent of teaching them simple circus stunts and then selling them within a few months for THB 200,000 (US$ 8,000) (Liar, 1997).

According to the results from questionnaire interview, 5 - 10 numbers of live wild elephants were annually smuggled out of Myanmar into Thailand through Three Pagoda Border pass. Especially poaching of live calve elephants, are demand from the TNR to Thailand in order to supply the tourism industry.

The main objective of commercial hunting for wild elephant is killed for their ivory. According to the results from questionnaire interview, ivory can be taken after dead of domesticated elephant. There is no information of elephant killing for taking of ivory purpose in TNR because most of local villagers obey the traditional elephant law of Karen National Union (KNU) in which if one wild elephant was killed by hunter for the taken of ivory, the hunter must be penalized with death toll bylaw of KNU in TNR.

CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

This study clearly shows that the maximum remaining numbers of wild elephants are 45.19 – 64.04 in 1601.30 km^2 of the total TNR area and its distribution and abundance of elephants from TNR is 0.087/ km^2 in high density strata (HDS), 0.029/ km^2 in medium density strata (MDS) and 0.004/ km^2 in low density strata (LDS) within TNR, based on 183 dung piles on the 60 line transects.

The result of experiment in this study is entirely based on four captive elephant's defecation rates which are on the average of 13.3 per 24 hour. The decay rate of 0.012 as stipulated is based on 10 dung piles of wild elephants, out of 20 dung-piles spotted near the service track of Total Gas Pipeline in TNR. This result can be used in the next dung count based estimation of population of elephants in the survey area.

The domain area of wild elephants in TNR is still very good and amount of fodder is also very plentiful which indicated that the availability of fodder of wild elephant is adequate enough for the remaining wild elephants of 45.19 -64.04 in 1601.30 km^2 (94.19% of total reserve area). One or two solitary bull elephants can be found in the Low Density Strata (LDS) by the migratory behavior in the vicinity of TNR at the beginning of every dry season. There are no wild elephants in the 98.70 km^2 (5.81%) total area of TNR due to the greater than 30% steep slope and high elevation more than 1500 feet above sea level.

Although elephants usually were not found in the steep mountainous area, most of the elephants are found wandering in the steep sided Zinba valley between Ban I Taung and Zimba-Mekhe ridge ahead to Khamaungthwe catchment as domain habitat which is between above sea level (ASL) 220 to 650 feet in the dry season. (Please see figure 5.1)

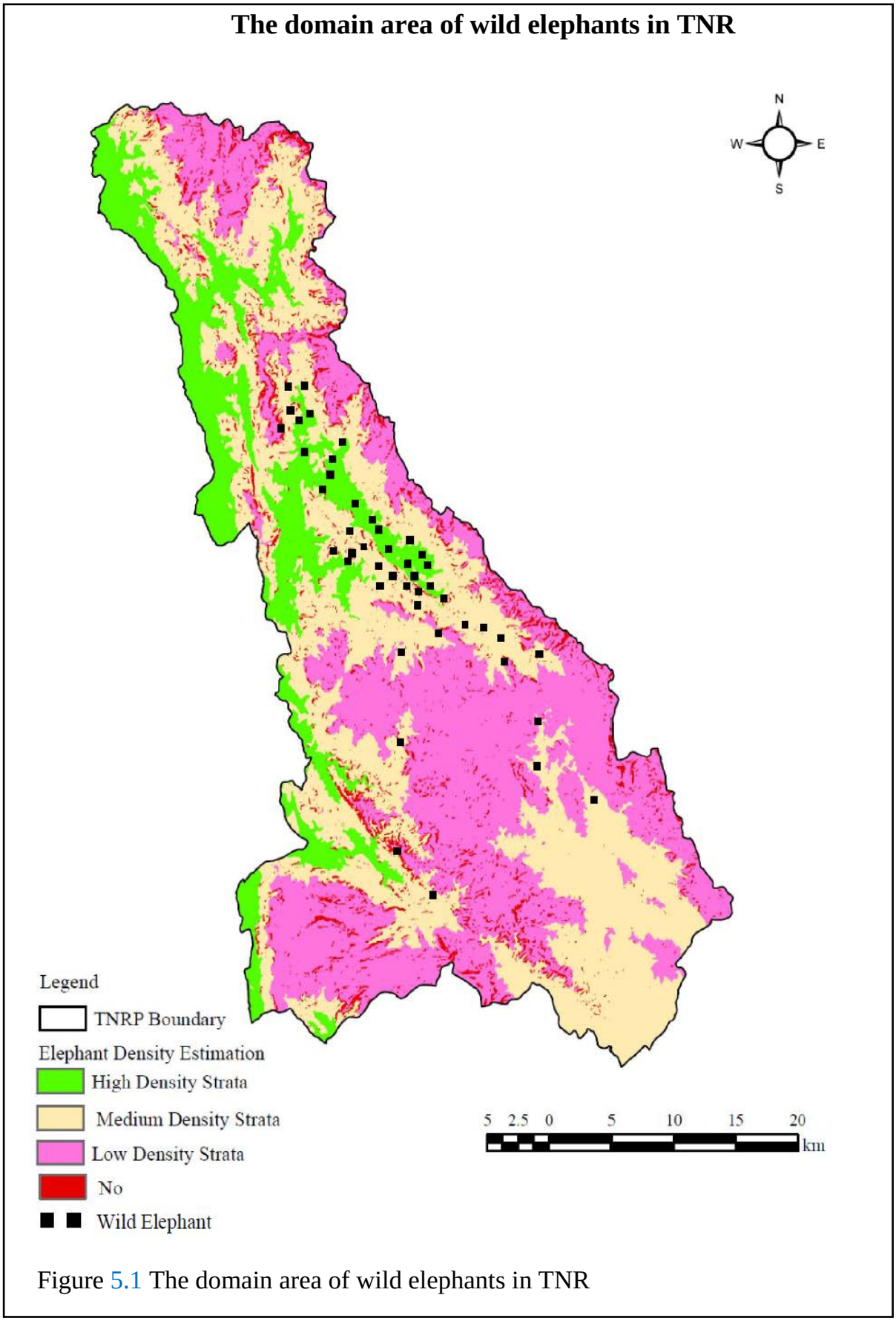

Figure 5.1 The domain area of wild elephants in TNR

This fact can therefore be integrated in the Operational Management Plan in future knowing that the remaining population size of wild elephants in TNR is at a critically low level compared to its habitat area and is declining gradually throughout most of their ranges due to major threats of poaching, deforestation and illegal capture. It is anticipated that the remaining elephants are declining with alarming rate and will continue to do so unless immediate action is taken to prevent this decline.

This study suggested that 35 plant species were consumed by elephants as their fodder food in the dry season and wild elephant density is correlated with vegetation type and availability of food and water in TNR. It was found out that wild elephant preferred fodder is Banana (*Musa bakeri*), Wazun (*Neohauzeaua dulloa*), Gonnyinnwe (*Entada pursaetha*), Kadat U (*Diocorea sativa*) and Damyetsii Grass (*Triticum spp*) in the dry season.

Moreover, the hot and warm mineral spring saltlicks are very important components of wild life conservation especially for wild elephant health in TNR. These saltlicks needed to be maintained for the health and longevity of many wild mammals including elephants and other wildlife.. This is supported by the photographs of elephants obtained from camera traps installed at saltlicks. This fact need to be taken into account as very significant when considering the revision of the Operational Management Plan for the next phase.

This study concludes that a few cases of conflicts between Human and Elephants had occurred one or two times in the temporary military base camps inside of TNR and some of the shifting cultivated areas in the vicinity of TNR. These incidences were not too serious at that time. As at present, there are no distinctive Human Elephant Conflict (HEC) cases as of wild elephants poaching and commercial hunting inside TNR are not allowed or tolerated.

Wild elephant are captured throughout most of their range in TNR during the last two and three decades and then these domesticated elephants are often used for illegal logging and for capture of the wild calves for illegal trade in Thailand. The capture of wild elephants for domestic use has become a threat to wild elephant population where the numbers have been seriously reduced. This serious reduction proved that crude capture methods (Pitfalls and Hlaung or Keddah) have lead to a high

mortality level (minimum 35% to maximum 75%) in accordance with the results from questionnaire surveys.

The Myanma Timber Enterprise (MTE) had no domesticated elephants in Taninthayi Region. It gives the impression that privately owned domesticated elephants may be involved in legal as well as illegal logging. The main reason is that wild elephants are not directly related to deforestation; however all domesticated elephants are now causative factors for deforestation in TNR as logging was banned in TNR since 2005.

The major problem facing the wild elephant in TNR is the increase of commercial uncontrolled illegal logging, hunting, and poaching by local and foreign hunters and the increasing of ivory from elephants, be it wild or domesticated demand. On other hand the majority of the people who capture these wild elephants are of the Karen tribe. This kind of threat should be given the highest priority and this issue should be considered seriously during the next revision of Operational Management Plan including the issue of licenses for capturing wild elephants.

The seasonal movements of wild elephants were from South Western toward North Eastern direction in the dry season**.**

From conservation point of view, protecting the tropical rain forests habitat is crucially important, not only for the future of the density and distribution of wild elephants but also for the other wildlife species and for the basic needs of people. Under the Myanmar Selection System (MSS) elephants are still holding a pivotal role in logging operations due to its low impact on the environment compared to those using machineries.

From the social and cultural stand point, elephants have good relationship with Myanmar people for a long time, in terms of religion and culture since 16th century.

From the economic stand point, the purchase price of one elephant is 6,000,000 Kyats to 10,000,000 Kyats this year depending on whether it has ivory or not.

From the land use stand point, TNR area is surrounded by a landscape dominated by people. Although human population is not too high, conversion of forest land to commercial plantations in the buffer zone of TNR strongly threatens the existence of biodiversity in the core area of TNR including elephants.

From the legal stand point, the border crossing at Ban-I-Taung and other points of entry and exits between Myanmar and Thailand is severely lacking in investigating and control of wildlife and wildlife products trafficing. Without effective law enforcement, illegal poaching and trade will obviously continue across TNR.

There is an urgent need to conserve the remaining wild elephants including the environment on which depends their livelihood and existence in the TNR.

5.2 Recommendations

In order to maintain the remaining herds of elephants in TNR area and to promote synchronization between fulfilling of human needs and improvement of wildlife conservation, the following recommendations are needed based on four months consultancy at TNR.

1. All local hunters, domesticated elephant owners and elephant catchers should be educated about Wildlife Laws and Forest Laws in the Michaunglaung Environmental Education Center. These persons are living in the vicinity of TNR and rely on wildlife and wildlife products of TNR for their livelihood.
2. The Forest Department of Taninthayi Region need to stop issuance of new capture licenses for wild elephants in order to reduce conversion of wild to domesticated elephants due to the increasing population of domesticated elephants (FD - Taninthayi Region, 2011). This has serious impact by having decreasing the population of wild elephants, especially in TNR area.
3. The Forest Department of Taninthayi Region also needs to monitor strictly the renewal of domesticated elephant license with detailed enquiry and fill in detail the measurements on Descriptive Roll of Elephant (annexure to forest records 11) form. Moreover, they need to check every 5 years interval, with 4 genuine photographs of each elephant. They should issue the Record (11) only after investigating application documents against the concerned elephant, because sometimes owner of the elephant can substitute new elephants in place of registered elephants.

4. Privately owned domesticated elephant populations with license should be controlled by both Forest Department and TNRP staff as far as is practicable in order to prevent illegal logging in the vicinity of TNR.
5. Migration and traveling without permission of domesticated elephants should be regularly checked by Township Forest Department in accordance with Forest and Wildlife Laws in order to prevent illegal logging activities in and around TNR area because elephants could probably be ready to engage for log dragging from forests to accessible area.
6. "Elephant Management Zone" should be established specifically inside TNR area specifically and protected with exclusive Law intensively similar to that of the first elephant range in Yakhine Yoma Elephant sanctuary. Otherwise, the remaining population of wild elephants will dwindle within a few years.
7. "Elephant Conservation Unit" should be formed in the priority wild elephant areas of TNR including forest rangers and wildlife officers, veterinarians experienced in wild elephant capture, mahouts and administrative staff in order to improve security and health care of wild elephants in TNR.
8. The TNRP need to create artificial (man-made) saltlicks and sugar cane plantations to improve the health of wild elephants. In turn, it is similar to enhance their habitat enrichment inside of the some forest areas especially in elephant range of TNR.
9. All potential wild elephant corridor area needs to be identified and surveyed so as to ensure free movement of wild elephants in TNR adjacent to WEFCOM area of Thailand.
10. With improved security condition, a main base camp (e.g., container like temporary camp of Total Co, Ltd.) should be built at a suitable place beside the service track in TNR area in order to regularly check illegal transportation and trades of wild animals and its products. This base camp can be used for monitoring illegal poaching and also for assisting researchers for scientific research.

11. At least 4 local staff and 1 ranger from LOU should be obligated weekly in the new main base camp inside TNR in order to monitor aforementioned duty and responsibility.
12. After receiving complete information from local staff concerning all old elephant captured pitfalls should be destroyed or refilled with earth or digging tunnels at abandoned pitfall's frontage walls as escape routes to save any kind of wildlife species from being trapped inside.
13. All LOUs should be provided with cellular hand phones in order to have good communications with the project office at Gangawtaung, especially security measures.
14. Although TNR management has carried out patrolling occasionally with the extension staffs, they need to acquire important information of wild elephant poachers, trade of ivory outside and calves under the administration of management committee inside and the vicinity of the Nature Reserve in different location so as to protect illegal activity in time.
15. Both patrolling staff and extension staff should gather information regarding wildlife poaching, wildlife trade and other matters that may hamper the integrity of TNR during they stay at villages.
16. The wild elephant population may face less immediate threat to the illegal hunting of elephant than other populations. However, if these activities are left uncontrolled, illegal and commercial hunting could conceivably become a serious threat to TNR in the future, as illegal commercial hunting for almost all species of animals still prevalent in the TNR.
17. Field allowances for TNR staff from FD as well as salaries of locals should be reviewed as soon as possible as the exchange rate of FEC is nose-diving at the moment. Moreover, traveling allowances during the field operations and charges for going to and fro from LOU to Gangawtaung office should be included in the provision of budget in future.
18. Existing Wildlife and Wild Plant Laws on illegal capture and trade of wild elephants and trade in wildlife products such as ivory and calve should be

streamlined with other international regulations such as CITES need to be strengthened urgently.

19. All level of locals, especially villagers in the vicinity of TNR, company staff and laborers from gas exploitation and transportation companies and all ranks of the army forces personnel who are taking security control at transportation corridor of TNR need urgent provision of effective extension and awareness on **"Do's and Don'ts"** that may seriously endangered the status of wild elephants in TNR.
20. Special life insurance program from Myanma Economic Bank for National Consultants as well as all project staff should be arranged because these persons may get into trouble at any time while working at TNR due to natural disasters such as landslides, falling of trees through strong wind and heavy rain, flooding in rainy season, and accidents such as being bitten by king cobras and attack by dangerous animals.

5.3 Further research

Further studies are needed to conduct in TNR in order to determine the actual sex ratio and the population of calves in their habitat of TNR. A basic need for effective elephant management is to conduct scientific research on its ecology in TNR. The research study radio-telemetry is needed for further research if funds and technology are available for studying home range of wild elephants in TNR. This research should also determine on seasonal elephant movement patterns beyond the elephant range of TNR and adjacent area of WEFCOM in Thailand. Moreover, scientific elephant research studies such as evaluation of habitat and their home range size, census techniques of captured and recapture of wild elephants needed to be conducted as much as is possible for strengthening the elephant research program at TNR in future.

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Appendix-1.1

Observation of Decay rate

Monitoring of decay rate

Checking of transformation stage

Transforming from S1 to S2

Changing from S2 to S3

Reclassification of transforming stage

Recheck on dung pile decay rate

Changing from Stage 3 to Stage 4

Changing from stage 3 to stage 4

Appendix-1.2

Observation of Defecation rate with captive elephant

Feeding of fodder to elephant

Monitoring of defecation trial

Elephant defecating

In the elephant's feeding ground

Experiment of elephant defecating

Counting of dung piles

Discussion with mahout for defecation

Checking of defecated bolus

Appendix-1.3

Observation of dung decay rate

Intact dung pile (8th March 2011)

Observation of dung decay rate

Intact dung pile (8th March 2011)

Observation of dung decay rate

Intact dung pile (8th March 2011)

Intact dung pile (Stage 1)

Intact dung pile (Stage 1)

Appendix-1.4


Identification of elephant fodder (Bamboo)


Finding of elephant fodder in MUMD


Identification of elephant fodder (Evergreen)


Observation of elephant feeding sign


Measuring of sample block


Elephant feeding sign

Measuring of elephant feeding ground


Measuring the elephant feeding sign

Appendix-1.5

Interview with Mahouts and Owners of Captive Elephants

Interview in Yebon Village

Interview in Mile 60 village

Interview in Michaunglaung village

Interview in Laukthaing village

Interview with Kaleinaung Forest Department

Interview in Kaleinaung Sub-township

Interview in Zinba village

Interview in Nyaungdon village

Appendix-1.6

Pictures from Camera traps

03-12-2011 (19:52:45)

03-19-2011 (20:00:59)

03-19-2011 (20:01:51)

03-30-2011 (07:08:52)

03-30-2011 (19:35:06)

03-30-2011 (19:35:31)

04-20-2011 (22:02:01)

03:30:2011 (19:52:33)

Appendix 1.7

Observation of pitfalls in TNR

Near the yebon byetkathan saltlick

Measuring of pitfall depth

Measuring of pitfall depth

Recording of location with GPS

The pitfall is near the Yaypugyi saltlick

Filling with bamboo leaves in the pit

Bamboos area growing in the pitfall

Dead pitfall with bamboo

Appendix -2

List of interviewee for elephant distribution and abundance in TNR

Sr.	Date	Village/ Organization	Soldier	Hunter	Owner	Mahout	Old Catcher	Gov staff	Total
1	7-3-11	Nataintaung	-	1	-	-	-	-	1
2	9-3-11	KLG camp	2	-	-	-	-	-	2
3	11-3-11	Point-1500	1	-	-	-	-	-	1
4	22-3-11	KLG camp	1	-	-	-	-	-	1
5	27-3-11	Yebon	-	3	-	2	3	-	8
6	3-3-11	Zimba	-	1	1	1	-	-	3
7	27-4-11	Yarphu	-	2	2	1	-	-	5
8	28-4-11	Laukthine	-	-	3	2	-	-	5
9	29-4-11	Tahyarmon	-	6	-	-	-	-	6
10	29-4-11	60 mile	-	1	2	-	-	-	3
11	29-4-11	Mayanchaung	-	-	-	3	-	-	3
12	5-5-11	Michaunglaung (old)	-	1	-	1	2	-	4
13	5-5-11	Michaubglaung (new)	-	2	1	1	-	-	4
14	6-5-11	Heinze	-	1	-	-	-	-	1
15	7-5-11	Hnankye	-	-	-	2	-	-	3
16	7-5-11	Thetkekhwet	-	-	-	1	-	-	2
17	8-5-11	Zimba	-	-	-	-	3	-	3
18	8-5-11	FD (KLA)	-	-	-	-	-	6	6
19	9-5-11	FD (Region)	-	-	-	-	-	1	1
20	10-5-11	FD (Dawei)	-	-	-	-	-	2	2
21	11-5-11	Myaykhanbaw	-	-	5	-	1	-	6
22	11-5-11	Seitphone	-	-	-	-	1	-	1
23	12-5-11	Nyaungdone	-	-	3	-	1	-	4
24	12-5-11	Taungthonelone	-	-	1	-	-	-	1
25	12-5-11	Myitta	-	-	-	-	1	-	1
26	13-5-11	Yephyu	-	-	-	-	-	2	2
27	15-5-11	Kyaukshut	-	1	-	2	-	-	3
28	19-5-11	Taliangya	-	-	2	-	-	-	2
29	20-5-11	Kalonehta	-	1	-	-	1	-	2
30	10-6-11	Nataintaung	-	2	-	-	-	-	2
31	11-6-11	Heinze	-	-	-	1	-	-	1
32	14-6-11	Yebon	-	2	-	-	-	-	2
33	14-6-11	Zimba	-	1	1	1	-	-	3
34	14-6-11	Hnankye	-	1	-	-	-	-	1
35	18-6-11	Kaukhline	-	1	-	2	-	-	3
36	18-6-11	Mayanchaung	-	2	2	-	-	-	4
37	19-6-11	Laukthine	-	-	2	2	-	-	4
38	19-6-11	Laukthine	-	2	2	-	-	-	4
39	19-6-11	Yarphu	-	3	1	-	-	-	4
40	20-6-11	Point-1500	2	-	-	-	-	-	2
		Total	**6**	**36**	**28**	**20**	**13**	**12**	**115**

Appendix-3

Recce-survey transect data entry form

Date:	Recce-survey transect number:	
General description of location:		
Start point (UTM):		
Finish point (UTM):		
Compass bearing:	Distance at finish (m): km	
Start time:	Finish time:	
Team member's names:		
Distance from start (m)	Number of dung-piles <2 m from RST line/ decay stage	Other notes
All data were noted in detail for every Recce Line Transect route		

Appendix-4

Line transect datasheet showing an example of typical field data

Date (dd/mm/yyyy): 09/01/2011				Line transect number: Example 1	
General description of location: 2 km from Mon village to Dawai village					
Start point (UTM): N E					
Finish point (UTM):N E					
Compass bearing:				Distance at finish (m): km	
Start time:				Finish time:	
Team member's names:					
Distance from start (m)	**Dung-pile data**				**Other notes**
	Number of boli	**Perpendicular distance (cm)**	**Decay stage**	**Diameter (cm)**	
All data were noted in detail for every line transect route					

More of the data sheet should be self-explanatory. A couple of points of clarification are however included below:

1. The line transect number is that on the survey locations map and GIS for the site;
2. For the General description of location' the team leader should write something like "approximately 2 km from Shan village to Mon village;
3. The "Other notes" column should be used for recording transition between vegetation types; elephant sighting, carcasses, etc.

Appendix- 5

Things to record along line transects

- To record all of the things in the list below, and make a note of the distance from the start point of the transect using a permanent ink pen or pencil. In addition, for those things indicated below, GPS locations should also be recorded.

Things	Record distance from start point using a pen	Record GPS location
All elephant dung-piles found (see below for further detail)	Yes	Yes
Any sightings of elephants	Yes	Yes
Any elephant carcasses found	No	No
All elephant trails that cross the line transect route	Some elephant trails cross the line transect route, some trails that not cross route	Yes
Any logging roads that cross the line transect route	No logging	No
Any crop fields or other agricultural activity encountered	No	No
Any other signs of human activity (e.g. snares, poachers' camps, etc.	Yes, Pitfalls & snares	Yes
Any saltlicks	Yes	Yes
Any streams or small waterholes	Yes	Yes
Any ponds or lakes	Yes	No
Transitions between major vegetation types	Yes	Yes

Appendix- 6

Data to record when monitoring dung-pile decay rates

a) Essential location data for monitored dung-piles

What to record:	Where to record it:
Reference number	All of dung piles were recorded
GPS location data (UTM data)	Mentioned in the Table 4.2
Paces and compass bearing from tree red painted reference number	No, record with only GPS Position
Paces and compass bearing from orange flagging tape	No, record with only GPS Position
A description of the location (to help you find the general area again)	Most of dung piles were found in the Khotama Military Base Camp, 8 dung piles were found beside of service tracks. Types of vegetation are diversified such as

b) Other data to record for each dung piles

In addition to the reference number and location data discussed above, the following data should be collected for each dung-pile:

- The date the dung-pile was found: Mentioned in Table 4.2
- The number of boli in the dung-pile: Mentioned in Table 4.2
- Whether the dung-pile was found on a trail or not: 7 are on a trail, other 3 are found in Bamboo and scrubland forest
- Whether the dung-pile was moved (e.g. whether it was moved off a trail into the surrounding forest): No movement
- The vegetation type: 1 & 2 -Moist Upper Mixed Deciduous, 3,4,5,6,7 – beside of service track, 8 –Bamboo forest, 9 – scrubland forests
- Slope (degree): 1 & 2 = 3% , 3 = 5 %, 4 = 10%, 5= 7%, 6= 12%, 7 = 15%, 8 = 9%, 9= 10%, 10= 15% beside of service tracks
- Altitude (meters above sea level): 1= 350 ft,2= 333ft, 3 = 462ft, 4= 429ft, 5= 512ft, 6= 484ft, 7= 385 ft, 8= 476 ft, 9= 492 ft, 10= 363 ft (Above Sea Level)

Appendix -7

Elephant abundance, distribution and ecology survey in Taninthayi Nature Reserve

Objectives

1. To study the abundance, distribution and ecology of Elephant in the Taninthayi Nature Reserve.
2. To maintain appropriate notes and records and prepare comprehensive reports for submission to the Project.
3. To assist in the development of biodiversity databases.

Time management (March 1st week to June 4th week)

Sr.	Time Period		Kinds of work
	From	To	
1	1-3- 2011	7-3-2011	Preparation & formation of survey team
2	8-3- 2011	14-3-2011	Giving short lecture on survey team (daily wages)
3	15-3-2011	17-3-2011	Monitoring of dung decay rate
4	18-3-2011	23-3-2011	Collection of secondary data for TNR
5	24-3-2011	28-3-2011	Drawing of survey design
6	29-3-2011	31-3-2011	Determination of survey design
7	1-4-2011	31-4-2011	Surveying with line transect in strata 1
8	1-5-2011	31-5-2011	Surveying with block s in strata 2
9	1-6-2011	15-6-2011	Surveying with line transect in strata 3
10	16-6-2011	22-6-2011	Data compilation , analysis & ratification
11	23-6-2011	30-6-2011	Writing survey reports
12	1-7-2011	7-7-2011	Submission of survey reports
13	8-7-2011	15-7-2011	Presentation of wild elephant survey

Appendix -8

Questionnaires of interview for wild elephants in TNR

Name ..... Date .....

Age ..... Venue .....

Employment .....

1. How many years are you staying in this place/ village? How many times did you find wild elephant in here and surrounding area?
2. Have you ever seen wild elephants in the surrounding area? (Yes or No)
3. Have you ever seen or hear which places were staying wild elephants?
4. If so, did you see how many elephants with herd or solitary? Foot prints or elephant?
5. Did you see only one or herd?
6. If you saw only one has that elephant tusk or bull?
7. If that elephant has tusk, how many tusk did he have? Left tusk or right tusk or small tusks?
8. If you saw elephants were herd, how many elephants? Please can you estimate the number of elephants what you seen, have they calves? How many calves in the herd?
9. Did you see some wild elephant during summer, rainy or winter season?
10. Is it escarpment/ beside of stream (riverine)/ ridge/ valley/ road side (beside of service track)?
11. Did you know how wild elephant's seasonal movement at summer/ rainy/ winter season in this area?
12. Which places were preferred by wild elephant for their home habitat?
13. How do you think the numbers of wild elephants is decrease or increase in TNR?
14. Can you estimate an existing numbers of wild elephant in this TNR area?
15. How do you think for comparison on habit size and number of wild elephants? Is it fair or unfair?
16. Do you think folder for wild elephants is quite enough or not in this TNRP area?
17. Have you ever seen or hear about of destroyed shifting cultivated land or orchard in this area?
18. If so, did wild elephants destroy such things when, where, what kind of plantation/ what to be crushed by wild elephant?

19. Do you have any information about of wild elephant cross the threshold to village area, if so when?
20. Did you know catchment of wild elephants in TNR area? If so, when did you know?
21. If so, how did they catch wild elephant? What kind of method for catch? How many wild elephant did they catch?
22. Did you know the about of Human Elephant Conflict (HEC) among local people? If so, when did this case occur?
23. Have you ever found carcasses such as bone, tusk, and meats of dead wild elephants in this TNRP area?
24. Have you ever seen selling of carcasses such as bone, tusk, and meats of dead elephants in the bazaar?

Appendix -9

List of project staff for the supporting to NC in this study

Trip No.	Name	Position	Duty	Survey period	
				From	To
1	U Kyi Oo Sai Thiha Aung Saw Showlamore	Range Officer Patrolling staff Patrolling staff	Team Leader Supporting & Measurement	7-3-11	12-3-11
2	U Kyi Oo U Aung Kyaw Myint U Win Zaw Aye U Win Min Oo Saw Thu Dee	Range Officer Forester Patrolling staff Patrolling staff Patrolling staff	Team Leader Asst. Team Leader Supporting staff Supporting staff Supporting staff	20-3-11	23-3-11
3	U Chit Zaw U Khet Khet Kyaw Saw PhoThar Htoo U Win Zaw Aye Saw Showlamore U Arkar Linn	Deputy Ranger Deputy Ranger Patrolling staff Patrolling staff Patrolling staff Casual Labor	Team Leader Second team Leader Supporting staff Supporting staff Supporting staff	27-3-11	30-3-11
4	U Am Khwi Shein U Zaw Min Naing Saw Eh Eh Saw Thein Soe Ko Soe Tun	Deputy Ranger Forester Patrolling staff Extension staff Extension staff	Overall arrangement Supporting staff Supporting staff Supporting staff Supporting staff	27-4-11	29-4-11
5	U Myint Shein U Tun Tun Oo Saw Shoelamore Saw Yoe Another Saw Sakapaw Mg Nge Nge Zaw	Deputy Ranger Forester Patrolling staff Extension staff Extension staff Labor	Team Leader Second team Leader Supporting staff Supporting staff Supporting staff	19-5-11	22-5-11
6	U Myint Shein U Tun Tun Oo Saw Yoe Another Saw Arkar Linn Mg Soe Tun Mg kyaw Soe Lwin	Deputy Ranger Forester Patrolling staff Extension staff Extension staff Labor	Team Leader Second team Leader Supporting staff Supporting staff Supporting staff	11-6-11	14-6-11
7	U Zaw Min Naing U Myo Aung Zin Saw Thu Htoo Saw Aeroplane Sai Thiha Aung	Forester Forester Patrolling staff Extension staff Extension staff	Team Leader Second team Leader Supporting staff Supporting staff Supporting staff	20-6-11	24-6-11

Appendix-10

Dung piles were found in the three strata

High Density Strata (HDS)

Sr.	Stratum	Length (km)	Width (m)	Area (km^2)	Transect	Distance	Cluster size	Decay stage	Diameter of Dung
1	Stratum A	1.2	40	0.048	Line 1	12	3	S 1	10.2
2	Stratum A				Line 1	27	3	S 1	15.6
3	Stratum A				Line 1	14	2	S 2	14.3
4	Stratum A	1.78	40	0.0712	Line 2	9	3	S 2	12.9
5	Stratum A				Line 2	8	3	S 2	13.7
6	Stratum A				Line 2	22	2	S 2	14.8
7	Stratum A	1.9	40	0.076	Line 3	41	2	S 1	15.9
8	Stratum A				Line 3	24	3	S 1	14.4
9	Stratum A				Line 3	15	2	S 1	13.8
10	Stratum A				Line 3	40	3	S 2	14.2
11	Stratum A				Line 3	10	4	S 2	12.3
12	Stratum A	2	40	0.084	Line 4	15	3	S 2	12.4
13	Stratum A				Line 4	22	3	S 1	14.3
14	Stratum A				Line 4	43	3	S 2	14.6
15	Stratum A				Line 4	11	3	S 2	14.5
16	Stratum A	2	40	0.084	Line 5	49	4	S 2	10.2
17	Stratum A				Line 5	27	4	S 2	10.2
18	Stratum A				Line 5	19	5	S 1	15.9
19	Stratum A				Line 5	48	3	S 1	14.6
20	Stratum A				Line 5	32	3	S 2	13.3
21	Stratum A				Line 5	43	4	S 3	14.5
22	Stratum A				Line 5	45	4	S 3	14.2
23	Stratum A	2.3	40	0.092	Line 6	43	3	S 3	12.3
24	Stratum A				Line 6	46	4	S 3	12.4
25	Stratum A				Line 6	12	3	S 2	14.3
26	Stratum A				Line 6	17	3	S 3	14.6
27	Stratum A	1.87	40	0.0748	Line 7	14	3	S 3	14.5
28	Stratum A				Line 7	28	2	S 3	15.3
29	Stratum A				Line 7	10	2	S 3	12.7
30	Stratum A				Line 7	26	3	S 2	14.2
31	Stratum A	1.54	40	0.0616	Line 8	33	2	S 3	12.3
32	Stratum A				Line 8	42	2	S 2	12.4
33	Stratum A				Line 8	30	2	S 2	14.3
34	Stratum A				Line 8	31	3	S 3	14.6
35	Stratum A	1.45	40	0.058	Line 9	36	3	S 3	14.5
36	Stratum A				Line 9	27	3	S 2	13.7
37	Stratum A				Line 9	16	4	S 3	15.8

High Density Strata (HDS)

Sr.	Stratum	Length (km)	Width (m)	Area (km^2)	Transect	Distance	Cluster size	Decay stage	Diameter of Dung
38	Stratum A	1.58	40	0.0632	Line 10	28	2	S 1	15.9
39	Stratum A				Line 10	23	5	S 2	14.6
40	Stratum A				Line 10	32	4	S 1	13.8
41	Stratum A				Line 10	34	2	S 2	10.2
42	Stratum A	1.45	40	0.058	Line 11	44	2	S 2	15.6
43	Stratum A				Line 11	23	3	S 2	14.3
44	Stratum A				Line 11	12	2	S 2	12.9
45	Stratum A				Line 11	26	1	S 1	13.7
46	Stratum A				Line 11	33	2	S 3	14.8
47	Stratum A				Line 11	42	3	S 3	15.9
48	Stratum A				Line 11	17	2	S 2	14.2
49	Stratum A				Line 11	13	4	S 1	12.3
50	Stratum A				Line 11	24	3	S 2	12.4
51	Stratum A				Line 11	28	2	S 2	14.3
52	Stratum A	1.9	40	0.076	Line 12	19	1	S 1	14.6
53	Stratum A				Line 12	30	2	S 2	14.5
54	Stratum A				Line 12	42	1	S 2	15.3
55	Stratum A				Line 12	13	1	S 1	12.7
56	Stratum A	2.2	40	0.088	Line 13	12	2	S 2	14.2
57	Stratum A				Line 13	8	1	S 2	10.2
58	Stratum A				Line 13	13	1	S 1	15.9
59	Stratum A				Line 13	19	3	S 1	14.6
60	Stratum A				Line 13	32	2	S 2	13.3
61	Stratum A				Line 13	34	2	S 1	14.5
62	Stratum A				Line 13	36	1	S 2	13.8
63	Stratum A				Line 13	26	1	S 2	13.8
64	Stratum A	2	40	0.080	Line 14	43	2	S 1	15.9
65	Stratum A				Line 14	46	3	S 2	14.5
66	Stratum A				Line 14	47	2	S 1	14.7
67	Stratum A				Line 14	35	3	S 2	14.8
68	Stratum A				Line 14	24	2	S 2	13.8
69	Stratum A				Line 14	49	1	S 1	13.7
70	Stratum A				Line 14	38	2	S 2	10.2
71	Stratum A				Line 14	37	2	S 1	14.1
72	Stratum A				Line 14	38	2	S 2	14.6
73	Stratum A				Line 14	32	2	S 2	14.9
74	Stratum A	2.1	40	0.084	Line 15	34	2	S 2	14.5
75	Stratum A				Line 15	32	3	S 1	13.5
76	Stratum A				Line 15	36	1	S 2	14.7
77	Stratum A				Line 15	10	3	S2	10.8
78	Stratum A				Line 15	18	2	S2	14.9

High Density Strata (HDS)

Sr.	Stratum	Length (km)	Width (m)	Area (km^2)	Transect	Distance	Cluster size	Decay stage	Diameter of Dung
79	Stratum A				Line 15	22	3	S 2	14.3
80	Stratum A				Line 15	32	2	S 1	14.0
81	Stratum A				Line 15	45	1	S 2	12.9
82	Stratum A				Line 16	25	3	S2	13.4
83	Stratum A				Line 16	21	2	S3	14.8
84	Stratum A				Line 16	27	3	S 2	14.9
85	Stratum A	1.9	40	0.076	Line 16	38	2	S 1	12.8
86	Stratum A				Line 16	44	1	S 2	13.2
87	Stratum A				Line 16	21	2	S 2	12.9
88	Stratum A				Line 16	28	2	S 1	14.1
89	Stratum A				Line 17	27	3	S 1	12.3
90	Stratum A				Line 17	29	2	S 1	14.7
91	Stratum A				Line 17	30	3	S 1	13.2
92	Stratum A				Line 17	32	2	S 1	14.3
93	Stratum A				Line 17	33	2	S 2	10.8
94	Stratum A				Line 17	28	3	S 1	14.2
95	Stratum A				Line 17	33	2	S 2	14.9
96	Stratum A	1.8	40	0.072	Line 17	34	1	S 2	12.4
97	Stratum A				Line 17	34	2	S 1	11.8
98	Stratum A				Line 17	35	2	S 2	13.7
99	Stratum A				Line 17	32	3	S 1	12.6
100	Stratum A				Line 17	30	2	S 1	14.2
101	Stratum A				Line 17	29	3	S 1	14.6
102	Stratum A				Line 17	28	2	S3	13.1
103	Stratum A				Line 17	18	1	S 1	12.4
104	Stratum A				Line 18	17	2	S 1	13.3
105	Stratum A				Line 18	14	2	S 1	12.2
106	Stratum A				Line 18	20	3	S 2	13.7
107	Stratum A				Line 18	21	2	S 1	12.3
108	Stratum A				Line 18	19	1	S 2	12.7
109	Stratum A	1.5	40	0.060	Line 18	18	2	S 2	13.9
110	Stratum A				Line 18	19	2	S 1	10.2
111	Stratum A				Line 18	20	2	S3	15.9
112	Stratum A				Line 18	21	3	S 1	14.6
113	Stratum A				Line 18	24	2	S3	13.3
114	Stratum A				Line 18	26	3	S 1	12.5
115	Stratum A				Line 19	28	2	S 2	14.1
116	Stratum A				Line 19	27	2	S 1	12.5

High Density Strata (HDS)

Sr.	Stratum	Length (km)	Width (m)	Area (km^2)	Transect	Distance	Cluster size	Decay stage	Diameter of Dung
117	Stratum A	1.72	40	0.0688	Line 19	30	3	S 2	10.2
118	Stratum A				Line 19	31	2	S 2	13.8
119	Stratum A				Line 19	34	1	S 1	13.9
120	Stratum A				Line 19	23	2	S 1	14.0
121	Stratum A				Line 19	27	3	S 1	13.8
122	Stratum A				Line 19	26	2	S 1	14.0
123	Stratum A				Line 19	25	2	S 2	10.2
124	Stratum A				Line 19	21	3	S 1	15.2
125	Stratum A				Line 19	19	2	S 2	13.6
126	Stratum A	1.59	40	0.0636	Line 20	14	1	S 2	13.3
127	Stratum A				Line 20	16	2	S 1	14.4
128	Stratum A				Line 20	18	2	S 2	14.2
129	Stratum A				Line 20	20	3	S 2	12.3
130	Stratum A				Line 20	33	2	S 1	10.7
131	Stratum A				Line 20	37	1	S 2	11.9
132	Stratum A				Line 20	39	2	S 1	11.8
133	Stratum A				Line 20	40	3	S 1	11.9
134	Stratum A				Line 20	32	2	S 2	13.4
135	Stratum A				Line 20	19	1	S 1	13.8
136	Stratum A				Line 20	34	2	S 2	13.2
137	Stratum A				Line 20	32	2	S 1	13.8
	Total	**35.78**		**1.4312**					

Medium Density Strata (MDS)

Sr.	Stratum	Length (km)	Width (m)	Area (km^2)	Transect	Distance	Cluster size	Decay stage	Diameter of Dung
1	Stratum B	1.87	40	0.0748	Line 1	31	4	S 2	13.1
2	Stratum B				Line 1	14	4	S 1	13.1
3	Stratum B	1.6	40	0.064	Line 2	19	3	S 1	12.8
4	Stratum B	1.75	40	0.07	Line 3	12	3	S 1	12.9
5	Stratum B	0.83	40	0.0332	Line 4	36	2	S 1	13.6
6	Stratum B	1.9	40	0.076	Line 5	39	2	S 1	13.8
7	Stratum B				Line 5	46	3	S 2	13.7
8	Stratum B				Line 5	30	4	S 1	13.7
9	Stratum B	1.65	40	0.066	Line 6	28	4	S 1	11.3
10	Stratum B				Line 6	18	3	S 1	11.3
11	Stratum B	1.8	40	0.072	Line 7	40	3	S 2	11.3
12	Stratum B				Line 7	24	3	S 2	12.3
13	Stratum B				Line 7	26	2	S 1	12.3
14	Stratum B	1.26	40	0.504	Line 8	28	2	S 2	13.5
15	Stratum B				Line 8	43	1	S 2	13.5
16	Stratum B	1.3	40	0.052	Line 9	30	2	S 1	10.3
17	Stratum B	1.55	40	0.062	Line 10	32	3	S 1	12.3
18	Stratum B				Line 10	49	4	S 1	13.7
19	Stratum B	1.25	40	0.05	Line 11	49	2	S 1	14.6
20	Stratum B				Line 11	42	1	S 1	14.6
21	Stratum B	1.25	40	0.05	Line 12	38	3	S 2	13.8
22	Stratum B	1.3	40	0.052	Line 13	40	2	S 1	15.3
23	Stratum B	1.35	40	0.054	Line 14	39	1	S 1	15.2
24	Stratum B				Line 14	35	1	S 1	14.3
25	Stratum B				Line 14	26	1	S 2	14.2
26	Stratum B				Line 14	33	2	S 1	13.6
27	Stratum B	1.2	40	0.048	Line 15	29	3	S 1	12.7
28	Stratum B	1.5	40	0.060	Line 16	41	2	S 1	12.7
29	Stratum B				Line 16	37	4	S 1	13.7
30	Stratum B	1.45	40	0.058	Line 17	35	2	S 1	14.8
31	Stratum B				Line 17	12	3	S 2	13.8
32	Stratum B	1.55	40	0.062	Line 18	18	3	S 1	13.7
33	Stratum B				Line 18	19	2	S 1	10.2
34	Stratum B				Line 18	20	2	S 1	14.5
35	Stratum B	1.4	40	0.056	Line 19	20	2	S 2	14.6
36	Stratum B				Line 19	20	1	S 1	14.8
37	Stratum B				Line 19	20	3	S 1	13.8
38	Stratum B	1.8	40	0.072	Line 20	21	2	S 1	13.7
39	Stratum B				Line 20	21	3	S 2	10.2
	Total	**29.56**		**1.1824**					

Low Density Strata (LDS)

Sr.	Stratum	Length (km)	Width (m)	Area (km^2)	Transect	Distance	Cluster size	Decay stage	Diameter of Dung
1	Stratum C	1.4	40	0.056	Line 1	0	0	0	0
2	Stratum C	0.9	40	0.036	Line 2	0	0	0	0
3	Stratum C	1.1	40	0.044	Line 3	25	3	S2	12.6
4	Stratum C	1.65	40	0.066	Line 4	0	0	0	0
5	Stratum C	1.6	40	0.064	Line 5	32	3	S 1	12.3
6	Stratum C	1.4	40	0.056	Line 6	0	0	0	0
7	Stratum C	1.6	40	0.064	Line 7	0	0	0	0
8	Stratum C	1.4	40	0.056	Line 8	15	1	S 2	15.8
9	Stratum C	1.65	40	0.066	Line 9	28	2	S 1	12.3
10	Stratum C	1.55	40	0.062	Line 10	0	0	0	0
11	Stratum C	1.55	40	0.062	Line 11	0	0	0	0
12	Stratum C	1.6	40	0.064	Line 12	29	2	S 1	12.3
13	Stratum C	1.8	40	0.072	Line 13	15	1	S2	13.2
14	Stratum C	1.65	40	0.066		0	0	0	0
15	Stratum C	1.67	40	0.0668	Line 15	0	0	0	0
16	Stratum C	1.2	40	0.048	Line 16	0	0	0	0
17	Stratum C	2	40	0.080	Line 17	0	0	0	0
18	Stratum C	1.25	40	0.05	Line 18	0	0	0	0
19	Stratum C	1.7	40	0.068	Line 19	22	2	S 1	13.7
20	Stratum C	1.9	40	0.076	Line 20	0	0	0	0
	Total	**30.57**		**1.2228**					

Appendix -11

Capture rate per trap night of elephant in TNR

Sr.	Location	No. of camera trap	Period	Trap night No. of day	Elephant	Sambar	Munjac	Wild Boar	Mouse deer	Jungle cat	Asian tapir	Hunter track
1	KPR 61 service track	1	14	14	6	12	2	7	0	0	0	6
2	Access 22 service track	1	2	2	10	13	0	8	0	0	0	8
3	Yebon salt lick	1	31	31	9	18	3	6	5	2	2	2
4	U Kyaing Mine Road	1	62	62	7	9	6	9	3	4	6	8
5	U Kyaing Mine Road	1	62	62	8	11	4	10	8	5	5	4
6	Maw Ka Pe stream	1	29	29	2	7	1	4	8	4	6	0
7	Byet Ka than saltlick	1	29	29	1	5	2	2	5	2	1	0
8	Byet Ka than saltlick	1	29	29	1	8	3	4	5	1	2	0
9	Byet Ka than saltlick	1	29	29	1	5	2	4	8	1	1	6
10	Byet Ka than saltlick	1	29	29	1	2	4	2	4	2	0	4
11	Byet Ka than saltlick	1	29	29	1	6	2	3	1	4	0	2
12	Kyauklonegyi ridge	1	29	29	1	8	3	4	2	5	2	0
13	U Kyaing Mine road	1	34	34	2	6	4	5	3	4	1	0
14	U Kyaing Mine road	1	34	34	5	5	0	2	1	2	2	3
15	U Kyaing Mine road	1	34	34	2	3	2	3	1	1	0	3
Total		15	447	447	57	108	38	73	54	37	29	51
Capture rate/ trap night					0.127	0.241	0.085	0.163	0.120	0.82	0.064	0.114

Appendix - 12 **Observation of Wild Elephant's Habitat and their Food in TNR area (along the valley)**

Sr.	Particulars	Sample plot A	Sample plot B	Sample plot C	Sample plot D	Sample plot E
1	Location (GPS)	N14° 41' 05.6" E 098° 17' 32.8"	N 14° 41' 14.8" E 098° 17' 36.4"	N 14° 43' 42.3" E 098° 14' 52.2"	N 14° 42' 55.6" E 098° 15' 46.4"	N 14° 42' 13.0" E 098° 16' 17.5"
2	Climate (tropical, subtropical, temperate) a. Average temperature b. Seasonal temperature patterns	Tropical 26.5 C -	Tropical 26.5 C -	Tropical 26.5 C -	Tropical 26.5 C -	Tropical 26.5 C -
3	Rainfall a. Average rainfall b. Seasonal rainfall patterns	 5,000 mm -	 5,000 mm -	 5,000 mm -	 5,000 mm -	 5,000 mm -
4	Topography a. Dominant landform (mountainous, flat, hilly) b. General steepness (0-15%, 16-30%, 30%>) c. Slope measurements	 Mountainous 13% -	 Escarpment 30% -	 Valley 0% -	 Opened forest 2% -	 Valley 7% -
5	Elevation gradients a. Description b. Average elevation	 Slightly slope 550	 Steep slope 405	 Flat 216	 Gentle slope 286	 Gentle slope 317
6	Major Floral community types a. Forest type (deciduous, evergreen) b. Open areas (grasslands, savannas) c. Dominant or common tree species	 Evergreen No Kanyin, phetwun	 Semi evergreen 5% grass land Banana, bamboo	 Moist Deciduous 7% grass land Pyinma, cane	 Degraded forest 25% grass land Wame, thinbaung	 Evergreen 2% grassland Kaunghmu,
7	Tree or herbaceous species important to wild elephant a. Species list b. Species density (if important for wild elephant) c. Percent ground cover	 Banana 30/ 10m^2 30%	 Banana, bamboo 45/ 10m^2 45%	 Cane, bamboo 50/ 10m^2 50%	 Wame, thinbaung 48/ 10m^2 48%	Dense big trees Bamboo 65/ 10m^2 65%
8	Water availability a. General availability (waterways, water holes) b. Distance to water c. Seasonal changes	 No 200 m Little	 Drainage 100 m Fair	 No 120 m Fair	 Waterway 10 m Strong	 No 300 m Little
9	Human settlement/ encroachment into the area a. Nature of disturbance b. Areas or species affected	 Little 5%	 Fair 10%	 No 1%	 Strong 15%	 Little 5%

Observation of Wild Elephant's Habitat and their Food in TNR area (along the valley) Cont'd

Sr.	Particulars	Sample plot A	Sample plot B	Sample plot C	Sample plot D	Sample plot E
10	Natural perturbations a. Severity and type (seasonal floods, drought, fires) b. Areas or species affected	Erosion 5%	Strong wind 10%	Fragile (fire) Roadside area	Seasonal fire Roadside area	No 5 % of roadside
11	Known critical habitat features for wildlife a. Geologic – mineral licks, water holes, caves, rock outcrops, cliffs b. Floral – important fruits, grasses, or browse species, large old growth tree stands.	Rock out crops Browse spp. Banana, big trees	Cliff Climber, bamboo Soft trees	Good bush Shrub & Fruits Cane, bamboo	Plain & sunshine Grasses, Thinbaung Myaukkyan	Good bush Tuber, rhizome Banana Soft trees

BIOGRAPHY

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