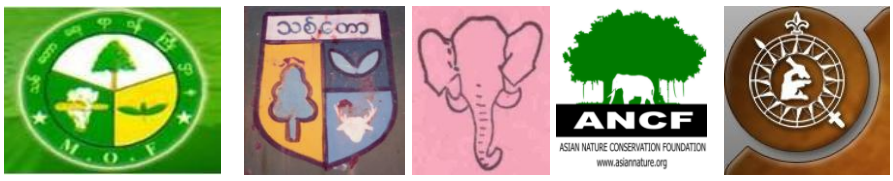
The Bio-diverse Myanmar And it's Elephants

Status Survey, Population Evaluation and Preparation of a Conservation Plan for Asian Elephants & Inventory of Biodiversity in Bago Yoma, Rakhine Yoma & Alaungdaw Kathapa National Park, Myanmar

ANCF
ASIAN NATURE CONSERVATION FOUNDATION
www.asiannature.org

The Bio-diverse Myanmar And it's Elephants

Status Survey, Population Evaluation and Preparation of a Conservation Plan for Asian Elephants & Inventory of Biodiversity in Bago Yoma, Rakhine Yoma & Alaungdaw Kathapa National Park, Myanmar



Suggested Citation
<Author name/s>. (2007). <Paper title>, In: The Bio-diverse Myanmar and it's Elephants: Status Survey, Population Evaluation and Preparation of a Conservation Plan for Asian Elephants and Inventory of Biodiversity in Bago Yoma, Rakhine Yoma and Alaungdaw Kathapa National Park, Myanmar, Asian Elephant Research & Conservation Centre (A Division of Asian Nature Foundation), C/o Centre for Ecological Sciences, Indian Institute of Science, Bangalore.

Photo Credits: Section 1; 4a, 6,8,Section 3; 5a, Section 5; 2a, d, e, 3a: Myanmar Forest Department; Section 1; 4b, Section 4; 2, 3a,b, 5, Section 6; 2,3b,4,5,6,7a,b,11 and 12: Scientific Exploration Society, Section 7; 2a: AERCC, all other photographs: Surendra Varma

Survey Team
(From Myanmar Forest Department and Myanmar Timber Enterprise)

U Than Tun Aye	Range officer
U Tin Aung Soe	Range officer
U Khaing Nyunt	Range officer
U Myint Maung	Ranger
U Soe Thiha Htwe	Ranger
U Aung Naing Aye	Ranger
U Sein Aung Min	Ranger
U Thein Lwin	Ranger
U Aung Maung	Ranger
U Saw Ble	Ranger
U Kan Aung	Deputy Ranger
U Aye Tun	Deputy Ranger
U Sein Win	Deputy Ranger
U Min Zaw	Deputy Ranger
U Win Naing	Deputy Ranger
U Lin Maung	Deputy Ranger
U Hla Thaung	Deputy Ranger
U Htay Win	Deputy Ranger
U Nyo Maung	Deputy Ranger
U Kyaw Min Oo	Deputy Ranger
U Myint Swe	Deputy Ranger
U Tun Wai	Deputy Ranger

(From Scientific Exploration Society –SES)

Cathy Summers	Expedition deputy leader
Paul Bates	Small mammal expert,
John Cosgrove	Expedition doctor
Ed Barnes	Expedition member
David Read	Expedition member
Hugh Bennington-Sears	Artist and Photographer
Rosa Bennington-Sears	Artist and Photographer
Mark Hewes	Expedition member
Nicky Dunnington-Jefferson	Expedition member
Debra Harper	Expedition member
Venetia Dearden	Photographer
Geoffrey Tomlinson	Expedition member

Principal Investigator
R. Sukumar

Conservation Biologist & Research Officer
Surendra Varma

Survey Co-ordinator
U Uga

Survey Team Leader
U Ye Htut

Expedition leader
Colonel John Blashford-Snell (JBS)

ORGANIZATIONS

Asian Elephant Conservation Centre
Centre for Ecological Sciences
Indian Institute of Science
Bangalore - 560 012, India

And

Asian Elephant Research and Conservation Centre
(A Division of Asian Nature Conservation Foundation)
Centre for Ecological Sciences
Indian Institute of Science
Bangalore - 560 012, India

In collaboration with

Wildlife and Nature Conservation Division
Ministry of Forestry
Yangon, Myanmar

IUCN/SSC Asian Elephant Specialist Group

And
Scientific Exploration Society, U.K

FUNDED BY

Rotterdam Zoo, The Netherlands
The John D. & Catherine T. MacArthur Foundation, USA

Contents

Preface

Myanmar covering a total land area of 677,577 km^2 is known for its rich floral and faunal diversity. Myanmar has varied forest types and these are generally classified as mangrove, estuarine, mixed deciduous, deciduous dipteocrap, wet evergreen, hill evergreen and dry thorn forests. These forests are home to nearly 7,000 species of plant species, 300 mammals, 1,000 birds, about 360 species of reptiles and other taxa which are poorly documented. Although the conservation of nature was a tradition among the people of Myanmar, the wildlife in Myanmar greatly suffered during the Second World War. Even after independence, the wildlife suffered much due to insurrection, helplessness of the government agencies to enforce effective laws, and consequently the large mammals particularly the Asian elephant and the tiger face a very serious threat to their survival, while the Sumatran rhinoceros is very close to extinction.

Myanmar still may have one of the largest remaining populations of Asian elephants. The wild elephants are distributed over 13 distinct locations. The country is also home for substantial number of captive elephants, considered to be the backbone of the timber industry. It is estimated that about 3000 working elephants are needed for the timber industry. The need was fulfilled by a regular capture of elephants from the wild; this was done without knowing the effect on wild population. Several attempts have been made to estimate elephant numbers; however, estimating numbers are very difficult due to varied reasons.

Myanmar is rich in biodiversity however; there are hardly any studies or even simple surveys of species distribution for most wildlife species. As and when surveys are carried out on a focal species, it would be very useful to also document information on other species of wildlife and even the vegetation. This way a profile of the overall biodiversity of the country could be built up. These insights and issues motivated the Ministry of Forestry of the Government of Myanmar initiated a project on Asian Elephant, with the assistance of the IUCN Asian Elephant Specialist Group (AsESG), on population evaluation, that could be eventually used to prepare of a conservation action plan for the species in Myanmar. This project is supported by Rotterdam Zoo, The Netherlands and the MacArthur Foundation, USA, and is being executed by the Asian Elephant Conservation Centre (the technical secretariat of the AESG) at the Indian Institute of Science.

To formally launch the project, the Myanmar Forest Department organised a workshop on Elephant Census and Conservation Techniques in July 1995. The inaugural session of the workshop was attended by Dr. R. Sukumar (Deputy Chairman of Asian Elephant Specialist Group & Head of the Asian Elephant Conservation Centre) and Mr. Surendra Varma (Conservation Biologist, AECC). The Myanmar Forest Department was represented by the Director General (Planning), Director General (Forestry), Director (Wildlife & Nature Conservation Division) and other officials. The 24 participants were drawn largely from the elephant survey team and included Range Officers, Rangers, Deputy Rangers from Forest Department and Myanmar Timber Enterprise. During this workshop, lectures and discussions on the direct and indirect methods of estimating elephant densities, elephant population dynamics and a computer demonstration using Program "GAJAHA" to estimate elephant density was given. Soon after this, elephant surveys were carried out in Bago Yoma region. Following the survey in Bago Yoma, work also began in surveying the elephant populations in Rakhine Yoma to the southwest of the country.

While these surveys were on, delegates from Myanmar, Forest and Myanmar Timber Enterprises (MTE) were also invited to India and exposed to various research and conservation aspects and experiences of implementing the same. After the surveys in Mynamr, an opportunity was emerged to provide technical support to the UK based Scientific Exploration Society, for it's Myanmar Wildlife Expedition in Alaungdaw Kathapa National Park (AKNP). Keeping the Asian elephant as main focus species, the expedition team studied various aspects of fauna and flora of the park. The objectives were fulfilled through biodiversity survey, captive and wild elephant management study, vegetation and village surveys.

These investigations begin in 1995 and were continued till 2000. The systematic investigations were carried out for Bago were from May 1995 to December 1995, for Rakhine, from December 1995 to May 1996, and for AKNP, in January 1999. Specific locations of Rakhine and Bago Yomas were investigated again in May 1998 and January 2000 respectively. An attempt to cover the northern Myanmar (regions such as Tamu, Homalin, Tamanthi and Tanai) was made in 2000, but insurgence and other logistic reasons made the mission impossible. The current information (since 2001) on particularly the status of mammals and other habitat was obtained through personal communications (Uga & Hpone Thant (Harry) and literature (James et al. 1999; Gutter 2001; Rao et al. 2002; Bennett and Rao, 2002; Sanderson et al., 2002; Leimgruber et al., 2003, Aung et al., 2004; FAO 2004; Rao et al. 2005; Lynman et al. 2006; Aung 2007). Including the principal investigators, census coordinators, team and expedition leaders, about 32 personals participated in the various levels of investigation. The team members were also assisted by ground staff, expedition coordinator and field guides. Overall, a total of 8100 man-hours were spent on investigations in Rakhine, 8500 man-hours in Bago and 1350 man-hours in AKNP respectively.

The combinations of work carried out for these purposes were brought under three distinct objectives; 1, conduct training programmes on elephant conservation issues for personnel of the Myanmar Forest Department. These would include methods of estimating elephant numbers, population dynamics of elephants, management of elephant-human conflict, management of captive elephants in Myanmar, sampling biodiversity and protected area design. 2, survey the status and distribution of elephants in different regions of Myanmar, make broad assessments of biodiversity particularly that of vegetation and mammals, and carrying out village survey to obtain information on human-elephant conflict. 3 prepare action plans for the conservation of elephants and biodiversity in Myanmar.

The collective experiences also become a source of a document on "**The Bio-diverse Myanmar And it's Elephants**". The document has seven sections. Section 1 provides an overview of the status of elephant in some of the commercially exploited habitats of Myanmar. This section provides an insight of the current habitat, population and legal status, recommendation for population survey based on management plans.

Section 2 and 3 provide exclusive knowledge on elephant status in Bogo and Rakhine Yoma respectively through elephant dung densities, decay and defecation experiments. Section 4 is aimed to provide the current status of both wild and captive elephants in Alang daw Kathappa National Park (AKNP). The wild elephant population of the region was estimated through line transect method and dung and defecation results were obtained from literatures. The park has history of keeping captive elephants, their current status was assessed, and an opportunity was utilized to assess the socio economic status of mahouts (keepers) locally called oozies. Records and medical history of each elephant was reviewd to study the disease and vetenary

care and some insights on the status of human elephant conflict for the park also were obtained.

Section 5 discusses the diversity, conservation and management of mammals in Bago Yoma and Rakhine Yomas and AKNP. The survey carried to study elephants through line transect was one of the important sources of data collection. In addition forest trial method, village survey method and other methods such as visiting specific places such as waterholes, watch towers and animal observation posts were used to document the significance of mammal species. A trend of mammalian diversity reported, similar mammalian species reported and the conservation status of mammals also reviewed through this section. This section is an example of combining effort to survey different species, different aspects.

Section 6 focuses on biodiversity assessment in AKNP. This was achieved by vegetation survey and animal survey. The animal survey focused on insects, reptiles, birds and mammals. Identification of species was difficult due to many constraints imposed. However this provided scope for knowing the presence and absence of some of the taxas. It is assumed this will give motivation for a more systematic and scientific future surveys and studies.

Section 7 is on a training programme on elephant research, conservation and management for personnel from Ministry of forestry Myanmar introducing many aspects of conservation and management of elephant experiences from high elephant density areas of southern India.

We assume this document is the first ever systematic approach to understand the status the Asian Elephant and basic knowledge on other species for the country which is little exportable geographically, but politically isolated. This document may also motivate others to initiate similar or more advance investigations from the biologically rich landscape.

Acknowledgements

The project has been funded through generous grants from the John. D and Catherine T. MaacArthur Foundation, USA and Rotterdam Zoo, Netherlands. Lt. Gen.Chit Swe, Minister for Forestry, Myanmar, has given active encouragement and support for the project. We also thank Col. U Myat Thinn (Director General, Planning & Statistics), U Thin Hla (DG, Forestry) and U Than Nwai (Director, Wildlife & Nature Conservation Division) for their interest and support. Dr. Khyne U Mar, Head of Research at Myanmar Timber Enterprise, and U Soe Win are thanked for their support in the training program and in the field. We also grateful to Mr. Lyn de Alwis, Chairman, IUCN/SSC Asian Elephant Specialist Group (AsESG), who initiated the project and Dr. Charles Santiapillai, Executive Officer, AsESG for their support. Members of Scientific Exploration Society, U.K., were keenly involved in AKNP survey, and special thanks are due to Colonel John Blashford-Snell (JBS) for his leadership.

Mr. Robert John, Mr. Mohinsish Sukula, Mr. H.S Suresh, Mr. Vijay Kumar, Mr. Sudhira, and Mr. Gururaj (Centre for Ecological Science, - CES) provided valuable suggestions in data processing. The quality of the work has been improved by the suggestions of anonymous reviewers and our colleagues; particularly, Dr. A.J. T. Johnsingh (Nature Conservation Foundation) Dr. Renee M. Borges (CES), Ms. Sujata S. Iyengar (Compassion Unlimited Plus Action), Ms. Tara Satyarata (Freelance Consultant), Prof. Nicholas Polunin, Editor in Chief, Environmental Conservation (Journal), Dr. Vijay D. Anand, Ms. Nimmy Varkey (A Rocha), Mr. Joshua David and Mr. Amit Kurien (Asian Nature Conservation Foundation-ANCF); we are very thankful to them for the same. U Phone Thant and colleagues at Swiftwinds Tours and Travel Company, Yangon, provided logistical and other support during the wildlife expedition at Alaungdaw Kathapa National Park.

We thank Mr. Kumaran Raju, GIS Expert, Asian Elephant Research and Conservation Centre, Mr. Kantharaju, Deputy Director Project Tiger, Bandipur National Park, Mr. Nirmal Kumar, IFS, Wildlife Warden, Wyanad Wildlife Sanctuary and Mr. A. Udhayan, IFS, Wildlife Warden, Mudumalai Wildlife Sanctuary, for their support conducting study tour for Myanmar delegates. Special thanks are due to Dr. K. Asokan, Forest Veterinary Surgeon, for his discussion with the delegates on captive elephant management. We are truly grateful to Mr. M.K. Appayya, IFS, Retired Chief Conservator of Forests (Wildlife) of Karnataka Forest Department, for sharing his vast experience on elephant and habitat management in Karnataka. Researchers from Centre for Ecological Sciences Indian Institute of Science (IISc) Mr. Arumugam, Mr. H.S. Suresh and Mr. H.S. Dattaraja and Bombay Natural History Society Mr. Ajay A. Desai, Mr. N. Baskaran are also appreciated for their time and sharing their knowledge with delegates at a discussion session conducted at the IISc Field Research Station, Masinagudi, Nilgiris.

Section 1:
Population Evaluation of Asian elephant (*Elephas maximus*) in Commercially Exploited Habitats of Myanmar

Surendra Varma[1], U Ye Htut[2], U Uga[2*3] and R. Sukumar[1]

[1]Asian Elephant Research & Conservation Centre
(A division of Asian Nature Conservation Foundation),
C/o Centre for Ecological Sciences,
Indian Institute of Science, Bangalore 560 012, India

[2] Wildlife and Nature Conservation Division,
Ministry of Forestry, Yongon, Myanmar

[3]Current address;
Chairman, Biodiviersity and Nature Conservation (BANCA),
14/A Bawga Strrt, 9th mile, Mayangon Township, Yangon, Myanmar

Abstract
A study on the status of the Asian elephant **(***Elephas maximus***)** was initiated in Myanmar with the objective of preparing a conservation plan for elephants in selected locations of the country. Five forest reserves of the Bago Yoma (central Myanmar), seven forest reserves in Rakhine Yoma (western Myanmar) and Alaungdaw Kathapa National Park (AKNP) of northern Myanmar were the survey sites. The indirect method of estimating elephant density from the elephant defecation rate/day, dung decay rate/day, and dung density estimates was used. The estimated mean daily defecation rate/day was 20.0 for Bago Yoma, 19.0 for Rakhine Yoma and 23.0 for AKNP. The mean daily dung decay rate/day was 0.072, 0.005 and 0.009 for Bago Yoma, Rakhine Yoma and AKNP, respectively. The mean elephant density for Bago was 1.62 (95% CI = 1.49–1.75) and for Rakhine it was 0.05 (95 % CI = 0.04–0.06) and for AKNP it was 0.6 (95 % CI = 0.528–0.74). Elephant dung density and elephant density varied substantially for Bago Yoma and Rakhine Yoma Reserves. The estimated elephant density for both Bago Yoma and AKNP appear to be very high compared to the earlier surveys. For Bago the result could be due to a very high dung decay rate that may not be representative of the entire wet season or for regions outside the observation area. Sample size for some reserves was very low, hence, laying more transects is recommended for these reserves. Additional dung decay rate experiments, particularly during the wet seasons, and similar systematic surveys covering other regions of the country, are desirable.

Introduction

The Asian elephant (*Elephas maximus*) is a globally threatened species and its survival depends on maintaining viable habitats and understanding the population status of the species (Sukumar, 1989; Santiapillai and Jackson, 1990). The current distribution of the species covers only a small portion of its earlier extensive range (Sukumar and Santiapillai, 1996). In this context, after India, Myanmar has the largest remaining habitat and population of both wild and captive elephants. The captive elephant has always been considered the backbone of the country's economy as nearly 50 percent of all timber in Myanmar is still extracted by these elephants and about 3000 working elephants are needed for the timber industry (Zaw, 1998). To replenish captive stocks for timber extraction, elephants have been captured from the wild (Salter, 1983; Htut, 1993). Timber extraction has two negative effects on the status of wild elephants; viable habitats are disturbed through extensive logging operations, and there is a substantial decline of the wild elephant population. In 1972 the estimated elephant number for Myanmar was 6000, which was reduced to 3000 by late 1970s and it was predicted that the wild elephant population in Myanmar would decline by about 5% per year (Caughley, 1980).

Estimating elephant numbers and mapping their distribution thus becomes imperative. However, no systematic surveys or studies on wild elephants have been carried out in the regions of logging and elephant capture. There have been several attempts to estimate elephant numbers, but these have no scientific basis (Htut, 1993; Sukumar and Santiapillai, 1996). Estimating elephant numbers is difficult as visibility within the forests is very poor and many of the forests are inaccessible. Most of the regions in this country are very remote, with rugged terrain, infested with malaria, and have few and very poor logistic facilities. However, these regions are very important due to the presence of globally threatened species (Salter, 1983; IUCN, 1989; Htut, 1993). Although Myanmar provides crucial habitat for Asian elephants, no scientific study or survey on the species has ever been undertaken. These aspects motivated us to conduct a status survey, population evaluation and preparation of a conservation action plan for the Asian elephant in commercially exploited habitats of Myanmar. This paper reflects the first ever scientific approach to study the elephants in this country and the findings should give scope for critical review of methods used and the results obtained.

Material and methods

Survey Sites

The survey sites (Figure. 1) were Bago Yoma (17°–20° N, 96°–97° E), Rakhine Yoma (17°–21° N, 93°–95° E) and Alaungdaw Kathapa National Park – AKNP (22°–23° N, 94°–95° E). The Bago, Rakhine and AKNP regions have very extensive tracts of hills situated in the central, western and northern regions of Myanmar, respectively. The hill ranges of Rakhine Yoma are a southward extension of the Himalayas. AKNP is in a well-forested mountainous region situated west of the lower Chindwin River and Myittha Valley. The average elevation of the Bago Yoma is about 700 m; the highest point is 900 m above sea level (asl). Rakhine Yoma, which runs for nearly 600 km, ranges from 1000 to 1400 m asl and average elevation in AKNP is about 1000 m (range 200–1400 m); steep slopes and narrow ridges characterize all regions. All have good drainage systems; the Pegu and tributaries of Yenwe Chaung, and the Kun Chaung are the major river sources in Bago Yoma. The Sandoway River (Sandoway Chaung) is the major river system in Rakhine. AKNP is drained by a number of tributaries of the Patolon River, Petpa Chaung and Taungdwin Chaung being perennial among them. In all these regions, the wet season lasts from May to October and rainfall is heaviest in August and September. The annual rainfall for Bago averages 1700 mm, for Rakhine it is 1800 mm and

1500 mm for AKNP. In all these regions, the vegetation is largely mixed deciduous forest, with semi-evergreen forests occurring in areas of high precipitation. Patches of evergreen trees consisting mostly of secondary growth occur in a few places.

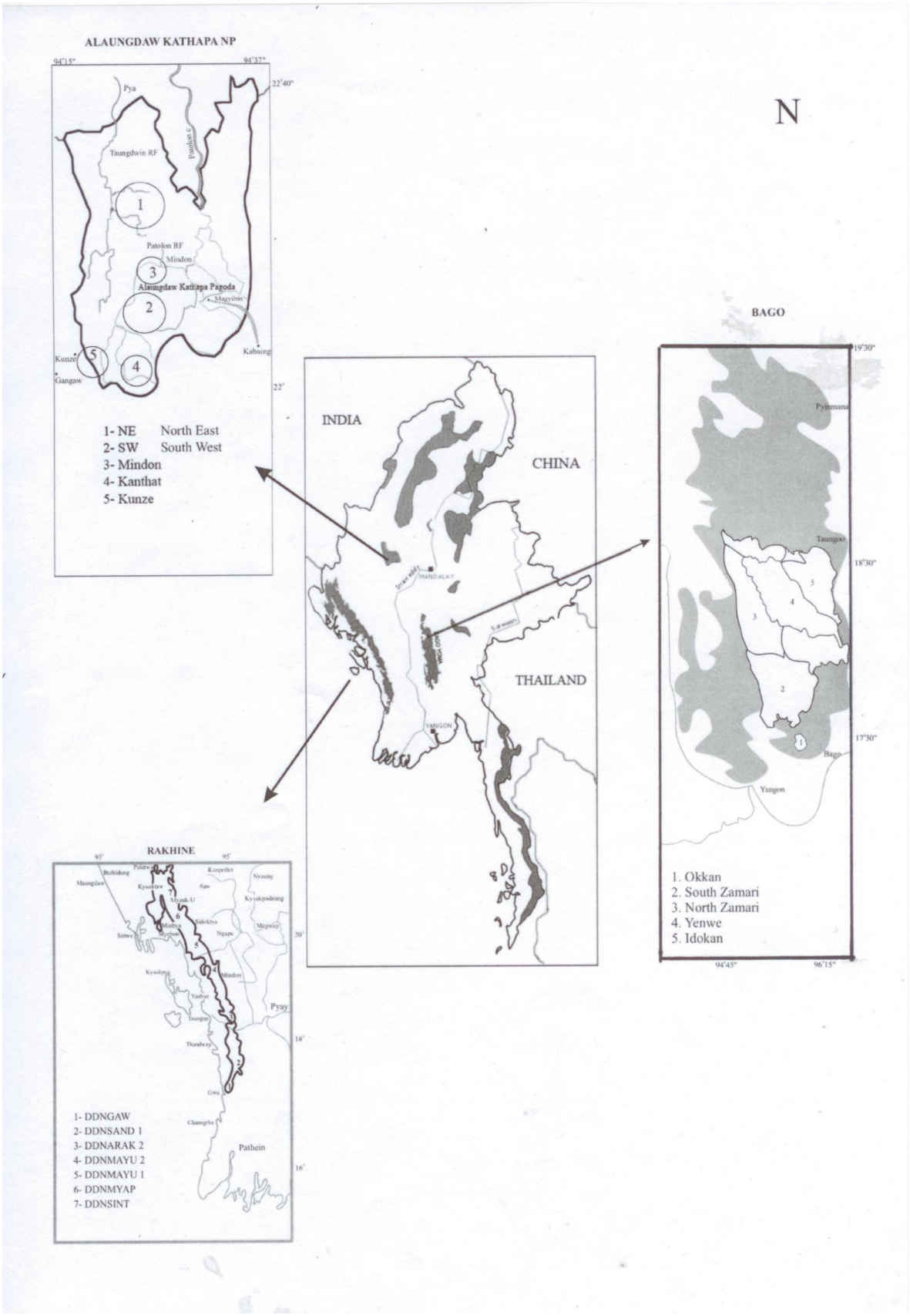


Figure1: Location of the survey sites in Myanmar. The location of the survey sites are marked along areas of the elephant distribution in the country

Notable among the mammal species seen here are rhesus macaque (*Macaca mulatta*), hoolock gibbon (*Hylobates hoolock*), Phayre's langur (*Semnopithecus phayrei*), sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), hog deer (*Axis porcinus*), gaur (*Bos gaurus*), Tsaine (saing) or banteng (*Bos javanicus*) serow (*Naemorhedus sumatraensis*), elephant (*Elephas maximus*), Sumatran rhino (*Dicerorhinus sumatrensis*), Asiatic black bear (*Ursus thibetanus*), Malayan sun bear (*Ursus malayanus*), leopard (*Panthera pardus*), tiger (*Panthera tigris*) and Asian wild dog (*Cuon alpinus*) (common and scientific names based on (Corbet and Hill (1992), Yin (1993), and Menon (2003).

Current habitat and legal Status

All these regions have been subject to intensive management for logging during (Figures 2a, b and c) the past 130 years (Salter, 1983; Myint, 1994; Tun, 1997).

a b c

Figure 2 a, b and c: Logging operations and remnants of the same

Under sustainable management of forests since 1856, timber has been extracted and the system prescribed a felling cycle of 30 years in a felling series. Except in a very small part of a steep slope of Bago Yoma (Uga, 1995), timber extraction has been carried out in all the regions. The 130 years of logging has had negative effects and in many places this disturbance, along with other human activities, has resulted in large areas being invaded by bamboo species (Salter, 1983; Uga, 1995).

Most of the regions have yet to evolve effective wildlife conservation and management programs. Out of the 16,000 km^2 area of Rakhine Yoma, only 1775 km^2 has been gazetted as Yakhine Yoma Wildlife Sanctuary in 1997 (Rao et al., 2002; Uga, 1995). To preserve the pristine nature of the teak and other forests (Figures 3a and b) a survey for declaring 1500 km^2 Bago Yoma Teak Nature Reserve was carried out in 1983, but the area has yet to be brought under legal protection or management. AKNP was legally gazetted as a wildlife sanctuary in 1984.

a b

Figures 3a and b: Forest types and the status of forests in the survey regions

Methods

General

To initiate the surveys in Bago and Rakhine Yoma, the Myanmar Forest Department organised a workshop on Elephant Census and Conservation Techniques. The workshop became an important source of identifying experienced personals from the forest department for the survey. Based this the elephant census team (Figures 4a and b), staff mainly drawn from Myanmar Forest Department and Myanmar Timber Enterprise was formed to carried out

Figure 4a: Bago and Rakhine Survey team

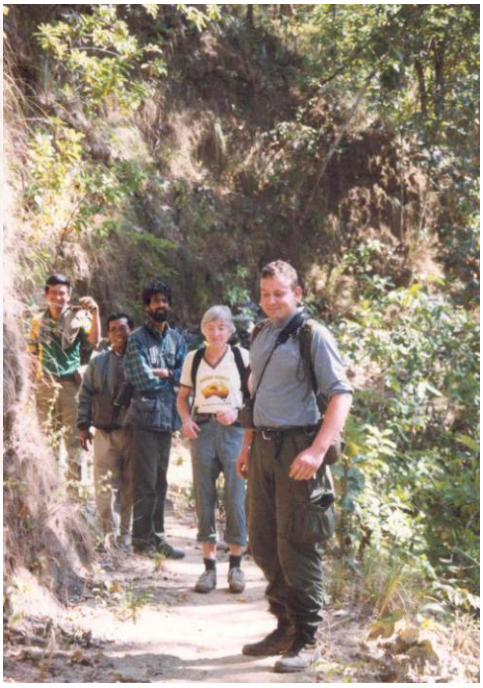


Figure 4b: Part of survey team from AKNP

surveys in Bago and Rakhine Yoma. After the workshop training program (Figure 5) was conducted at Myainghawan elephant nursing camp for field exercises on indirect count of elephants. The main survey team was further divided in to two teams and different part of the survey regions were surveyed at the same time. Each team had several sub groups, one sub group from Team 1, involved in collecting in data on elephant defecation and decay rate, while other sub groups of both teams concentrated on dung density estimates, animal survey, vegetation survey, and the village survey. The survey for AKNP was a part of Wildlife expedition carried out by the UK based Scientific Exploration Society. The expedition team was divided into sub groups, each sub group with a group leader, carried out the survey.

Figure 5: Training programme for the survey team

Density Estimation

The indirect method of estimating elephant density Barnes and Jensen, 1987; Dawson and Dekker, 1992; Santosh and Sukumar, 1995) was followed for the survey. Based on village surveys and discussions (Figure 6) with forest and Myanmar Timber Enterprise staff, the survey areas were divided into high, moderate and low elephant use areas. Line transects of indefinite width (Burnham et al., 1980) were used for estimating dung density in 5 forest reserves of the Bago Yoma, 7 forest reserves of the Rakhine Yoma and 5 regions of AKNP. Line transects of indefinite width are used when animal densities are low, and the numbers recorded from fixed-width transects are assumed to be too low for meaningful statistical analyses (Eberharat, 1968)

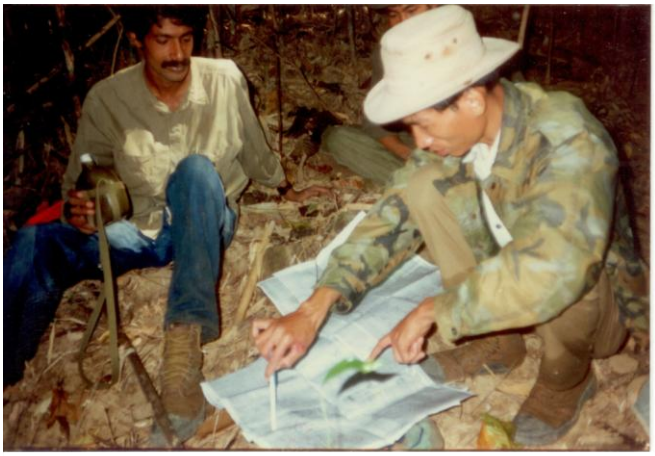


Figure 6: Discussions with forest staff for survey plans

Each transect was cut afresh (Figure. 7) using a field compass, a 50-m nylon rope and knife. The compass was used for fixing a straight line; the rope was to estimate the perpendicular distance from the line to the dung piles, and the total distance covered. The rope was also useful in assessing the topography and microhabitats at every 50-m interval. The total number of transects laid was 142 for Bago, 148 for Rakhine, and 22 for AKNP. The total length of transects in a particular reserve within a region was roughly proportional to the total area of the reserve. For example Zamari reserve in Bago constituted 30% of total area of the reserves sampled for Bago and 25% of transects were laid in this reserve (Table 1). The same sample design was followed for other regions surveyed and lines were well distributed, covering different regions of the reserves sampled. The survey team moved (Figure 8) one site to other using *kunki* elephants. In a given site, not more than 3 groups of workers operated for cutting transects and a minimum distance of 2 km was maintained between the two groups.

Figure 7: Clearing a path for transect survey

Figure 8: Camp move for the survey

For each transect, the date of sampling, its location, vegetation type, topography, start and end times of survey and distance along the transect were recorded. The topography was recorded

as small hill with slope, undulating terrain, flat land, and other types. The categories of vegetation types were: semi-evergreen forest, evergreen forest, moist upper mixed deciduous forest, and bamboo. The percentage of transects laid in each category of terrain and forest type roughly matched their overall percentages within a given region (Table 1). On sighting a dung pile during a transect walk, the perpendicular distance of the pile to the transect line was measured and the condition of the dung pile was noted using the stages of decay prescribed by Barnes and Jensen (1987).

For both Bago and Rakhine Yoma, a study of elephant defecation (Figures 9a and b) was carried out in elephant camps (observing 32 elephants at Bago and 57 at Rakhine), as these elephants feed only on natural vegetation from the surrounding forest areas.

a

b

Figures 9a and b: Camp elephant observed for defecation study

In total 1704 man-hours were spent for the defecation study. Fresh dung piles observed during the defecation study were marked for monitoring of decay rate, and a total of 100 dung piles were monitored (Figure 10) in each region. For AKNP data from available literature (Myint, 1994) on these two parameters were used.

Figure 10: Decay rate experiment

Data Analysis

The density of dung piles, daily defecation rate and dung decay rate were estimated using an updated version of GAJAHA software (Archana and Sukumar, 2006). The same program was also used to compute elephant density. Elephant density was estimated separately for each reserve, and for AKNP the data of all regions were pooled, as the sample size of the dung piles for each region was very low.

The density (E) in elephants/km^2 was calculated using the formula:

$$E = Y \cdot r / D$$

where, Y = density of dung piles/km^2, r = dung decay rate/day, and D = defecation rate/day.

Results and Discussion

Table 1 summarizes the information on the area of the reserves sampled, number and percentage of transects, their topography and microhabitat, distance covered, and the sample size of the dung piles for each reserve in Bago, Rakhine and different regions in AKNP. The results of dung density mean elephant density and mean elephant number for different regions surveyed are summarized in Table 2. The defecation rate for the wet season in Bago was 20.02/day (Standard Error SE = 0.55) and for Rakhine in the dry season it was 19.04/day (SE = 0.55). Overall decay rate for 100 fresh dung piles in Bago during the wet season was 0.072/day (SE = 0.0035) and for Rakhine during the dry season, 0.0057/day (SE = 0.0000). The mean defecation rate was 23.0/day (SE = 1.5) and the mean decay rate of dung piles were 0.0090/day (SE = 0.001) for AKNP (Myint, 1994).

In Bago, for a 285 km transect survey with a dung encounter rate of 2.4/km, the elephant density varied from 0.4 to 5 elephants/km^2 and an average density of 1.6 elephants/km^2 (95% Confidence Interval CI = 1.4–1.7 elephants/km^2) could be estimated for all the regions surveyed in Bago. The elephant survey in Rakhine is based on a 300-km transect survey with a dung encounter rate of 1.2/km. The density estimates for different regions in Rakhine varied from 0.008 to 0.2 with an average density of elephant for all the regions surveyed being 0.05 elephants/km^2 (95% CI = 0.04–0.06). For AKNP, a density of 0.61 elephants/km^2 (95% CI = 0.5–0.7) was estimated through a 50-km survey with a dung encounter rate of 0.85/km.

The encounter rate of dung piles indicated that the elephants were found to be using only the southwest regions of the park. For Bago, estimated mean density (2/km^2) and number (2600) appear to be very high. Considering the amount of logging and other disturbances (Salter, 1983; Htut, 1994) and also the numbers presented for Bago (Myint, 1994), only 300 elephants could be expected for the regions surveyed. Earlier observation of Myint (1994) also suggests that the density estimated during the current study of Rakhine to be acceptable. For a habitat area of 16,000 km^2 in Rakhine, Myint (1994) estimated 750 elephants. Although the habitat is disturbed by logging and other activities, the relatively low human population density, inaccessibility, and large and contiguous forest cover offer some hope for the conservation and management of elephants in Rakhine.

For AKNP, the overall elephant dung encounter rate was 0.8/km (varying between 0 and 3/km) and most other regions surveyed had no dung along the transects. MYINT (1994) estimated a density of 0.09 elephants/km (95 % CI = 0.04–0.15) for AKNP and our density estimate of 0.61 is six times higher than the earlier estimate. As observed by Myint (1994), it is likely that elephants do not use some of the regions of the park and the estimated density thus cannot be extrapolated for the entire park. The lack of sightings or low density of elephants could be due to logging in the past, other disturbances, and distribution of food and other resources.

Only 20% of locations surveyed had elephant dung piles, and if the density estimates are extrapolated to only a small portion (say 10 to 20 %) of AKNP, only 100 to 190 elephants would be predicted for the park. Many other reasons also could be identified for the high density of elephants in some of the reserved surveyed. Two extreme dung decay rates were found for the dry and the wet seasons. The dung decay rate was high during the wet season, but low or slow in the dry season. If the decay rate of the old dung piles is very slow but fresh dung disappear faster then the old during the wet season, some of the old dung piles from the dry season would also remain in the wet season and increase the dung density resulting in over estimation of density.

As this is the first scientific study of its kind in Myanmar, comparative figures on population density are not available from anywhere in the country. However, it is important to mention that the encounter rates of dung piles are relatively lower than reported for some of the elephant habitats in India. The encounter rate of dung piles/km was 0.14–1.1 times that of elephant habitats in India for Bago, 0.07–0.59 that in Rakhine, and 0.05–0.44 that in AKNP. Considering the encounter rate of dung piles/km and density estimates of the elephant habitats in India, and incorporating the elephant dung encounter rate/km of the regions surveyed in Myanmar, a density range of 0.1–0.3 elephants/km^2 for Bago, 0.05–0.13 elephants/km^2 for Rakhine and 0.03–0.1 elephants/km^2 for AKNP would result (Table 3).

Recommendations for Population Survey Based on the Management Plan

As mentioned earlier, wild elephants are being captured to replenish captive stocks for timber extraction and it is not known what effect this capturing has on the wild elephant population. Given this, the first and foremost conservation strategy for the country should be to determine the number of elephants in the wild.

Reliable surveys will be possible only when suitable methods of estimating numbers are available or the existing methods are reviewed and their applicability is well investigated. After achieving this goal, population estimation should seek to identify regions of high, moderate and low elephant density or usage within the country.

Through our efforts, only a small proportion of the country has been surveyed and a few personnel have been trained. More regions need to be explored for population estimation and capacity building and the knowledge gained through these approaches should be reviewed periodically for more effective use.

The results for Bago appear to overestimate of the density and the number of elephants, which could have been due to the rapid decay rate of the dung piles. The decay rate results could be biased and not representative of regions outside the reserves which were surveyed. The results could also be influenced by the fact that the surveys were carried out in the wet season. One way to overcome this problem is to carry out a series of decay rate experiments spread over the wet months and get a more realistic mean rate of decay. It may also be better to avoid carrying out censuses during the wet season and confine these entirely to dry months when the variation in dung decay rates can be expected to be substantially lower.

References

Archana, P., and Sukumar, R. (2006). Gajaha 2.0 based on Monte Carlo simulation, Centre for Ecological Sciences and Asian Nature Conservation Foundation (www.asiannature.org), Indian Institute of Science, Bangalore.

Barnes, R.F.W., and Jensen, K.L. (1987). How to count elephants in forests. *IUCN/SSC African Elephant & Rhino Specialist Group Technical Bulletin* 1: 1–6

Caughley, G. (1989). Comments on elephants in Burma, FAO, United Nations, Rangoon, Burma.

Corbet, G.B., and Hill, J.E. (1992). *The Mammals of the Indomalayan Region*. Nature History Museum Publications, Oxford University Press, New York

Dawson, S., and Dekker, A.J.F. M. (1992). *Methods for Counting Asian Elephants in Forests: A Field Techniques Manual*. FAO, Bangkok.

Eberhardt, L.L. (1968). A preliminary appraisal of line transects. *J.Wildl. Manage*. 32: 82–82.

Htut, Ye, (1993). Management of Wild Elephants in Myanmar. Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar

IUCN. 1989. *Burma: Conservation of Biological Diversity.* World Conservation Monitoring Centre, Gland, Switzerland. Pp. 1–13.

Menon, V. (2003). *A Field Guide to Indian Mammals*. Dorling Kindersely (India) Pvt. Ltd.

Myint, A. (1994). A view on distribution, status and conservation of wild elephants in Myanmar. Wildlife and Nature Conservation and Sanctuary Division, Ministry of Forestry, Yangon, Myanmar.

Myint, A. (1994). Preliminary estimates of the abundance of wild elephants in Alaungdaw Kathapa National Park. Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar.

Rao, M., Rabinowitz, A., and Khaing, S.T. (2002). Status review of the protected areas system in Myanmar with recommendations for conservation planning, *Cons. Biol.* 16(2) 360–368

Salter, R. E. (1983). Summary of currently available information on internationally threatened wildlife species of Burma. Working People Settlement Board, FAO Rangoon, Burma.

Santosh, J. A., and Sukumar, R. (1993). Some solutions to problems in estimation of elephant density. Pages 394–404 *in: Proc. International Workshop on Conservation of Asian Elephants: A Week with Elephants*. J. C. Daniel and H. Datye (Eds.). Bombay Natural History Society, Bombay, and Oxford University Press, New Delhi.

Santiapillai, C., and Jackson, P. (1990).. *The Asian Elephant: An Action Plan for its Conservation*. IUCN/SSC Asian Elephant Specialist Group.

Sukumar, R. (1989). *The Asian Elephant: Ecology and Management*. Cambridge Studies in Applied Ecology and Resource Management, Cambridge University Press, Cambridge, U.K.

Sukumar, R., and Santiapillai, C (1996). *Elephus maximus*; status and distribution. The Proboscidea : Evolution and Palaeoecology of Elephants and Their Relatives, J. Shoshani, and P. Tassy (Eds.), Oxford University Press, Oxford, New York. Part VI, Chapter 33.

Uga, U. (1995). Situation of biological diversity conservation in Myanmar. Nature and Wildlife Conservation Division, Forest department, Myanmar.

Yin, U. T. (1967). *Wild Mammals of Myanmar*, Yangon Gazette Ltd, Yangon. Myanmar

Zaw, K.U. (1998). 1998. Utilization of elephants in timber harvesting in Myanmar. *Gajah* 17: 9–22.

Table 1. Forest reserves sampled, area, number and percentage of transects surveyed, their topography and microhabitats, distance covered and number dung piles recorded for Bago, Rakhine and AKNP regions.

Regions	Name of Reserves	Area (km^2)	%	No of transects	%	Topography along the transects	%	Forest types along the transects	%	Distance covered (km)	Dung piles recorded
Bago	South.Zamari	882	29.9	36	25.4	Undulating	35.2	MUMD	45.3	72	309
	North Zamri	714	24.2	35	24.6	Hill with slope	41.5	SEG	35.3	70	62
	Yenwe	795	26.9	36	25.4	Flat land	12.7	EG	12.9	72	122
	Idokan	521	17.6	23	16.2	Ridges with valley	0.0	LMD + SEG	3.6	46	105
	Okkan	40	1.4	12	8.5	Small hill	5.6	MUMD + SEG	2.2	23.5	60
						Undulating and steep slope	4.9	MUMD + EG	2.9		
	Total	**2952**		**142**						**283.5**	**658**
Rakhine	DDNSAND 1*	750.5	6.3	16	10.8	Gentle slope	13.5	MUMD	10.1	32	42
	DDNARAK 2 *	2600	21.9	70	47.3	Flat land	0.7	EG	33.8	140	108
	DDNGAW *	2600	21.9	20	13.5	Hill with slope	30.4	SEG	51.4	40	66
	DDNMAYU 1*	2652.8	22.4	12	8.1	Undulating and steep slope	47.3	Others	4.7	24	71
	DDNMAYU 2 *	1200	10.1	8	5.4	Undulating	8.1			16	36
	DDNMYAP*	1750	14.8	12	8.1					24	11
	DDNSINT*	307.2	2.6	10	6.8					20	20
	Total	**11860.5**		**148**						**296**	**354**
AKNP	South-west			6	27.3	Undulating	45.5	BAM	43.5	12	36
	North-west			4	18.2	Gentle slope	27.3	MUMD + BAM	23.5	8	0
	Mindon			4	18.2	Undulating and steep slope	13.6	RF + BAM	14.1	6	0
	Kunze			4	18.2	Steep slope	4.5	RF	1.2	8	0
	Kanthat			4	18.2	Ridges with valley	9.1	EG	5.9	8	0
								MUMD	11.8		
	Total	**1606**		**22**						**42**	**36**

*Part of Thandwe Reserved Forest (DDNSAND1), Sabyin & Mindon (DDNARAKAN2), part of Gwa Reserved Forest (DDNGWA), north of May Yu Reserved Forest (DDNMAYU1), south of May Yu Reserved Forest (DDNMAYU2), part of Miva Pya (DDNMYAP) and part of Sin Tanung Reserved Forests (DDNSINT).

BAM (Bamboo), MUMD + BAM (Moist Upper Mixed Deciduous and Bamboo), RF + BAM (Riverian Forest and Bamboo), RF (Riverian Forest) EG (Evergreen forest) MUMD (Moist Upper Mixed Deciduous), SEG (Semi Evergreen forest).

Table 2. Elephant density estimates for different reserves in Bago, Rakhine and AKNP.

Region	Reserve	Dung density (SE)	Mean elephant density (95% CI)	Mean number of elephants (95% CI)
Bago	South Zamari 1	1380 (98.2)	4.95 (4.65–5.26)	542 (504–576)
	South Zamari 2	121 (28.6)	0.43 (0.37–0.51)	70 (59–82)
	South Zamari 3	–	–	–
	North Zamari	151 (21.6)	0.54 (0.49–0.60)	388 (349–426)
	Yenwe	300 (30.6)	1.07 (0.98–1.16)	852 (781–922)
	Idokan	361 (42.2)	1.29 (1.18–1.42)	675 (613–737)
	Okkan	392 (59.2)	1.41 (1.25–1.56)	56 (50–62)
			Mean 1.62 (1.49–1.75)	**Total 2583 (2433–2805)**
Rakhine	DDNSAND 1	132 (22.4)	0.03 (0.03–0.04)	–
	DDNARAK 2	71 (8.9)	0.02 (0.01–0.02)	–
	DDNGAW	165 (20.3)	0.04 (0.04–0.05	–
	DDNMAYU 1	452 (66.0)	0.17 (0.12–0.14)	–
	DDNMAYU 2	225 (37.5)	0.06 (0.05–0.07)	–
	DDNMYAP	27 (21.5)	0.01 (0.00–0.01)	–
	DDNSINT	83 (18.6)	0.02 (0.02–0.03)	–
			Mean 0.05 (0.04–00.5)	**Total 722 (686.4–758.7)**
AKNP	AKNP	1633.8 (375.8)	**0.64 (0.52–0.74)**	–

Table 3: Comparison of results across elephant habitats in India and Myanmar

Name of region	Encounter rate of dung/km	Estimated density (km^{-2})
India:		
Mudumalai Wildlife Sanctuary, southern India	15.7	1.74
Buxa Tiger Reserve, west Bengal	8.7	0.35
Kalakadu Mundanthurai Tiger Reserve, southern India	2.0	0.2
Myanmar:		
Bago Yoma	2.3	1.6[1]
Rakhine Yoma	1.2	0.05[1]
AKNP	0.9	0.6

[1] Mean elephant densities

Section 2:
Population Estimation of the Asian elephants (*Elephas maximus*) in Bago Yoma, central Myanmar

Surendra Varma[1], U Ye Htut[2], U Uga[2] and R. Sukumar[1]

[1]*Asian Elephant Research & Conservation Centre*
(A division of Asian Nature Conservation Foundation),
C/o Centre for Ecological Sciences,
Indian Institute of Science, Bangalore 560 012, India

[2] *Wildlife and Nature Conservation Division,*
Ministry of Forestry, Yongon, Myanmar

[3]*Current address;*
Chairman, Biodiviersity and Nature Conservation (BANCA),
14/A Bawga Strrt, 9th mile, Mayangon Township, Yangon, Myanmar

Abstract
A status survey, population evaluation and preparation of a conservation action plan for the Asian elephant in Bago Yoma, Myanmar was initiated. Line transects of indefinite width were used for estimating dung density in five forest reserves such as South Zamari, North Zamari, Yenwe, Idokan and Okkan in Bago Yoma. Free ranging captive elephants were selected for defecation study. For estimating daily rate of decomposition of the dung piles, fresh dung piles were monitored. A dung encounter rate of 2.42/km was estimated, it varied across the regions from 0.8 to 4.2/km and it was more in south Zamari 1 and low in north Zamari. The mean defecation rate for the region was 20.02 and overall decay rate was 0.072. The elephant density varied from 0.4 to 5 elephants/km^2 and the average density of elephant for Bogo was 1.6 animals/$km^{2.}$ In relation to a specific usage zone for all the regions surveyed, south Zamari appears to more used and though North Zamari has relatively larger area than the other regions surveyed, it is less used by elephants. In the low utilization zone the near-absence of elephants was attributed to disturbance from logging operations.

Introduction

After India, Myanmar has the largest remaining population of Asian elephants (Elephas maximus). These wild elephants are distributed over 13 distinct populations. Among them Bago Yoma (formerly known as Pegu Yoma) situated in central Myanmar, is a crucial area for large mammals including the Asian elephant (Salter 1983, Hut 1993). In the past, the forest department had been capturing elephants from the wild to replenish the captive stock for timber extraction. Although the capture quotas are set each year supposedly on a sustainable basis, it is certain that the wild populations have declined substantially during this century. It is thus important for Myanmar to formulate an effective elephant conservation strategy. Though Myanmar is rich in biodiversity, there have hardly been any studies or even simple surveys conducted of species distribution for most wildlife species. Estimating large mammals, in particular, elephant numbers and mapping their distribution thus becomes imperative, as the population estimates are only educated guesses. There have been several attempts to estimate elephant numbers, but these have no scientific basis. Estimating elephant numbers is very difficult as the visibility within the forests is very poor and the forests in which elephants occur are inaccessible. It is with these objectives in mind, a status survey, population evaluation and preparation of a conservation action plan for the Asian elephant in Bago Yoma, Myanmar was initiated.

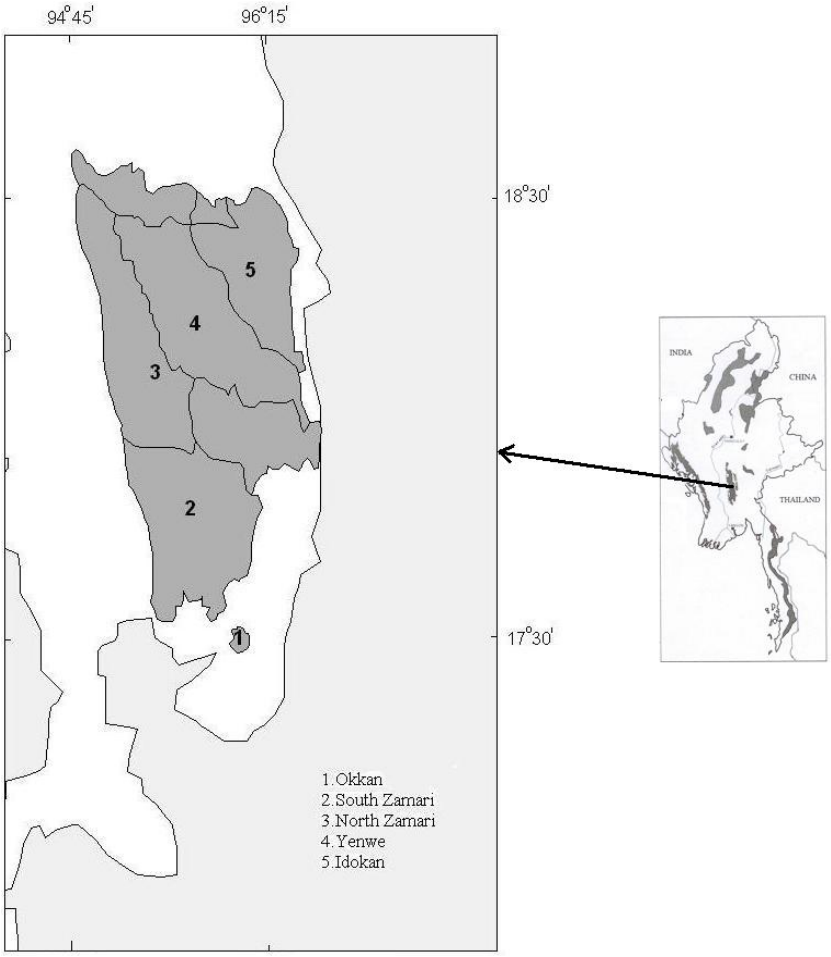


Figure 1: Location of Bago Yoma in Myanmar, and location of the survey region Bago Yoma is marked among the areas of elephant distribution in the country.

Materials and method

Study area

The Bago Yoma region (Figure. 1), which is situated in the central Myanmar, lies between 18^o to 20^o N and 96^o to 97^o E. The region is a very extensive tract of hill country, composed of tertiary sedimentary rocks. The average elevation of the Yoma is about 1000msl, the highest point in the entire Bago Yoma being 1050msl. The entire area is characterised by steep slopes and narrow ridges. The region has very good drainage; the Pegu, tributaries of Yenwe Chang, and the Kun Chang are the major river sources. The wet season lasts from May to October and the average annual rainfall varies from 160 to 330 cm.

The region is famous for reputedly being the most valuable block of teak forest in the world. Thus, the region has been subject to intensive management (Figures 2a and b) for logging for the past 130 years (Salter 1983).

a

b

Figures 2a and b: mixed deciduous forest (2a and b) with the sign of human interference (2a)

The vegetation is largely mixed deciduous forest, with semi-evergreen forests occurring in areas of high precipitation. Patches of evergreen trees consisting mostly of secondary growth are seen in a few places. Notable among the mammal species (Hut 1993) seen here are Phayres langur (*Trachypithecus phayrei*), Himalayan black bear (*Selenarctos thibetanus*), Malayan sun bear (*Helarctos malayanus*), leopard (*Panthera pardus*), tiger (*Panthera tigris*), elephant (*Elephas maximus*), hog deer (*Axis porcinus*), gaur (*Bos gaurus gaurus*), wild dog (*Cuon alpinus*), sambar (*Cervus unicolor*), tsaine (saing) or banteng (*Bos banteng*) and serow (*Capricornis sumatraensis)*

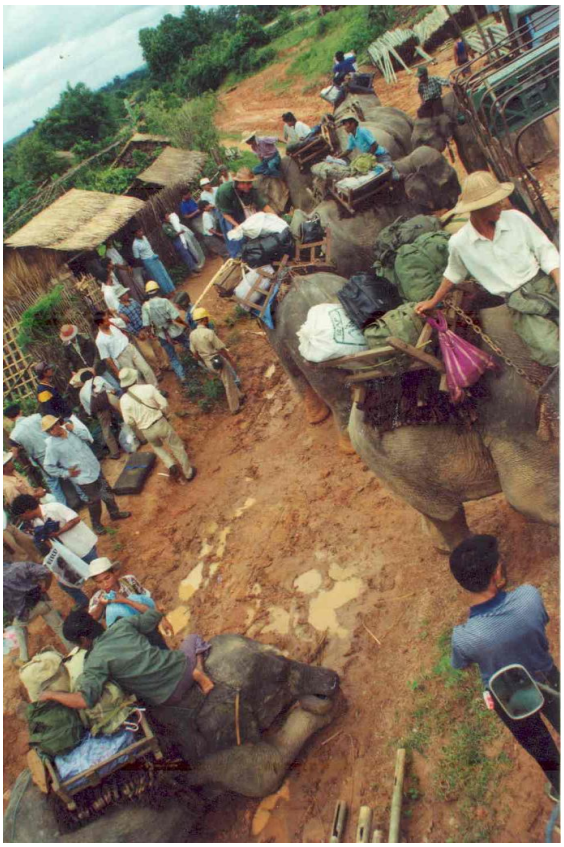


Figure 3: Census team and preparation for the survey

Methods

Dung density

In dense forests with poor visibility, as is the case with most forests in Myanmar, counting elephants by direct methods is extremely difficult. It was thus decided to use indirect methods to estimate elephant density (Barnes and Jensen 1987, Dawson and Dekker 1992, Santosh and Sukumar 1993). The method involves computing 3 parameters: dung density, estimating defecation rate and decay rate of dung piles to compute the density of elephants and thus the population size within an area.

Line transects of indefinite width (Burnham et al. 1980) were used for estimating dung density in five forest reserves of the Bago Yoma - South Zamari, North Zamari, Yenwe, Idokan and Okkan. In each reserve the census team (Figure 3) split into six groups (each group consisting of 4 persons, including a field tracker). Transects (Figure 4) of 2 km length were cut afresh and walked by a group to record dung piles.

Figure 4: Census team on ground marking transect for dung density survey

Defecation rate experiment

The defecation study was carried out in Myainghawan elephant nursing camp. Elephants from this camp were selected for the study as these elephant feed only on natural vegetation from the surrounding forest areas. The elephants are free from timber extraction work and kept here for training and veterinary care. For the defecation observation the census team participants were divided in to 4 groups of 5 participants each. Each group observed five elephants (of total 32 elephants of different age and sex class) for defecation rate of elephants, and a total of 48 hours (both day and night) was spent for observing each elephant.

Decay rate experiment

The estimation of the rate of decomposition of the dung piles was done by monitoring fresh dung piles. Fresh dung piles were marked (Figure 5) during the defecation observations for subsequent monitoring. Four microhabitats were selected and in each habitat 25 dung piles were marked using bamboo stakes. Two trained staff of MTE continued to monitor the experiment after the departure of the census team.

Figure 5: Marking dung piles for decay rate experiment

Data analysis

The density of dung piles, daily defecation rate and decay rate was estimated using GAJAHA program (AECC 1995). The same program was used to compute the elephant density. Density of elephant was estimated separately for each reserve.

Results

A total of 142 transects covering 284 km was surveyed, and a total of 658 elephant dung piles accounting for a dung encounter rate of 2.42/km was estimated for the region (Table 1). Encounter rate varied across the regions from 0.8 to 4.2/km and it was more in south Zamari 1 and low in north Zamari. The results of dung density, defecation rate and decay rate for different reserves are summarized in Table 2. The mean defecation rate for the wet season was 20.02 (Standard Error-SE = 0.55). Overall decay rate for 100 fresh dung piles was 0.072 (SE = 0.0035). The elephant density varied from 0.4 to 5 elephants/km^2 and an average density of 1.6 (95% CI = 1.4 to 1.7) elephants/km^2 could be estimated for all the regions surveyed in Bago.

Elephant densities have been calculated assuming the same defecation and dung decay rates for all reserves during the wet season. In South Zamari three zones were identified based on differential utilization by elephants. The high utilization zone had an elephant density of 5

animals/km^2 within an area of 109.5 km^2, and the medium utilization zone a density of 0.43 animals/km^2 within a 161.2 km^2 area. The estimated elephant number in these two zones was 613 individuals. In North Zamari an elephant density of 0.54 animals/km^2 was indicated or a population of 388 for the 714 km^2 reserve. Yenwe Reserve, which has area of 795 km^2, had a density of 1.07 animals/km^2 and the population size estimated for this reserve is 852 animals. The density for Idokan reserve is 1.2 elephants/km^2 and the total number elephant estimated for an area of 521 Km^2 is 675 animals. In Okkan the estimated elephant density was 1.4 animals/km^2 and total number of elephant is 56 animals for 40 Km^2. Overall a minimum of 2513 elephants for only few reserves in Bago could be estimated.

Discussion

In the low utilization zone the near-absence of elephants was attributed to disturbance from logging operations (from inquiries with MTE) and thus no transects were laid here. This would however not make any substantial difference to the estimates of elephant numbers in the reserve. In relation to a specific usage zone for all the regions surveyed, south Zamari appears to more used and though North Zamari has relatively larger area than the other regions surveyed, it is less used by elephants. With reference to the area, size and density of elephants (which could indicate the usage pattern by elephants of given area), the Okkan reserve estimates show more density compared to other regions surveyed. Except for north Zamari, the density estimates for all the regions are very high, which is almost equal to high elephant density regions in south India. The previously reported number of elephants for Bago Yoma is 700 animals; the present estimated mean density (1.6/km^2) and number (2583) appear to be very high. Going by the facts of logging and other disturbances (Salter 1893; Htut 1994), only 800 elephants could be anticipated for the regions surveyed.

There could be several reasons for this difference. A major reason could be that the estimated decay rate, which is extremely high, is biased and not representative of regions outside reserves, which surveyed and also throughout the wet season. The experiment may have been carried out during an exceptionally heavy spell of rain and this may not be sustained throughout the wet season when the census was carried out. This would result in substantial over-estimation of elephant densities. The other important point to be noted is, two extreme dung decay rate were found for dry and wet seasons. Dung decay rate is very high during the wet season, and it is low or slow for the dry season.

Knowing the dung density and the decay rate of each stage of the decay is important. If dung decay rate of the old dung piles are very slow but fresh dung disappear faster than the old ones during the wet seasons, some of the old dung piles of dry season would also remain in the wet season and increase the dung density resulting in an over estimate of the number. The results could also be influenced by the fact that the surveys were carried out in the wet season. One way to overcome this problem is to carry out a series of decay rate experiments spread over the wet months and get a more realistic mean rate of decay. It may also be better to avoid carrying out censuses during the wet season and confine these entirely to dry months when the variation in dung decay rates can be expected to be substantially lower.

Obviously the density estimate made in selected reserves cannot be extrapolated to the entire Bago Yoma region. For this sampling has to be carried out in other areas of the region. Our estimate is thus a first minimum approximation and needs further refinement.

References

AECC, 1994. GAJAHA - A Computer program for estimating elephant densities. Asian Elephant Conservation Centre, Indian Institute of Science, Bangalore, India

Barnes, R.F.W. and Jensen, K.L.1987. How to count elephants in forests? IUCN African Elephant & Rhino Specialist Group Technical Bulletin 1: 1-6.

Burnham, K.P. Anderson, D.R. and Laake, J.L. 1980. Estimation of density from line transect sampling of biological populations. Wildlife Monographs 72: 1- 202.

Dawson, S. and Dekker, A.J.F.M. 1991. Methods for counting Asian elephants in forests: a field techniques manual. FAO, Bangkok.

Santosh J A and Sukumar R. 1993. Some solutions to problems in estimation of elephant density. In Proc. International Workshop on Conservation of Asian elephants (ed) J C Daniel (Bombay Natural History Society)

Salter. R..E. 1983. Summery of Currently available information on internationally threatened Wildlife Species of Burma. Working People Settlement Board, FAO Rangoon, Burma.

Ye Hut, 1993. Management of Wild Elephants in Myanmar. Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar.

Table 1: Forest reserves sampled for elephant density estimation during elephant survey in Bago Yoma

S.no	Name of Reserves	No of transects	Distance covered (km)	Dung piles recorded
1	South.Zamari	36	72	309
2	North Zamri	35	70	62
3	Yenwe	36	72	122
4	Idokan	23	46	105
5	Okkan	12	23.5	60
	Total	**142**	**283.5**	**658**

Table 2: Elephant density estimates in different reserves of Bago Yoma. Dung and elephant densities are expressed in per km^2. Mean defecation Rate/day is 20.02 and Standard Error (SE) is 0.559 and mean decay rate of elephant dung pile is 0.072 and standard Error (SE) is 0.0035

S.no	Reserves	Dung Density (SE)	Mean elephant density (95 % CI)	Mean Number of Elephants (95%CI)
1	South Zamari 1	1380 (98.2)	4.95 (4.65 – 5.26)	542 (504 -576)
	South Zamari 2	121 (28.6)	0.43 (0.37 – 0.51)	70 (59 - 82)
	South Zamari 3	-	-	-
2	North Zamari	151 (21.6)	0.54 (0.49 – 0.60)	388 (349 - 426)
3	Yenwe	300 (30.6)	1.07 (0.98 – 1.16)	852 (781 - 922)
4	Idokan	361 (42.2)	1.29 (1.18 – 1.42)	675 (613 - 737)
5	Okkan	392 (59.2)	1.41 (1.25 – 1.56)	56 (50 - 62)
			Mean 1.62 (1.49 - 1.75)	**Total 2583 (2433 - 2805)**

Section 3:
Population Status of the Asian Elephant (*Elephas maximus*) in the Rakhine yoma, Myanmar

Surendra Varma[1], U Ye Htut[2], U Uga[2] and R. Sukumar[1]

[1]*Asian Elephant Research & Conservation Centre*
(A division of Asian Nature Conservation Foundation),
C/o Centre for Ecological Sciences,
Indian Institute of Science, Bangalore 560 012, India

[2] *Wildlife and Nature Conservation Division,*
Ministry of Forestry, Yongon, Myanmar

[3]*Current address;*
Chairman, Biodiviersity and Nature Conservation (BANCA),
14/A Bawga Strrt, 9th mile, Mayangon Township, Yangon, Myanmar

Abstract
Myanmar perhaps supports the second largest remaining populations of Asian elephant in the world. The current survey was carried out in seven forest reserves of the Rakhine Yoma, using indirect method of estimating elephant density. In addition to this, village surveys were carried out to obtain information on the extent of human-elephant conflict. A total of 148 transects covering 296 km was surveyed and the encountered rate of dung piles varied from 0.4 to 2.9/km with a total dung encounter rate of 1.19/km. The defecation rate was 19.04 and overall decay rate for 100 fresh dung piles was 0.0057. The density estimates for different regions in Rakhine varied from 0.008 to 0.2 with an average density of elephant for all the regions surveyed being 0.05 elephants/km^2. Of the 44 villages visited during the survey, 47 % villages had problems with elephant depredation. Although the habitat is disturbed by logging and other means, relatively low human population density, inaccessibility, and large and contiguous forest cover have some hope for the conservation and management of elephants in Rakhine.

Introduction

Myanmar perhaps supports the second largest remaining populations of Asian elephant in the world. They represent the most economically important species in the country and they have always been the backbone of Myanmar timber industry (Blower 1980). In contrast to many other countries in Southeast Asia, the elephant habitats in Myanmar have remained reasonably intact for a long time, but due to insurrection and other issues, the habitats of large mammals, particularly the Asian elephant (*Elephas maximus*), face very serious threats (IUCN 1989). The prediction for the long-term survival of the elephant could be good if effective protection of both the animal and its habitat were assured; along with the protection, population numbers also have to be assessed regularly. However, estimating elephant numbers in this country is very difficult as the visibility within the forests is very poor and the forests in which elephants occur are inaccessible.

Elephants in the Myanmar are reported to inhabit the evergreen, semi-evergreen, moist deciduous, and bamboo forests. Bamboo is among the elephant's most preferred food items and it is particularly abundant in the Rakhine (formarly known as Arakan) Yoma, Bogo Yoma, and Tenasserim regions. The Rakhine is particularly rich in bamboo forests and so represents one of the largest elephant ranges in Myanmar. According to Sayer's (1983) report, "The Rakhine Yoma as a whole probably supports amongst the world's largest remaining populations of Asian Elephant". The main conservation goal for Rakhine population could be assessing their number and identifying the ground status. This survey was aimed for assessing the status of the Asian elephant in Rakhine, in particular, estimating the population number and brief assessment of the status of human – elephant conflict the region.

Materials and method

Study area

The Rakhine Yoma region (Figure.1) is a series of hills ranges, which run for nearly 600 km (300 miles) along the west coast of Myanmar. The hill ranges of Yoma are a southward extension of the Himalays. The average elevation of the Yoma is about 1000msl. The entire area is characterised by steep slopes and narrow ridges, the steep slops and friable soils result in frequent landslides and geological the region has many exposed rocks in most of the areas. The Sandoway River (Sandoway Chaung) is the major water source for the region. The average annual rainfall varies from 300 to 1200mm. Three distinct seasons can be identified and the dry season lasts from

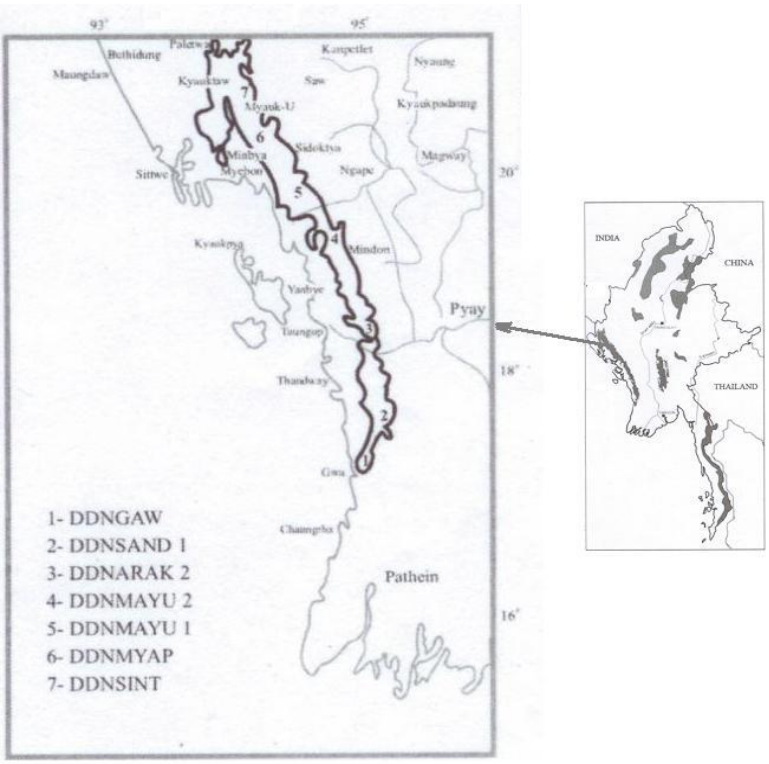
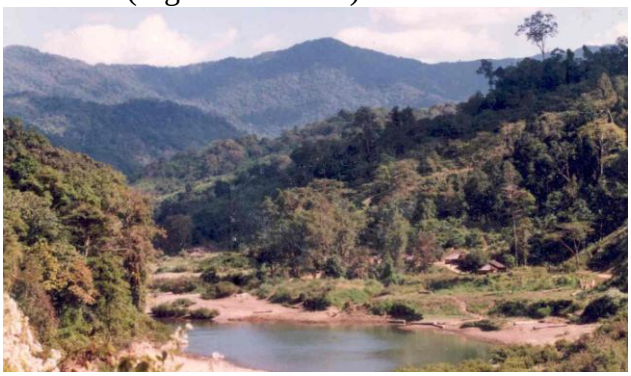


Figure 1: Location of Rakhine Yoma in Myanmar, and location of the survey region Rakhine Yoma is marked among the areas of elephant distribution in the country.

January to April. The distinct rainfall gradient results in a diversity of vegetation types. At low elevation near the coast, the climax vegetation is semi-evergreen forest, while further inland from the coast the vegetation changes to deciduous forest type (Figure 2a). Like the other regions of Myanmar, Rakhine also has been subject to intensive management for logging for the past several decades. In many places, past human disturbance has resulted in large areas being invaded by bamboos (Figures 2b and c).



a

b

Figures 2a and b: Mixed deciduous forest (2a) dominated by bamboo patches (2b)

The region is known for its variety of wildlife. Major mammal species seen here are Rhesus macaque (*Macaca mulatta* Zimmermann), Hoolock Gibbon (*Hylobates hoolock* Harlan), Phayres langur (*Semnopithecus phayrei* Blyth), Asiatic black bear (*Ursus thibetanus* Cuvier), Malayan sun bear (*Ursus malayanus* Raffles), leopard (*Panthera pardus* Mayer), tiger (*Panthera tigris* Linnaeus), elephant (*Elephas maximus* Linnaeus), hog deer (*Axis porcinus* Zimmermann), gaur (*Bos gaurus* Smith), wild dog (*Cuon alpinus* Pallas), sambar (*Cervus unicolor* Kerr), Tsaine (saing) or banteng (*Bos banteng* Wagner) and serow (*Capricornis sumatraensis* Blyth*).*

Figure 2c: Signs past logging operation

Methods

For the current survey the indirect method (Figures 3a, b, c and d) of estimating elephant density

a

b

Figure 3a, and b, Preparation for dung survey method using captive elephants for camp move (3a) and walking along the rope for the survey (3b)

was used (Barnes and Jensen 1987, Dawson and Dekker 1991, Varman et al 1995).

c

d

Figure 3c: Preparation for the survey (3c); camp site and discussions with among the survey team

For this method 3 parameters such as: dung density, estimating defecation rate and decay rate of dung piles were computed to arrive at the density of elephants. Apart from this, village surveys were carried out to obtain information on the extent of human-elephant conflict.

Dung density estimates

Based on the initial village surveys and discussions with staff of the Myanmar Timber Enterprise (MTE) the survey area was divided into high elephant use, moderate use and low use areas. Line transects of indefinite width (Burnham et al. 1980) were used for estimating dung density in seven forest reserves of the Rakhine Yoma:-

Reserve
1, Part of Thandwe Reserve forest (TRF)
2, Sabyin & Mindon (SM)
3, Part of Gwa Reserved Forest (GRF),
4, May Yu reserved forest:North (NMYRF),
5, May Yu reserved forest:South (SMYRF)
6, Part of Miva Pya (MP) and
7, Part of Sin Tanung reserve forests (STRF)

In each reserve several transects of 2 km length were cut afresh and walked by a census team of 3-4 persons to record dung piles.

Defecation rate experiment

The defecation study was carried out using free ranging MTE elephants at Thaung Chan elephant camp. Observations on 57 elephants of both sexes and different age classes were made for two days each by Team 1 and elephant oozis (elephant keepers) from the respective elephant camps. In total the observations covered 1704 elephant hours for the defecation study.

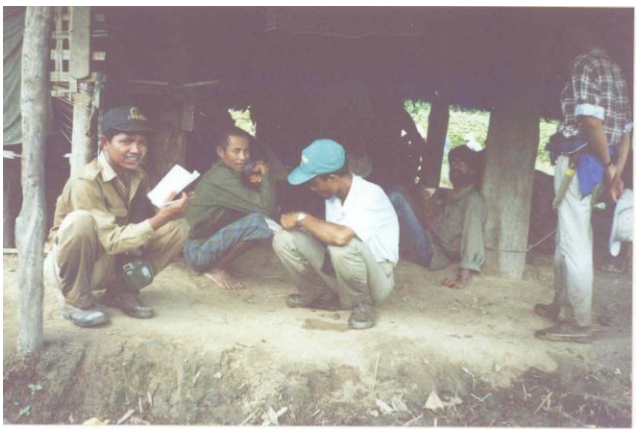
Decay rate experiment

The estimation of the rate of decomposition of elephant dung (Figure 4) was done by monitoring fresh dung piles. Two habitat types were selected and in each habitat 50 dung piles were marked using bamboo stakes during the last week of December 1995. Two trained staff of MTE continued to monitor the experiment after the departure of the census team. A veterinary inspector of MTE, stationed at the campsite, took the responsibility of supervising the dung decay experiments.

Figure 4: Dung pile being marked for decay rate experiment

Village survey

Villages surrounding and situated close to survey reserves were visited to obtain information on human-elephant conflict. This survey was conducted through interviewing villagers (Figures. 5a and b), particularly farmers, through a questionnaire. Information such as name of the village, crop size, crop cultivated, elephant visit to the crop lands, number of animals, frequency of visits, crop damaged, human death and households damaged by elephants, and method of preventing elephant problem were collected.



a

b

Figures 5a and b: Village visits and interviews for survey

Data processing

The density of dung piles, daily defecation rate and decay rate, and elephant density were estimated using Programme GAJAHA (Santosh and Sukumar 1995). Elephant densities were estimated separately for each reserve.

Results

A total of 148 transects covering 296 km was surveyed and a total of 345 dung piles were encountered (Table 1). Encountered rate of dung piles varied from 0.4 to 2.9/km with a total dung encounter rate of 1.19/km. The encounter rate of dung piles was more in DDNMYU 1 and low in DDNMYAP. The results of dung density, defecation rate and decay rate for different reserves are summarized in Table 2.

The defecation rate for the wet season was 19.04 (SE = 0.55). Overall decay rate for 100 fresh dung piles was 0.0057 (negligible SE). Elephant densities have been calculated assuming the same defecation and dung decay rates for all reserves during the dry season. As sample size for some reserves such as SMYRF, MP and STRF are very low, it is proposed to carry out more transect in these reserves. The density estimates for different regions in Rakhine varied from 0.008 to 0.2 with an average density of elephant for all the regions surveyed being 0.05 elephants/km^2 (95% CI = 0.04 to 0.05). DDNMYU 1 and 2 regions appear to have high elephant density zone, followed by DDNGAW and DDNSAN.

Status of human–elephant conflict

A total of 44 villages were visited during our survey and most of the villages (98 %) visited were surrounded by forests. Agriculture was the major income for these villages. Crops such as paddy (*Oryza sativa*), sugar cane (*Saccharum* spp), banana (*Musa* spp), maize (*Zea mays*), groundnut (*Arachis hypogaea*) and vegetables were cultivated. Of the 44 villages visited during the survey, 47 % villages had problems with elephant depredation. The frequency of visits varied from almost daily during the crop season to just once in a year. According to the farmers, the crop damaged by elephants ranged from 1 acre to 20 acre and the most frequently visited crop was paddy. Elephant numbers ranging from 1 to 20 animals visited the fields. Human causalities, such as number of people killed and injured were very low; only two deaths were recorded during the past ten years. Catapult was mainly used for chasing elephant from the fields and human habitation. Other animals such as wild boar, sambar deer, barking deer, porcupine and capped langur were also reported to visit agricultural land for paddy and other crops.

Discussion

The density estimates for different regions in Rakhine varied from 0.008 to 0.2 with an average density of elephant for all the regions surveyed being 0.05 elephants/km^2. Based on FAO survey in Rakhine, Sayer (1983) reported that elephant signs were seen throughout the area and southern Rakhine Yoma may support a large population of wild elephants. According to the report (Sayer 1983), this area is of national significance for elephant conservation and this could be one of the main considerations in determining management objectives.

However, elephants in Rakhine are subjected to many threats, including poaching for meat and for ivory, According to Salter (1983), poaching incidents have been reported on the eastern and western slopes of the Rakhine Yoma. The extent of death due to poaching is not well known, but according to Salter (1983), poaching could be more than the total removal of elephants by government controlled captures operations. However, according to Sayer (1983), elephant population continue to exist in Rakhine because the rugged topography and dense vegetation cover make it difficult to hunt them. The rugged terrain with dense bamboo cover could work negatively for the species, as physical protection by traditional law enforcement methods would have limited effectiveness because of the difficulty of patrolling the area. Sayer (1983) suggest that most cost effective way of protecting elephants and preventing the establishment of settlement would be by enlisting the co-operation of the local township councils in enforcing existing legislation.

Although the habitat is disturbed by logging and other means, relatively low human population density, inaccessibility, and large and contiguous forest cover have some hope for the conservation and management of elephants in Rakhine. However, habitat conversion, habitat fragmentation and poaching for ivory could still be prime conservation issues but human-elephant conflict could be still of secondary importance. As in other regions of Asia the human-elephant conflict is one of the conservation problems, the issue at present is not a major conservation concern in Myanamr, including Rakhine.

It is likely that the conflict might worsen with the steady growth and increase of the human population or the reduction or disturbance of the present forest cover. As predicted by Salter (1993), the major drawback to some part of the Rakhine was the difficulty in controlling human land use, especially the spread of permanent cultivation, which would lead to increased human elephant conflict in future. Salter (1983) concluded that the bamboo forests of the region appeared to contain one of the largest populations of elephants in Myanmar, and thus provide a logical setting for one or more protected areas to ensure the conservation of the species. He also had proposed for establishing a number of large extensive Managed Elephant Reserves in Myanmar for the long-term viability of the species, and Rakhine has been identified as one such areas.

References

Barnes, R.F.W. and Jensen, K.L. 1987. How to count elephants in forests? IUCN African Elephant & Rhino Specialist Group Technical Bulletin 1. pages 1-6.

Blower, J. 1980. Nature conservation in Burma. Report on a mission to the Socialist Republic of the Union of Burma. August 1980. FAO, Rangoon. pages 1- 28.

Dawson, S. and Dekker, A.J.F.M. 1992. Counting Asian elephants in forests: a field techniques manual. FAO, Bangkok. pages 1 – 56.

IUCN, 1989 Burma, Conservation of Biological diversity, world Conservation Monitoring Centre. pages 1-13.

Santosh, J.A. and Sukumar, R. 1995. Some solutions to problems in estimation of elephant density. A week with elephants: Proceedings of the International seminar on the conservation of Asian elephants. Daniel, J.C. and Datye, H.S., (Eds.), Bombay Natural History Society and Oxford University Press, Oxford:

Salter, R.E.1983. Nature Conservation and National Parks Project: Burma. Summary of currently available information on internationally threatened wildlife species in Burma. Field Document No. 7/83. FAO: BUR/006. Rangoon.

Sayer, J.A., 1983. Wildlife in the southern Arakan Yoma, Survey report and interim conservation plan, Nature Conservation and National Parks project Burma, Working people's settlement board, FAO/United Nations, Rangoon, Burma

Varman K S, Ramakrishnan U. and Sukumar R. 1995 Direct and indirect methods of counting elephants: a comparison of results from Mudumalai Sanctuary A week with elephants: Proceedings of the International seminar on the conservation of Asian elephants. Daniel, J.C. and Datye, H.S., (Eds.), Bombay Natural History Society and Oxford University Press, Oxford

Table 1: Forest reserves sampled for elephant density estimation during elephant survey in Rakhine Yoma.

S.no	Name of Reserves	No of transects	Distance covered (km)	Dung piles recorded
1	DDNSAND 1*	16	32	42
2	DDNARAK 2 *	70	140	108
3	DDNGAW *	20	40	66
4	DDNMAYU 1*	12	24	71
5	DDNMAYU 2 *	8	16	36
6	DDNMYAP*	12	24	11
7	DDNSINT*	10	20	20
	Total	**148**	**296**	**354**

*Part of Thandwe Reserve forest (DDNSAND1), Sabyin & Mindon (DDNARAKAN2), part of Gwa reserved forest (DDNGWA), north of May Yu reserved forest (DDNMAYU1), south of May Yu reserved forest (DDNMAYU2), part of Miva Pya (DDNMYAP) and part of Sin Tanung reserve forests (DDNSINT).

Table 2: Elephant density estimates in different reserves of Rakhine Yoma. Dung and elephant densities are expressed in per km^2. Mean defecation Rate/day is 19.040 and Standard Error (SE) is 0.550 and mean decay rate of elephant dung pile is 0.005 and standard Error (SE) is 0.000

S.No	Reserves	Dung Density (+ SE)	Mean elephant density (95 % CI)
1	DDNSAND 1	132 (22.4)	0.03 (0.03 - 0.04)
2	DDNARAK 2	71 (8.9)	0.02 (0.01 - 0.02)
3	DDNGAW	165 (20.3)	0.04 (0.04 - 0.05
4	DDNMAYU 1	452 (66.0)	0.17 (0.12 - 0.14)
5	DDNMAYU 2	225 (37.5)	0.06 (0.05 - 0.07)
6	DDNMYAP	27 (21.5)	0.008 (0.004 - 0.01)
7	DDNSINT	83 (18.6)	0.023 (0.0215 - 0.028
			Mean 0.05 (0.04 - 00.5)

Section 4:
Population Status and Conservation of Wild and Captive Asian Elephants (*Elephas maximus*) in Alaungdaw Kathapa National Park (AKNP), Myanmar

Surendra Varma

Asian Elephant Research & Conservation Centre
(A division of Asian Nature Conservation Foundation),
C/o Centre for Ecological Sciences,
Indian Institute of Science, Bangalore 560 012, India

Abstract
An investigation on the status and conservation of both wild and captive Asian elephant was carried out in Alaungdaw Kathapa National Park (AKNP). Population status of wild elephant was done through indirect method of estimating population number and the survey on human – elephant conflict was through visiting villages located within and around the park. The status of captive elephants was assessed through recoding the morphological measurements and relating its influence on overall body condition of the captive elephants managed there. The results showed a dung encounter rate of 0.85/km for the park and it indicated that the elephants were found to be using only the southwest regions of the park (3 dung piles/km) and other routes encountered no dung piles. A mean dung density of 1633.85/km^2 was estimated resulting to a mean elephant density of 0.64-elephants/ km^2 for the park. The human- elephant conflict was nil and no human casualty or household property damage has been reported. It was found for most of the elephants in the camp that the measurements of height and neck girth were identical and that relationship is possible only if the elephants are in good condition.

Introduction

Alaungdaw Kathapa National Park (AKNP) situated in the northern Myanmar, has exceptional beauty, known for its historical and scientific significance, natural landscape undisturbed by developmental activities or exploitation, large in size, and has great diversity of flora and fauna (Salter, 1982, IUCN 1989, Hut 1997). The park also has one of the last remaining contiguous habitats for the Asian elephant (*Elephas maximus*). Conserving a flagship species (Sukumar 1989) may eventually protect the overall biodiversity. However, the terrain and the vegetation of AKNP are such that direct observation on elephants is extremely difficult and information collected from local hunters and villagers provide basic information on occurrence and status of the species.

More than in any other country the captive elephant has always been considered the backbone of the timber industry of Myanmar and about 50% of all timber in Myanmar is still extracted by elephants. The country has substantial captive elephant population and care and management of these elephants have been formulated through the adaptation of the indigenous people's traditional practices, research and experiences (Zaw 2000). AKNP also contributes some experience and knowledge of captive elephant management: the animals, which are unable to work in the timber logging camps and zoological garden, are brought to an elephant camp in AKNP and managed there. The survey was aimed at assessing the current status of both wild and captive Asian elephants. The objectives were fulfilled through assessing the population number, status of human – elephant conflict and captive elephant management in the park.

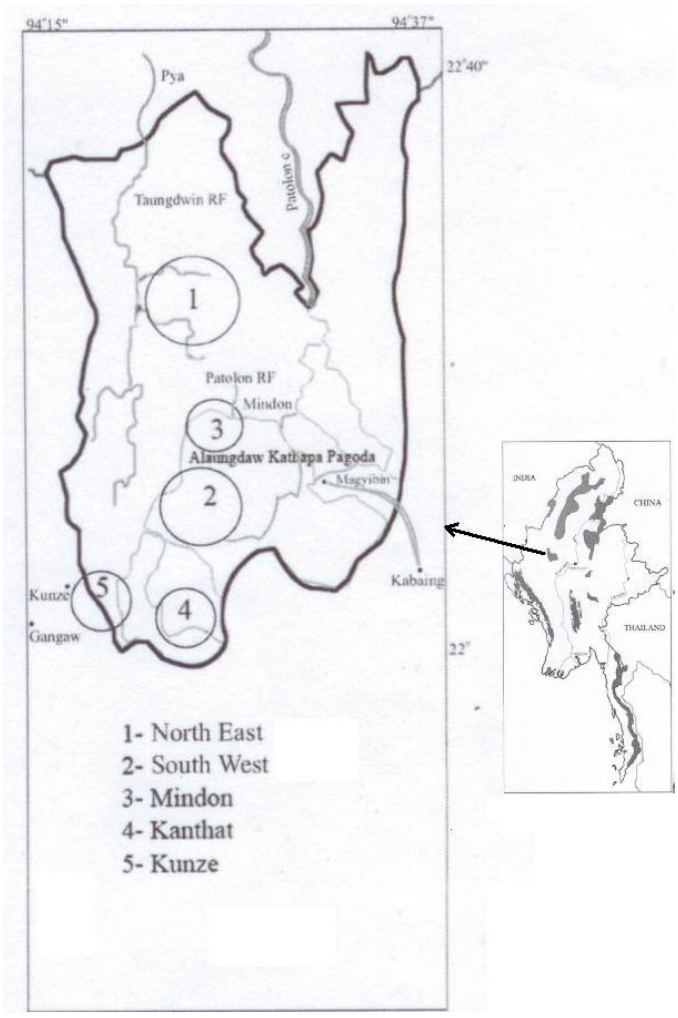


Figure 1: Map showing the location of AKNP in Myanmar, and its detailed topography and the terrain

Materials and methods

Study area

The AKNP (22^o to 23^o N and 95^o to 96^o E) is a well-forested mountainous region situated in west of the lower Chindwin River and Myittha Valley (Figure 1). The 1606 Km^2 Park comprises the Patolon and adjoining Taungdwin Reserved Forests. The elevation of the park varies from 200 to 1300msl with an average of 1000msl and Hlaingma Taung (1290msl) is the highest peak of the park. The park is drained by a number of tributaries of Patolon River: Petpa Chaung and Taungdwin Chaung being perennial among them (FAO 1982, Tun 1997). Major rainfall occurs between May and October and is heaviest in August and September. Rainfall is affected by the western Chin Hills, with annual mean of 1500 mm (FAO, 1982;Tun 1997). Except selective logging of teak (Tectona grandis) in the past, the natural forest cover (Figure 2a) is least

disturbed and the major forest types found here being Moist Upper Mixed Deciduous, Dry Upper Mixed Deciduous, Semi – Indaing, Pine and Evergreen (FAO, 1982;Tun 1997). There is a rich wildlife prevalent in the park; elephant, tiger, gaur, tsaine, sambar and muntjac are the major mammalian fauna here (FAO 1982). Black bear, dhole (Indian wild dog), otter, jungle cat, golden cat, fishing cat, civets, pigs, serow and other species are reported in the park (Tun 1997).

Figure 2: Natural forest cover of the park

Methods

General

Along with line transect survey, different survey routes were identified for sampling wild elephants and villages located within and out side the park were visited for the status of human elephant conflict. The captive elephants belonging to the park were chosen to study captive elephant management. The survey was a part of Wildlife expedition carried out by the UK based Scientific Exploration Society. The expedition team was divided into sub groups, each sub group with a group leader, carried out the survey.

Population estimate of wild elephant through line transect method

The line transect method (Burnham et al 1980) was followed to estimate the density of wild elephant dung piles. Transects were cut afresh for each count, and on locating a dung pile, the perpendicular distance of the dung pile to the transect line was measured. The other parameters such as dung decay and defecation experiments (to compute the elephant density) were not carried out as there was a time constraint, and also the data on these two parameters is already available from the study conducted earlier by Forest Department, Myanmar (Myint 1994).
.

Village survey for assessing the status of human–elephant conflict

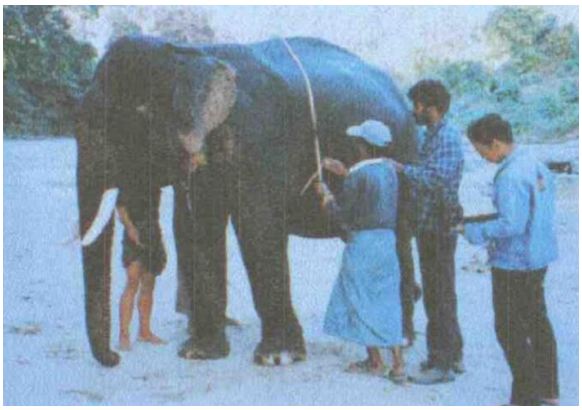
Villages within and outside the park were surveyed for human-elephant conflict. A questionnaire was used. The survey also extracted data on elephant sighted by the villagers during their visit to forest areas for collecting various forest products.

Captive elephant survey

To create an informative database and to understand the status of elephants and their keepers (locally called oozies), elephant and oozi management, veterinary care and benefits (cost benefit) of keeping the elephants in the park were studied (Figures 3a and b) by the following methods:

Type I: Morphological measurements of captive working elephants were recorded.

Type II: Interviews with the park warden, veterinary surgeon, oozi leaders, oozies and assistant oozies were made with the help of an interpreter wherever necessary.



a

b

Figures 3a and b: Captive elephant survey; body measurements (a) and interviews (b)

Photographs of each elephant and their oozies were taken. Drawings of distinguishing features (ears, tusk, and tails) were also made to identify the individual animal.

Data processing

Elephant dung density was estimated using the Computer Program Gajaha (AECC 1995). The results of data on elephant defecation and dung decay rate were obtained from the earlier study and was incorporated into the program to arrive at the elephant density.

The analysis of village survey data included relationship between distance to the forest and conflict with elephants, water source and conflict, type of crops cultivated and conflict and efficacy of methods to detect the elephant problem. For captive elephant, using the information collected through the questionnaire and direct observations, fact sheets were prepared for each elephant, its oozi (elephant keeper) which included veterinary care and management. The data has been analyzed for the population parameters, and the relationship between various body measurements (paricularly height, neck girth and the circumference of the front foot) were also compared. Comparison of the values of mean height and neck girth was made for a specific age class elephants to validate the relationship between height and neck girth.

Results

Status of wild elephants

Based on the transect survey a mean dung encounter rate of 0.85 (Standard Error = 0.12) /km was calculated for the park. The encounter rate of dung piles indicated that the elephants were found to be using only the southwest regions of the park (Table 1). The southeast route encountered a mean 3 dung piles (Standard Error = 0.54)/km, which is about 72% higher then the mean encounter rate for the park and other routes encountered no dung piles.

Based on the survey of dung piles across different sighting distance class (through line transect survey), histogram of perpendicular distance of dung piles in kilometers was arrived and the same is given in Figure 4. From this it can be seen, elephant dung piles are seen more at 2 to 3 meter class intervals, followed by 3 to 4 and least in 6 to 7 meter class interval. The results of elephant dung density; decay rate and defecation rate are given in table 2. A mean dung density of 1633.85 (Standard Error = 375.8) was estimated for the park and elephant density of 0.64 ranged from 0.53 to 0.74 elephants/ km^2 for the park.

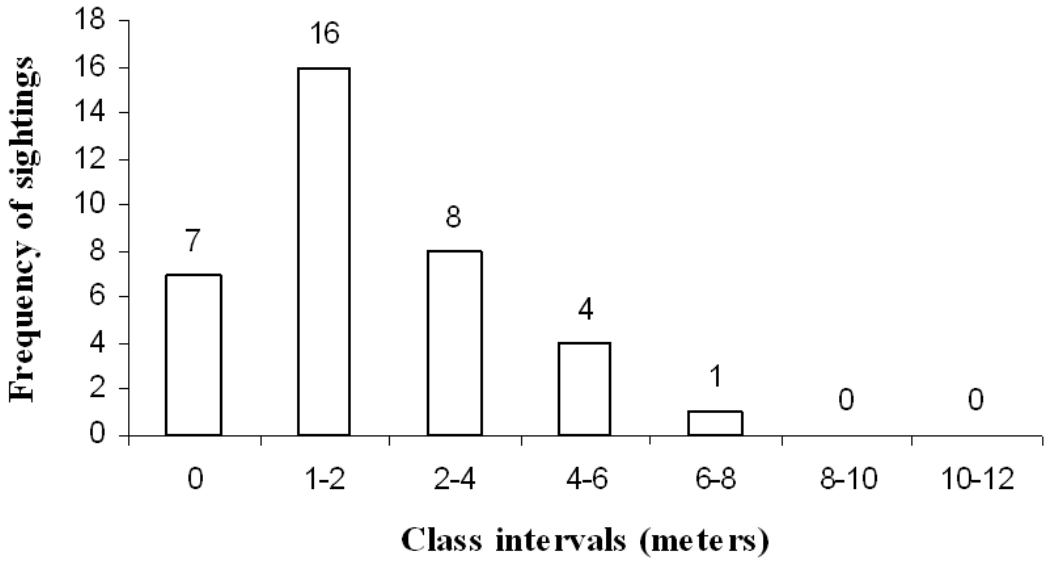


Figure 4: Histogram of perpendicular distance of dung piles in meters. The values are arrived based on the probability density function. Here the assumption is that as distance of sighting (from the line) increases, the probability sighting object decreases. The number of dung piles detected is plotted against the distance class of dung piles sighted.

Status of human elephant conflict

A total of 12 villages were visited. Agriculture (Figure 5) was the main source (98%) of income for all these villages. Paddy, wheat, peanut and vegetable are the major crops cultivated here. All these villages are located very close (Mean 2, Standard Error =0.24 km distance) to forest and water source (within mean distance of 3.2, Standard Error = 0.64). The major forest type found in these regions is mixed deciduous (3 km radius of the village). Though these villages are located close to forest and rivers, the human- animal conflict, particularly with elephants, is almost nil and no human casualty or household property damage has been reported

Figure 5: Agriculture and associated activities of village surveyed

Captive elephant management

Population status

The park was started as a sanctuary in 1984 and later notified as a National Park in 1989. Since then elephants are kept in this camp. The elephant camp was started with 3 elephants and later more elephants were included. The animals, which are wounded, retired and unable to work in the timber logging camps and zoological garden, are brought to this camp and is a refugium for such elephants. Since the establishment of Park and the camp, there has been a gradual increase in the number of elephants with the annual increase of 0.928 animals and currently the park has 14 elephants. For 13 years of existence, only two elephants have died (One 50-year-old female due to old age and a 21 yrs old due to disease), resulting to an annual morality of only 0.14%. There is no captive-breeding program here.

Disease and veterinary care

Anthrax**,** lameness, worms, injury/wounds, anemia, jaundice and eye injury/cataract are some of the medical problems and the local or traditional approaches adopted to treat these problems are listed in the Table 3. De-worming is given every month, tamarind ball containing de-worming medicine is given. The overall body condition, veterinary care and management appeared to be relatively good. This can be evident from the results of comparison of various body measurements of the animal. It was found for most of the elephants in the camp that the measurements of height and neck girth were identical (Figure 6) as the mean values of height and neck girth for a specific age class (where more data was available for comparison) were not

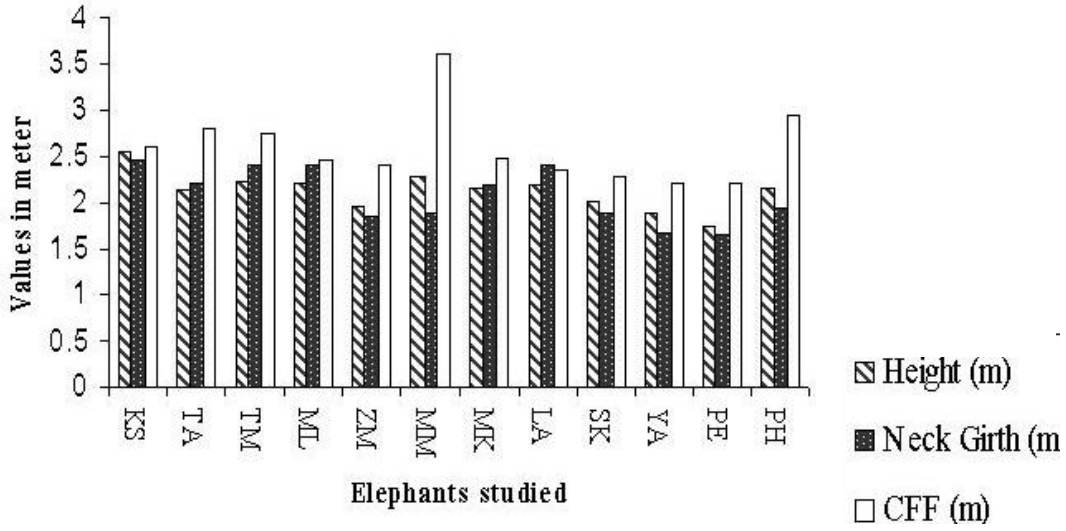


Figure 6: Height, Neck girth and Circumference of Front Foot (CFF) measurements of the Park elephants, the value presented for CFF is based multiplying CFF values into a factor of 2. The values for Height, Neck Girth, and CFF are plotted against the elephants studied.

statistically different ($z = 1.33$, $P < 0.05$). According to a captive elephant expert (Krishnamuthy, personal communication), such a relationship (no difference of mean values of neck girth and height) is possible only if the elephants are in good condition.

Figure 7: Work type; occasionally elephants are made to remove or transport logs

The good health status of elephants of the elephants kept here could be also related to the natural working atmosphere given to them. The elephants start working (Figure 7) when they are ten years old and retire at the age of 65 and veterinary history of each elephant is maintained. During the dry season the elephants transport the pilgrims who visit Alaungdaw Kattapa Shrine and only 50 % these elephants are used for this purpose. As most of the park area is inaccessible through other transport, the elephants are used to transport goods from the nearest town Kapang, patrolling the forests and to transport sick and old people from the camp to the nearest village or town for treatment. Very specific working hours are followed, which were between 7 to 11 in the morning, and 4 to 6 in the evening. In the morning working hours rice is given as food and in the evening,

tamarind and salt are given to the elephants. When elephant is released for free ranging, they are hobbled and released, their "free-ranging" duration depending on the work given to the animal.

Socio – economic status of elephant keepers

Every elephant in the camp has an oozi, each oozi works (Figure 8) with given elephant for a number of years. An oozi is promoted to 2nd head oozi, to first head oozi, and head oozi; every 2 years oozi is promoted depending on the necessity. An average of 600 kyats (200 = 1 US$) is given as monthly salary for oozi. Although no accommodation is given for the elephant staff, the Government provides land and small-scale agricultural practice is followed by the oozi. They cultivate vegetable and other crops in this land; as the land is close to forest, house construction materials (generally bamboo and wood) are obtained from the forest. The salary of 600 kyats is not sufficient for family maintenance, and according to oozies, an inome of 7,000 kyats is required for overall maintenance of family. Agricultural and animal farming activities (rearing chicken and pigs, selling them to local market) bring some income to the family. During the rainy season, the markets do not function and only barter system takes place. The oozies wish to have a large family, and everyone works to raise a decent income. No oozi is educated beyond fourth standard but are keen on providing good education to their children. The nearest school (middle, primary and high school level) was situated 22 miles away and children stay in the village to get educated.

Figure 8: Giving bath one of the work types for oozi

Discussion

Status of wild elephants in the park

The status of wild elephants in this park is not well known, nor has it been studied scientifically. Information available on the species is only based on indirect observations. As the visibility, in most of the forest is very poor, it's very difficult to study them directly. Through the current survey, it was noticed that the elephants have specific places for their movement and utilization in the park. Patches of typical deciduous forest were noticed in some part of the park along with other species, the forest surveyed had tree species of teak, (*Tectona grandis*) gooseberry (*Emblica officinalis)* and xylia *(Xylia dolabriformis*).

Only close to these forests, elephant dung was noticed. Overall the dung density was very low, but in some patches, where the forest has sufficient food (tall grass), shade and water, elephants may regularly use these places. For elephants the availability of food or such forests (typical deciduous with grass cover) are ideal microhabitat, but these forests are very rare or the distribution of such forest type is patchy in the park. Myint (1994) found elephants using more of (87%) moist mixed deciduous forest, followed by indaing forest (9%), dry upper mixed forest (6%) and grassland (3%) However the habitat usage pattern in relation to different habitat or forest types available to elephants was not clearly established by this study.

Myint (1994) estimated a total population of 101 elephants for the park, our estimate of 0.64/km2 could be a over estimate of numbers; however, stratification of habitat based on actual elephant

usage area and extrapolating the estimated density to only those area would give a reasonable or acceptable number of elephants for the park. Elephants used occur, particularly in the Taungdwin drainage, but is not a very common mammal. They are reported to be heavily hunted for their ivory by poachers from Chin region (FAO 1982).

Status of human habitation and resultant human elephant conflict

AKNP has no or very negligible state of human elephant conflict, as there are no villages located within the forest; the nearest village is about 50 miles away. The fertile Myittha Valley located in the western side of the park is a heavily populated region. However, the only settlements within the reserved forests of Patolon and Taungdwin are the two small villages of Zanabok and Pya. Along the Chindwin Valley, the main population centres are Kani, Monya, Yimmabin and. Kabaing, the nearest village to the park.

The lower valley of the Patolon and bordering Taungdwin RF with many flat and fertile valleys, has many villages, majority of the population of these villages are primarily agriculturalists, cultivating rice and groundnuts along the river valley. The other regions of Asia, the human-elephant conflict is one of the main conservation problems, and at present the issue is not a major conservation worry in AKNP. However, it is probable that the conflict is likely to heighten with the increase of the human population or activities along the peripheries of the forests.

Captive elephant status

The elephant camp was started with a small number of elephants and later more elephants were included. The major objective of having this camp was to manage animals that were wounded, retired and unable to work in the timber logging camps and zoological garden. Since the establishment of the camp, there was a gradual increase in the number of elephants. The camp does have some problems; although good veterinary care is available; there were problems in identifying sensitive diseases, there was no veterinary clinic and the medical budget to run the camp was very low.

However, the overall body condition, veterinary care and management appeared to be relatively good. This is evident from the matching measurement values of both height and neck girth of animals surveyed. From socio economic status point of view, the status of elephant keeper appeared to not be in a positive state, there was no accommodation provided to the keepers, the salary given was not sufficient for family maintenance and no oozi is educated beyond fourth standard.

References

AECC, 1994. GAJAHA - A Computer program for estimating elephant densities. Asian Elephant Conservation Centre, Indian Institute of Science, Bangalore, India

Burnham, K.P. Anderson, D.R. and Laake, J. L. 1980. Estimation of density from line transect sampling of biological populations. Wildlife Monographs 72: 1- 202

FAO, 1982. Proposed Alaungdaw Kathapa National Park, Preliminary Master Plan UNDP/FAO Nature Conservation and National Parks BUR/8-/006, FAO of United Nations, Rangoon

IUCN, 1989. Burma, Conservation of Biological diversity, world Conservation Monitoring Centre, 1-13.

Myint. A. 1994. Preliminary estimates of the abundance of wild elephants in Alaungdaw Kathapa National Park. Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar.

Tun, N. 1997. Alaungdaw Kathapa National Park (Brief Notes), Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar.

Salter, R.E. 1983. Summery of Currently available information on internationally threatened Wildlife Species of Burma. Working People Settlement Board, FAO Rangoon, Burma.

Sukumar, R. 1989. The Asian Elephant: Ecology and Management. Cambridge Studies in Applied Ecology and Resource Management. Cambridge University Press, Cambridge. Xvii: 251pp

Hut, Y.1993. Management of Wild Elephants in Myanmar. Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar.

Zaw, K. 2000 Capturing and training wild elephants for utilization in timber harvesting, Myanmar forestry, July 2000.

Table 1: Forest reserves sampled for elephant density estimation during elephant survey in AKNP

S.no	Name of the route covered	No of transects	Distance covered (km)	Dung piles recorded
1	South-west	6	12	36
2	North-west	4	8	0
3	Mindon	4	6	0
4	Kunze	4	8	0
5	Kanthat	4	8	0
6	Total	22	42	36

Table 2: Elephant density estimates for AKNP. Dung and elephant densities are expressed in per km^2 and the dung density estimates are based on fourier series analysis

Parameters	**Values**
Dung Density	1633.85
Standard Error of dung density	375.84
Decay Rate	0.01
Standard Error of decay rate	0.00
Defecation Rate	23
Standard Error of defecation rate	1.5
Mean Elephant Density	0.64
95 % Lower Confident limit	0.53
95 % Upper Confident limit	0.74

Table 3: The common disease reported in camp elephants and the treatment given for the disease.

Disease	Treatment
Anthrax	Annual vaccine after weaning
Lameness	Anti-biotic and analgesic
Worms	Neguvon (anti-helmet) powder form mixed with tamarind in food
Injury/wounds	Dincor iodine – applied to wound. Occasional stitching and plaster with fly repellent
Maggot	Forcepstoden fly repellent
Anemia	Multivitamins
Jaundice	
Eye injury/cataract	Local method – roll paper with turmeric powder and blow into the eye or burn hair and blow into the eye

Section 5:
Diversity, Conservation and Management of Mammals in Bago Yoma, Rakhine Yoma and Alaungdaw Kathapa National Park in Myanmar

Surendra Varma

Asian Elephant Research & Conservation Centre
(A division of Asian Nature Conservation Foundation),
C/o Centre for Ecological Sciences,
Indian Institute of Science, Bangalore 560 012, India

Abstract
This investigation was aimed to provide baseline data for the occurrence and diversity of mammals and their conservation status in Bago Yoma, Rakhine Yoma and Alaungdaw Kathapa National Park (AKNP) in Myanmar. Direct and indirect evidence of animals were assessed along transect lines, existing forest trails, waterholes, caves, from animal observation posts, and through village visits. A total of 33 species of mammals was reported across all the regions investigated and an average of 22 mammalian species per region was reported. Among these, 21% were classified as endangered, 21% as vulnerable, 7% fall under the Data Deficient category of the IUCN Red list status; thus about 50% of the species reported had high conservation significance. Differences in mammalian diversity across all the regions investigated were not statistically significant. For every 5 individuals, a new species of mammal was encountered in AKNP; for Rakhine, this occurred for only every 12 individuals and in Bago for every 9 individuals. The percentage of all mammals, large mammals and endangered species reported in Rakhine Yoma was high. Although the region surveyed was considered as being rich in mammal diversity, continuing commercial exploitation of the forest for the timber industry, destructive agricultural practices and unrestricted hunting have resulted in rapid loss of natural habitat and a significant decline of wildlife.

Introduction

Myanmar, covering a total land area of 677 577 km^2, is known for its rich floral and faunal diversity (Wint 1993). The country is home to nearly 7000 species of plants, 300 species of mammals, 1000 species of birds, about 360 species of reptiles and other taxa, which are poorly documented (IUCN 1989). Conservation of nature is a tradition among the people of Myanmar (Htut 1993). However, wildlife in Myanmar suffered greatly during the Second World War (IUCN 1989; Htut 1993). Even after independence, it suffered a great deal from issues such as insurrection and ineffective law enforcement, and consequently, large mammals, particularly the Asian elephant (Elephas maximus) and the tiger (Panthera tigris) today face serious threats to their survival (Htut 1993; IUCN 1989) while the Sumatran rhinoceros (Didermocerus sumatrensis) is very close to extinction (Salter 1983; Rabinowitz and Schaller 1995).

Bago Yoma, located in central Myanmar, has been recognised as being rich in wildlife and containing the largest and most valuable block of teak forest in the world (Uga 1995). The FAO/UNDP survey carried out in 1981 (FAO 1982) suggested that within Bago Yoma the entire Yenwe catchment upstream of the dam and the rich wildlife habitat in north of Zamari needed protection. Proposing a protected area of not less then 320,000 acres, FAO (1982) recommended that the Yoma be protected as an instance of outstanding landscape and also as habitat of rare animals such as the serow (Naemorhedus sumatraensis).Rakhine Yoma located in the western region of the country has greater number of endangered and vulnerable species, making it a more important region for large mammal conservation (Sayer, 1983). According to Sayer (1983), the rugged topography and dense vegetation cover in the Rakhine region made it difficult to hunt animals enabling existence of a diverse animal population. He also felt the reduced presence of settlements/clearings in the forest was due to the low agricultural value of the land. The Alaungdaw Kathapa National Park (AKNP), located in northern Myanmar still has a large area under forest cover, harbouring the endangered Eld's deer (Cervus eldi) along with other species of large mammals (Tun 1997).

Although the regions have been considered to be rich in mammal diversity, undoubtedly, the commercial exploitation of forests for the timber industry and destructive agricultural practices and unrestricted hunting have resulted in significant wildlife decline and rapid loss of natural habitats (Rao et al. 2002) in these regions. Since 1856, under the sustainable management of forests intensive timber extraction has been put in practice in these regions and the prescribed felling cycle has been 30 years in a felling series (Salter 1983, Tun 1997). Except for a very small part of steep slope of Bago Yoma (Uga 1995), timber extraction has been carried out in all the regions. The activity, which has been carried out for 130 years has its own negative effect and has resulted in a large area being occupied by bamboo spp (Salter 1983; Ugo 1995).

Effective wildlife conservation and management programs are yet to make an impact in these regions. Only in 1997, 1775 km^2 (out of 16000km^2 area of Rakhine Yoma) area was gazetted as Rakhine Yoma Wildlife Sanctuary (Rao et al. 2002; Uga 1995). Under the Bago Yoma Teak Nature Reserve (covering 1500 km^2), there was a proposal of preserving the pristine nature of the teak and other forests. To fulfil the objective a survey was carried out in 1983, however, the areas are yet to be brought under legal management system. AKNP is one of the oldest forested regions of the country, but only in 1984, the area was legally gazetted as a wildlife sanctuary.

Evaluating the status of animals and their habitat in Myanmar is difficult as visibility within the forests is very poor and many of the forests are inaccessible. The survey regions are very remote, with rugged terrain, infested with mosquitoes carrying malaria, and have non-existent or extremely poor logistical facilities, making direct observation of animals extremely difficult.

However, these regions are very important due to the presence of globally threatened species (Salter, 1983; IUCN, 1989; Htut, 1993). Therefore, observation of tracks, defecation and other signs, along with information collected from local hunters and villagers were used to provide basic data on the occurrence and status of the animal species found in these regions (FAO 1982; Salter 1983; IUCN, 1989; Htut, 1993; Ugo 1995; Rao et al.2002).

For a country like Myanmar, to specifically assess the status of animals found in different regions is never easy given the constraints of time, manpower and other resources available and the difficulties associated with carrying out a survey in most of the region. A study on the status of the Asian elephant and its conservation was initiated in Myanmar in the regions of Bago Yoma (formerly known as Pegu Yoma), Rakhine Yoma (formerly known as Arakkan Yoma), and the Alaungdaw Kathapa National Park (AKNP) of Northern Myanmar. The areas were chosen as they are considered to be important regions for elephants (FAO 1982; Salter 1983; Htut, 1993; Myint 1994; Tun 1997)

The elephant survey provided an opportunity for investigations on the presence and relative abundance of mammalian species, trends of species diversity, similarity and conservation status of mammals and their habitats in these regions. Conservation of mammals including Asian elephants in the survey regions or for the entire country is possible only through knowing their presence and absence or reviewing the current management status of these regions.

The investigation was also aimed at reviewing the establishment of protected areas, staff strength, status of hunting, annual net deforestation rate, legislation to protect mammals and their habitat, law enforcement, budget and land use polices. Myanmar still contains large areas of relatively intact forest, (Rao et al. 2005) as one-third of the country's total area is still under forest cover (Aung 2007) coupled with a low human population density and impact (Sanderson et al. 2002). Relative importance of these factors and their scope for conservation of mammals and their environment is also discussed through this survey.

Materials and methods

Investigation sites

The investigation sites (see Figure 1 of section 1) were Bago Yoma (17^o to 20^o N and 96^o to 97^o E), Rakhine Yoma (17^o to 21^o N and 93^o to 95^o E) and Alaungdaw Kathapa National Park – AKNP (22^o to 23^o N and 94^o to 95^o E). The Bago, Rakhine and AKNP regions that are situated in the central, western and northern regions of Myanmar, respectively have very extensive tracts of hills (Figure 1). The hill ranges of Rakhine Yoma are a southward extension of the Himalayas. AKNP is in a well-forested mountainous region, situated west of the lower Chindwin River and the Myittha Valley. The average elevation of the Bago Yoma is about 700 m; the highest point is 900 m asl. In Rakhine Yoma, which runs for nearly 600 km, the height ranges between 1000 and 1400 m asl and the average elevation in AKNP is about 1000 m (ranging between 200 and 1400 m); steep slopes and narrow ridges characterise all regions.

All these regions have good drainage systems (Figure 1): the Pegu and tributaries of Yenwe Chaung, and the Kun Chaung are the major river sources in Bago Yoma. The Sandoway River (Sandoway Chaung) is the major river system in Rakhine. AKNP is drained by a number of tributaries of the Patolon River, the Petpa Chaung and Taungdwin Chaung being perennial. In all these regions, the wet season lasts from May to October and is heaviest in August and September. The annual mean rainfall for Bago is 1700 mm, for Rakhine it is 1800 mm and for AKNP it is 1500 mm. In all these regions, the vegetation is largely mixed deciduous forest, with semi-evergreen forests occurring in areas of high precipitation. Patches of evergreen trees consisting, mostly of secondary growth occur in a few places.

Figure 1: Forest cover and drainage system in one of the study sites

The mammalian species reported in these regions include the rhesus macaque (*Macaca mulatta*), hoolock gibbon (*Hylobates hoolock*), Phayre's langur (Semnopithecus phayrei), sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), hog deer (*Axis porcinus*), Eld's deer (*Cervus eldi*) gaur (*Bos gaurus*), Tsaine (saing) or banteng (*Bos javanicus*), serow (*Naemorhedus sumatraensis*), elephant (*Elephas maximus*), Sumatran rhino (*Dicerorhinus sumatrensis*), Asiatic black bear (*Ursus thibetanus*), Malayan sun bear (*Ursus malayanus*), leopard (*Panthera pardus*), tiger (*Panthera tigris*), and wild dog (*Cuon alpinus*). The sources for the common and scientific names are Corbet & Hill (1992), Yin (1993) and Menon (2003).

Methods

General

Besides the author, the study team (Figures 2a b, c, d and e) for the Bago and Rakhine Yoma were drawn largely from the Forest Department and Myanmar Timber Enterprise (MTE) which included Range forest Officers, Rangers, and Deputy Rangers. In AKNP, along with the author, the study was conducted with the help of a 14-member expedition team from the UK-based Scientific Exploration Society. Separate training programs for each region were conducted for the teams on various aspects of the investigation.

The investigation was carried out in five reserves of the Bago Yoma – 1) South Zamari, 2) North Zamari, 3) Yenwe, 4) Idokan and 5) Okkan. Seven forest reserves of the Rahine Yoma 1) Part of Thandwe Reserved Forest –RF – (DDNSAND1), 2) Sabyin & Mindon area (DDNARAKAN 2), 3) Part of Gwa RF (DDNGAW), 4) North of May Yu RF (DDNMAYU1), 5) south of May Yu RF (DDNMAYU2), 6) Part of Miva Pya (DDNMYAP) and 7) Part of Sin Tanung RF (DDNSINT) were studied. The locations within the AKNP were referred to as Southwest (SW),

Northwest (NW), Mindon, Kunze and Kanthat. In each reserve, the team was split into a number of groups (each consisting of three to four persons, including a field tracker) and data was collected through various methods.

Survey methods

Line transect method

Direct and indirect evidence of animals was assessed along transect lines to record the species of animals, the number and frequency of occurrence and their diversity. A total of 142 transects for Bago, 148 for Rakhine and 22 for AKNP were laid. The length of transects in a particular reserve, within a region, was roughly proportional to the total area of the reserve and lines were well distributed, covering different regions of the reserves sampled (Table 1). In a given site, not more than three sub groups operated to cut transects, and a minimum distance of 2 km was maintained between two sub groups.

Figure 2a: Survey team members after a long field trip at the camp site

Figure 2b: Survey team preparing for camp move

Forest trail survey method

Existing forest trails were considered for systematic sampling and the start time and end time of every forest or sampling route were noted. During this time, sightings of animals (mammals) were recorded through direct and indirect observation (vocalisation, tracks, signs, defecation and other evidence). At every sighting, the time of sighting, name of the animal (where possible), the number of animal sighted or indirect evidence was recorded along with other features of the habitat. Whenever possible, the GPS location was noted and acetate transfers of tracks obtained.

Village survey method

The clearest indication of the abundance of wildlife could be obtained from the village survey, for which the systematic approach of a questionnaire-based survey was used in villages situated close to forests. A total of 89 villages were visited for this survey, and 76% of the villages were located within the forests and 24 % villages were located in a mean distance of 2.88 (SE = 0.55) km from the forests.

Other methods

Specific places such as waterholes, watch towers and animal observation posts were visited. The Image Intensifier (II) was used and observations were made by selecting a site, depending on the visibility of the location, with a 50 m radius, (The II device works on available light without magnification). Observations were made between 7:30 and 9:30 p.m. Apart from these methods; observations were also made by waiting for animals near rivers and streams (without II), and on journeys between camps from vehicles or while alighting from vehicles. Signs of animals were also observed in and around camp and while creating transects. Caves were visited to observe bats. Mist nets were set up over rivers and within the camp areas and observers waited for at least an hour at each site, sometimes the wait extending up to two hours.

Figure 2c: Survey team on foot to reach survey location

The ground investigation was initiated in 1995 and was continued till 2000, and the current information (since 2001) on the status of mammals and other habitat was based on personal communications (Uga & Hpone Thant (Harry) and literature (James et al. 1999; Gutter 2001; Rao et al. 2002; Bennett and Rao, 2002; Sanderson et al., 2002; Leimgruber et al., 2003, Aung et al., 2004; FAO 2004; Rao et al. 2005; Lynman et al. 2006; Aung 2007). The systematic investigations carried out for Bago were from May 1995 to December 1995, for Rakhine, from December 1995 to May 1996, and for AKNP, in January 1999. Specific locations of Rakhine and Bago Yomas were investigated again in May 1998 and January 2000 respectively. An

Figure 2d: Group discussions for survey planning

attempt to cover the northern Myanmar (regions such as Tamu, Homalin, Tamanthi and Tanai) was made in 2000, but insurgence and other logistic reasons made actual ground investigation impossible. Overall, a total of 8100 man-hours in Rahine, 8500 man-hours in Bago and 1350 man-hours in AKNP, respectively, were spent on investigations.

Figure 2e: Discussions of the methodology in the field

Data analysis

Only the line transect, trail and village investigations provided meaningful observations, though considerable time was spent for observing animals through other approaches (observations with II and without II and using mist nets for bats), they did not provide much scope as number animals observed through these approaches were substantially low. Results of all these methods were pooled together only to construct species list, and their presence and absence in the regions sampled. Results of line transect sampling were used for arriving at the frequency occurrence, species diversity and similarity.

Initially, the total number of mammalian species encountered for all the regions together was computed and an overall mean number for species (with standard error – SE and % coefficient of variation – CV) was calculated for each region. Mammals were classified based on their size or weight or a combination of both, also taking into consideration their mention in literature (Nameer et al. 2001; Shankar & Sukumar 1999; Datta 1999). Body length (head to base of tail) was given more importance as the weight of an animal could change depending on its food intake and other factors. Animals above 50 cm were considered large mammals, those between 20 and 40 cm were small/to medium size mammals, and animals below 20 cm were treated as small mammals with body size measurements based on Yin (1993) and Menon (2003).

The percentage of Endangered, Vulnerable and Data Deficient categories of the IUCN red list (Menon 2003; IUCN 2007) was calculated to arrive at the conservation significance of each survey region. This was done in relation to the occurrence of different categories for all three regions taken together and also individually. Mammalian diversity and other associated parameters for each region were calculated using the computer program BIODIVERSITY Pro (McAleece et al. 1997). Diversity and species abundance calculated across the regions were tested using the Kruskal Wallis (Hc) test for significance, through the computer program PAST (Hammer et al. 2001).

The number and percentage of similar species shared (based on similarity matrix) across regions were calculated, more specifically large mammal similarity across different regions. This was based on a Bray–Cluster Analysis (Single line) using BIODIVERSITY Pro (McAleece et al.

1997). In addition, for each region, the mean percentage (with SE and % CV) of large mammals shared with other regions was calculated. For both these sections, the computation was done in relation to the occurrence of similar species across different regions, and surveys carried out in the same region at different times and in regions that had geographical and ecological similarities.

Results

A total of 33 species of mammals (Figure 3a, and b) were reported for all the three regions together, and an average of 22.3 (SE =1.8, CV % 7.9) mammalian species were reported for a region. A total of 15 species (45%) of large mammals was recorded for all the regions investigated, and 93 % species were readily identifiable (Prater 1971; Corbet & Hill 1992; Yin 1993; Menon 2003).

Figure 3a: Survey team near a trap set for some mammals by the villagers

Among the species identified, 21% were classified as endangered, 21% vulnerable, and 7% belonged to the Data Deficient category of the IUCN Red list status; thus about 50% of the species were reported to have high conservation significance. A total of 14 species (42 %) of small to medium sized mammals (Rabinowitz & Schaller, 1995) were reported for the regions surveyed; 57 % of them were identifiable either to genera or to species; only 42 % were identifiable up to species level. Four species (12 %) of small mammals were reported for these regions and none of them were identifiable (Table 2) by specific species name.

Figure 3b: Mammalian species identified from the collection of skins from the villagers

Significance of occurrence of mammalian species for different regions

Bago Yoma

A total of 22 species of mammals were identified for the Bago Yoma region (Table 2) of which 82 % species was easily identifiable. Among all species encountered, barking deer dominated (35%) for the region, followed by sambar (17%), capped langur (12%), gaur (9%), and wild boar (8%). Overall mammalian diversity value (H') for the region was 2.05 and the

equitability value was 0.66 (Table 3). Bago Yoma, under IUCN Red list status, had three species of endangered mammals, two species of the vulnerable category and one species under the data deficient category (Table 2).

Rakhine Yoma

For Rakhine Yoma, 25 species of mammals were encountered (Table 2). The pattern of occurrence of different species followed the same trend as Bago Yoma, with the most frequently sighted mammal being the barking deer (31%), followed by sambar (16%), capped langur (11%), gaur (9%) and wild boar (8%). Overall mammalian diversity value (H') for the region was 2.18 and the equitability value was 0.67. Rakhine Yoma, under IUCN Red list status, had four species of endangered mammals, three species of vulnerable category with one species under the data deficient category.

AKNP

In AKNP, a total of 20 species was encountered, of which 82% were readily identifiable. Overall large mammal diversity value (H') for the region was 2.5, and the equitability value was 0.83 (Table 2). AKNP under IUCN red list status had only one species of endangered mammal, but three species within the vulnerable category and one species under the data-deficient category. The most frequently sighted mammal on all routes was the gaur, followed by the sambar, wild dog, barking deer and leopard. On the SW route, both gaur and sambar were sighted with the same frequency. On the NW route, gaur was the most frequently sighted animal followed by sambar and wild dog. No sightings or signs of primates were noticed. This could have been due to the fact that they had been heavily hunted, or since the forest had been logged, not much tree cover was available for this arboreal taxon. All along the Mindon River, fish poisoning was noticed and the investigation team found bloated fish carcasses along the river.

Trend of species diversity reported across regions

Trend of species diversity and other parameters associated with it are presented in Table 3. The results of the differences across the diversity and abundance values across these regions were not statistically significant (for diversity value $Hc = 0$, $p>0.01$, for abundance $Hc = 0.38$, $p>0.01$) suggesting that mammalian diversity across these regions were equal. While in Rakhine, 18 % of individuals were represented by a single species.

In AKNP, only 11% individuals represented a single species. For every 5 individuals, one new species was encountered in AKNP, while in Rakhine this occurred in only every 12 individuals and in Bago, for every 9 individuals. If we consider large mammal diversity and abundance exclusively across the surveyed region, the diversity and abundance were the same in all the regions as the differences were not statistically significant (for diversity, Hc 0, $p>0.01$, for abundance, $Hc = 0.12$, $p>0.01$). Species dominance across Rakhine and ANKP was the same and in both regions 19 % individuals were represented by a single species. For every 8 individuals a new species of large mammal was reported for AKNP, while in Bago it was for every 15 individuals and in Rakhine for only every 19 individuals.

Trend of similar species reported across regions

The investigation results indicated that Bago and Rakhine shared 12 similar species of large mammals, and between Bago and AKNP 8 similar species were reported. The number of similar species shared by Rakhine and AKNP was 9. A specific examination of large mammal similarity across the region, at different times revealed that Bago and Rakhine had a similarity of 92%; while Bago and AKNP had 76%, and Rakhine and AKNP 78%. If one compares similarity over the years, then Bago 1982 and 1995 has species similarity of 69% while Rakhine 1983 and 1996 have 80% similarity (Figure 4). An average of 72 % (SE = 8.6) large mammalian species reported for Bago was found in other regions of Myanmar (Tamanthi WLS and Rakhine both in 1982 and in current investigations including a survey carried out in Bago in 1982 (FAO, 1983). The mean of 80 % (SE = 7.2) large mammals reported for Rakhine was comparable with other regions of

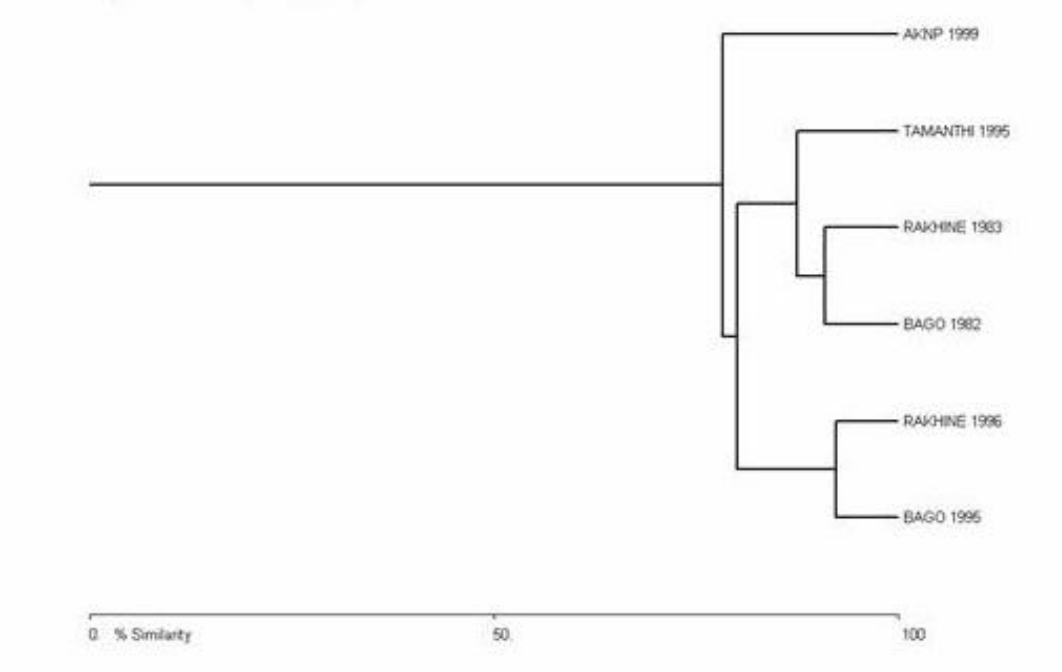


Figure 4: Large mammal similarity across different regions of Myanmar; the results are based on Bray-Curtis Cluster Analysis (Single Link)

Myanmar (including the 1983 survey by Sayer, in Rakhine). When the regions were considered together for the differences in large mammals shared among them, the results were not statistically significant (Hc = 4.42, p>0.01). Considering specific regions, the differences across Bago and Rakhine were not significant (Hc = 1.104, p>0.01). A mean of only 61 % (SE = 5.0) of similar species of large mammals recorded in AKNP were reported for other regions of Myanmar; however, the differences between AKNP and Rakhine (Hc = 3.57, p>0.01) and between Bago and AKNP (Hc = 1.87, p>0.01) were not significant.

Conservation Status of the large mammals reported for different regions

The percentage of all mammals, and endangered species (in relation to number of species recorded for each region) reported for Rakhine Yoma was high. The percentage of small mammals, vulnerable species and species under the data deficient category was greater in AKNP (Figure 5). Bago contributed more only towards the percentage of small medium sized mammals and its conservation status could have been equal to Rakhine in terms of the number of species of large mammals, endangered species and number of similar species shared with other regions (Figure 5).

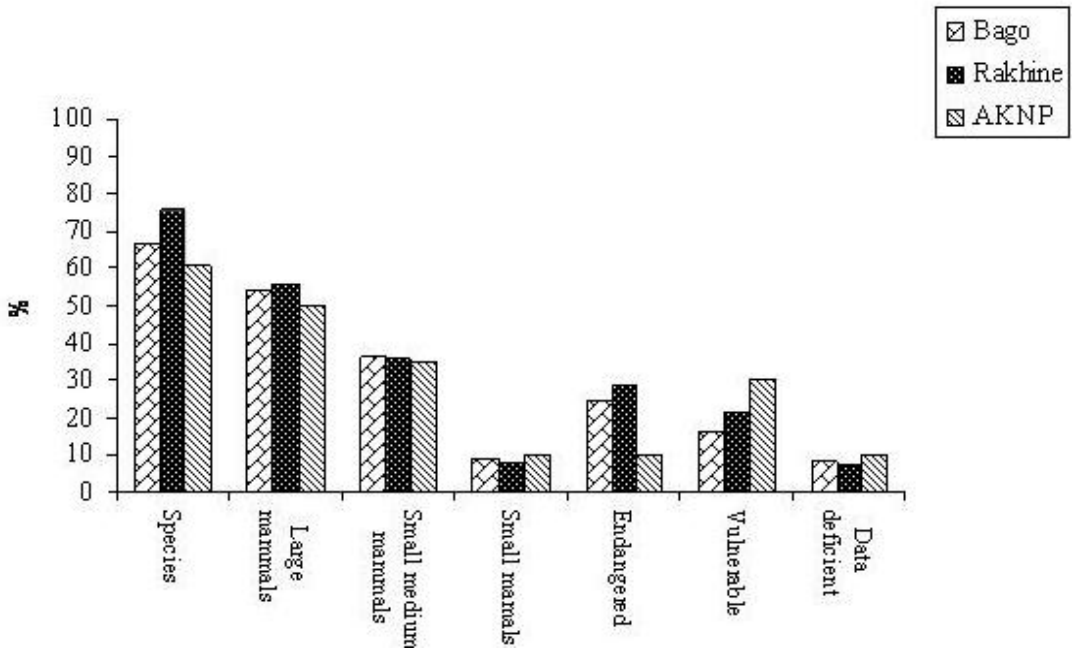


Figure 3: Conservation status of mammals in different regions of Myanmar. Percentage values are plotted against all species, large mammals, small medium sized mammals, small mammals and mammals under endangered, vulnerable, and data deficient categories of IUCN red list. Percentage values for all species were based on total number of species recorded for all the regions and for types (large mammals, small medium sized mammals, small mammals and mammals under endangered, vulnerable, and data deficient categories of IUCN red list) are based on total number of species recorded for each region.

Discussion

The current investigation results were comparable with that of earlier surveys carried out in Bago and Rakhine (FAO 1982; Sayer 1983) or in a region that has geographical and ecological similarities (Rabinowiz & Schaller 1995). The FAO (1982) survey reported about 17 species of large mammals in Bago with two species of bear, elephant, gaur, banteng, Eld's deer (thamin) and tiger. Except for the Eld's deer, Sumatran rhino, banteng and serow, all other species were encountered by the current investigation. Sayer (1983) reported 16 species of large mammals for Rakhine; except banteng and the Sumatran Rhino, all other species reported by him have been recorded in the current investigation.

A one-month survey carried out in the Tamanthi Wildlife Sanctuary of north Myanmar by Rabinowiz & Schaller (1995) reported 22 species of mammals for the region; of these, 17 were classified as large mammals and 5 species as small to medium sized mammals. Duckworth (1996) reported 30 species for the training and model forest of the Vientiane Forestry College in Laos. His survey reports more of small to medium size mammals with 7 similar species of large mammals occurring in the current investigation regions.

Sayer (1983) and FAO (1982) reported the Sumatran rhino, serow, banteng and Phayre's langur for both Bago and Rakhine and FAO reported the Eld's deer for Bago Yoma; no sighting of these species was reported in this investigation. It is also possible that some of these species have been completely eliminated or numbers have become so low that the sighting probability of these species has been reduced considerably. As mentioned by Rabinowitz & Schaller (1995), the level of human activities along with low law enforcement reported in some of the regions could

indicate many large mammals following the path of the Sumatran rhino towards extinction. It is also expected that low density and endangered species could be wiped out from some of these regions (Rabinowitz & Schaller (1995). In the past, species considered as problem animals suffered through human–animal conflict. According to FAO 1982, a man-eating problem by tigers was reported in Bago Yoma and several tigers were shot to mitigate this issue. Like the tiger, each species suffers from different problems and their conservation status continues to be speculative. Sightings of tigers through indirect method (Table 2) in Bago and Rakhine Yomas have to be read with caution, as even with the past two decades of extensive efforts by National Park and Wildlife Conservation Division of Myanmar, no evidences of tigers anywhere in Myanmar has been discovered.

The percentage of total man-hours spent for collecting information was not the same across regions; it was maximum for Rakhine followed by Bago and the least for AKNP. This may have had some implication for the species reported for different regions, and it would have been possible to encounter more species for AKNP, if more time had been spent collecting data. Tun (1997) reports species such as banteng, serow, Eld's deer and capped langur for AKNP and noted that such species were not encountered during this investigation.

However, the information provided by Tun (1997) was not based any specific surveys, but was a compilation of species or expected species reported for the region. The species list did show some uncertainty regarding species identification and a confusion of species between the banteng and the gaur was reported for the region (Tun 1997). Similarly, there may be some uncertainty for the species reported for AKNP. Another interesting point to be noted is that even with an equal or a slightly greater number of man-hours spent, surveys conducted for regions such as Tamanthi WLS, Rakhine (Sayer 1983) and Bago (FAO, 1982) report more species of large mammals than AKNP.

Most of the animals (seen in the forest or visiting crop fields) were hunted, trapped and snared and a significant amount of meat sold in the local markets. Wire snares, simple but very efficient, and locally made traps were used. Porcupine, wild boar, barking deer, sambar, langurs, gaur, sun bears, jungle fowl, hornbills, pheasants and a variety of other mammals and birds were hunted for meat and other uses. The most obvious indication of abundance of wildlife in Rakhine was the frequency with which game meat was sold at the roadside. Restaurants had abundant supplies of fresh, recently dried meat. Nearly all the forests of the region had been degraded as part of logging and taungya cultivation, but interestingly, this secondary vegetation proved to be the ideal habitat for wildlife.

In all these three regions, no evidence of strong and regular enforcement of law was noticed. A major threat to wildlife in the region surveyed would be the presence of professional hunters. Fish poisoning observed could affect both people and wildlife, being the removal of a valuable protein source from their habitats. Threatened large mammals such as the big cats, deer, gaur, and elephant continue to be in a critical state due to the illegal hunting of these species. In Tamanthi WLS of northern Myanmar, Rabinowitz & Schaller (1995) found people claiming ignorance of the fact that the area was protected under law and people did not understand what such protection meant other than not actively killing wildlife.

A similar trend could have been expected for the areas investigated. Threats to major species in Myanmar are from the escalating prices in the black market for animal products (Rao et al. 2005). For instance, illegal markets for tigers also offer scope for tiger prey species and other wildlife species (Bennett & Rao 2002; Rao et al. 2005). Recovery of most species of mammals is not

possible due to the presence of permanent human settlements, roads and railway lines, cultivated lands, military and insurgence camps (Rao et al. 2005). Current government budget allocation for protected areas may be less than that recommended for effective management (James et al. 1999). Legislation to protect both, mammals and their habitats is weak and difficult to enforce (Gutter 2001). Most of the regions need to evolve sensible wildlife management programs and protection, effective patrolling along the entry points of forests, and develop working or management plans and stopping legal and illegal extraction of forests.

Since 2000, only one wildlife sanctuary has been established in this country, and only one legislation has been enacted (Aung 2007). Myanmar has 39% of paper parks (Braatz et al. 1992, Aung 2007) that lack site staff, law enforcement, delineated park boundaries and infrastructures. AKNP with its total area of 1601 km^2 has only 0.08-forest staff/km^2 and the recently established Rakhine Yoma Wildlife Sanctuary for its 1756 km^2 has only 0.01 staff/ km^2 (Aung 2007). Major threats to the parks in this country during the last two decades have resulted from economic and land use decisions (Aung et al. 2004). Most of the landscapes have changed from old growth of forests to a patchwork of degraded secondary growth forest (Aung et al. 2004).

The annual net deforestation rate between 1989 and 2000 was 0.2% (Leimgruber et al. 2003), with some areas within the country experiencing a more severe rate of loss, which may exceed the global average (Lynman et al. 2006). However, although the current forest covers one third of the total land area of the country (Aung 2007), still has relatively low human population and impact (Sanderson et al. 2002). Myanmar includes the most extensive wild lands for large mammals in Asia (Leimgruber et al. 2003) and the protected area system has grown from less than 1% of the total land area in 1996 to a current level of 7% and there is a proposal to increase it to 10% (Rao et al. 2002). The species' richness along with the presence of endangered and vulnerable species, could still lead to all these regions investigated reaching the status of conservation importance. A collective and dynamic conservation approach to save these species will provide long-term conservation scope for these regions.

Conclusion

Geographically, Myanmar forms a land bridge between the mainland of continental Asia and Peninsular Malaysia; consequently, it encompasses varied ecosystems, diverse biological resources and geographical features. Myanmar still has a low human population density. However, the population is increasing alongside numerous developmental activities. This change could cause increased pressure on the biodiversity of this little explored, species-rich region of Southeast Asia. Ironically, there are hardly any studies or even simple surveys of species distribution for most wildlife species. As and when any surveys are carried out on any focal species, it would be very useful to also document information on other species of wildlife in this region.

The three regions surveyed represent a small portion of the major habitats in Myanmar and investigation was also restricted to providing some insights on the status of large mammals, and there was no scope for understanding the status of rodents, bats and the elusive, lesser-known, or other mammalian species not known to science. It could be assumed that understanding the status of major species of mammals and conservation of their environment will eventually help in understanding the status of lesser-known but highly diverse mammalian species. The current understanding of the status of mammals in these survey regions may also be motivating factors for future surveys in other regions of the country.

References

Aung M, Khaing, KS Ooa T, Moe KK, Leimgruber P, Allendorf T, Duncan C and Wemmer C 2004 The environmental history of Chatthin Wildlife Sanctuary, a protected area in Myanmar (Burma) *Journal of Environmental Management* **72** 205–216

Aung M 2007 Policy and practice in Myanmar's protected area system *Journal of Environmental Management* **84** 188–203

Bennett EL and Rao M 2002 Hunting and wildlife trade in tropical and subtropical Asia: Identifying gaps and developing strategies; Report from a meeting held in Khao Yai National Park Wildlife Conservation Society, Bangkok pp 33

Braatz, S, Davis G, Shen S and Rees C 1992 Conserving biological diversity, a strategy for protected areas in the Asia-Pacific region; World Bank Technical Paper 193, pp 1–66.

Corbet, GB and Hill JE 1992 *The Mammals of the Indomalayan Region*; Nature History Museum Publications (New York: Oxford University Press)

Datta A 1999 Small carnivores in two protected areas of Aruanchal Pradesh *Journal of Bombay Natural History Society* **96 (3)** 399 – 404

Duckworth, JW 1996 Bird and mammal records from the Sangthong district, Vietiane Municipality, Laos in 1996 *Nature History Bulletin Siam Society* **44** 217-242

FAO 1982 Proposed Pegu Yoma National Park, Report on preliminary survey of Yenwe Chaung area, November 1981 and January – February 1982 UNDP/FAO Nature Conservation and National Parks, BUR/8-/006

Gutter P 2001 Environment and law in Burma, Legal Issues on Burma Journal No. 9, August 2001, Burma Lawyer's Council

Hammer Ø, Harper DAT and Ryan PD 2001 PAST: Paleontological Statistics Software Package for Education and Data Analysis.Palaeontologia Electronica 4(1), pp 9 http://palaeo-electronica.org/2001_1/past/issue1_01.htm.

Htut Y 1993 Management of Wild Elephants in Myanmar, Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar

IUCN 1989 Burma, Conservation of Biological diversity, World Conservation Monitoring Centre 1-13

IUCN 2007 IUCN Red list of Threatened Species, IUCN, Gland, Swithzerland, UK http://www.iucnredlist.org

James AN, Green MJB and Paine JR 1999 Global review of protected area budgets and staff, World Conservation Monitoring Centre (UK: Cambridge)

Leimgruber P, Gagnon JB, Wemmer C, Kelly DS, Songer MA and Selig ER 2003 Fragmentation of Asia's remaining wild lands: implications for Asian elephant conservation, *Animal Conservation* **6** 347–359

Lynam A, Khaing ST and Zaw KM 2006 Developing a National Tiger Action Plan for the Union of Myanmar, *Journal of Environmental Management* **37(1)** 30–39

McAleece N, Lambshead PJD and Paterson GLJ 1997 Biodiversity Pro The Natural History Museum, London, http://www.sams.ac.uk/

Menon, V. (2003) *A field guide to Indian Mammals*. Dorling Kindersely (India) Pvt. Limited.

Myint. A. 1994. Preliminary estimates of the abundance of wild elephants in Alaungdaw Kathapa National Park. Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar.

Nameer, P.O., Molur, S. & Walker, S. (2001) Mammals of Western Ghats: A simplistic overview. *Zoo's Print Journal* **16 (1):** 629 – 639.

Prater SH 1971 *The book of Indian Mammals*, 3rd Edn (Bombay: Bombay Natural History Society)

Rabinowitz A and Schaller GB 1995 Brief assessment of the status of large mammals in Tamanthi Wildlife Sanctuary of north Myanmar, *Myanmar Forestry* **3 (4)** 10-11

Rao M, Rabinowitz A and Khaing ST 2002 Status review of the protected areas system in Myanmar with recommendations for conservation planning, *Conservation Biology* **16 (2)** 360-368

Rao M, Zaw MT and Tun S 2005 Hunting patterns in tropical forests adjoining the Hkakaborazi National Park, North Myanmar, *Oryx* **39** 292–300

Salter RE 1983 Summery of Currently available information on internationally threatened Wildlife Species of Burma. Working People's Settlement Board, FAO/United Nations, Rangoon, Burma

Sayer JA 1983 Wildlife in the southern Arakan Yoma, Survey report and interim conservation plan, Nature Conservation and National Parks project Burma, Working people's settlement board, FAO/United Nations, Rangoon, Burma

Shankar K and Sukumar R 1999 Synchrony in small mammal populations of montane forest patches in southern India *Journal of Animal Ecology* **68** 50 – 59

Sanderson EW, Jaiteh M, Levy MA, Redford HA, Wannebo V and Woolmer G 2002 The human foot print and the last of the wild *Bioscience* **52** 891–904

Tun N 1997 Alaungdaw Kathapa National Park (Brief Notes), Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar

Uga U 1995 Situation of biological diversity conservation in Myanmar. Report submitted to the Nature and Wildlife Conservation Division, Forest department, Myanmar

Yin UT 1993 *Wild mammals of Myanmar* Yangon Gazette Ltd, Yangon
Wint SM 1993 Myanmar strategy for forest resource development *Myanmar Forestry* **1** 10-17

Table 1: Forest reserves sampled, area, number and percentage of transects surveyed and distance covered for Bago, Rakhine and AKNP regions.

Regions	**Name of Reserves**	**Area km^2**	**%**	**No of transects**	**%**	**Distance covered (km)**
Bago	South.Zamari	882	29.9	36	25.4	72
	North Zamri	714	24.2	35	24.6	70
	Yenwe	795	26.9	36	25.4	72
	Idokan	521	17.6	23	16.2	46
	Okkan	40	1.4	12	8.5	23.5
	Total	**2952**		**142**		**283.5**
Rakhine	DDNSAND 1*	750.5	6.3	16	10.8	32
	DDNARAK 2 *	2600	21.9	70	47.3	140
	DDNGAW *	2600	21.9	20	13.5	40
	DDNMAYU 1*	2652.8	22.4	12	8.1	24
	DDNMAYU 2 *	1200	10.1	8	5.4	16
	DDNMYAP*	1750	14.8	12	8.1	24
	DDNSINT*	307.2	2.6	10	6.8	20
	Total	**11860.5**		**148**		**296**
AKNP	South-west			6	27.3	12
	North-west			4	18.2	8
	Mindon			4	18.2	6
	Kunze			4	18.2	8
	Kanthat			4	18.2	8
	Total	**1606**		**22**		**42**

*Part of Thandwe Reserved Forest (DDNSAND1), Sabyin & Mindon (DDNARAKAN2), part of Gwa Reserved Forest (DDNGWA), north of May Yu Reserved Forest (DDNMAYU1), south of May Yu Reserved Forest (DDNMAYU2), part of Miva Pya (DDNMYAP) and part of Sin Tanung Reserved Forests (DDNSINT).

Table 2: Mammal species recorded for the survey regions of Myanmar

S.no	Species	Scientific name	Mammal category	IUCN Red List status	Method of identification	Frequency of occurrence (%)		
						Bogo	Rakhine	AKNP
1	Capped langur	*Trachypithecus pileatus*	LM	E	Direct	12.3	10.9	0
2	Tiger	*Panthera tigris*	LM	E	Indirect	0.5	0.3	0
3	Elephant	*Elephas maximus*	LM	E	Direct & indirect	0.9	0.6	5.8
4	Hoolock gibbon	*Bunopithecus hoolock*	LM	E	Direct & indirect	0	1	0
5	Gaur	*Bos gaurus gaurus*	LM	V	Direct & indirect	9.4	0.7	24.3
6	Himalayan black bear	*Selenarctos thibetanus*	LM	V	Indirect	2.4	2.3	1
7	Dhole	*Cuon alpinus*	LM	V	Direct & indirect	0	0.3	7.8
8	Malayan Sun bear	*Helarctos malayanus*	LM	DD	Direct	0.5	0.3	1
9	Barking deer	*Muntiacus muntjak*	LM	LR	Direct & indirect	34.9	31.5	5.8
10	Jackal	*Canis aureus*	LM	LR	Direct & indirect	0.5	0.3	0
11	Leopard	*Panthera pardus*	LM	LR	Direct & indirect	0.5	0.3	6.8
12	Sambar	*Cervus unicolor*	LM	LR	Direct & indirect	17.5	16.1	16.5
13	Wild boar	*Sus scrofa*	LM	LR	Direct & indirect	8.5	7.4	3.9
14	Rhesus macaque	*Macaca mulatta*	LM	LR	Direct	0.5	0.3	0
15	Monkey	Species unknown	LM	-	Direct	0	0	1
16	Jungle cat	*Felis chaus*	SMM	LR	Direct & indirect	0.9	0.6	0
17	Mongoose	*Herpestes spp.*	SMM	LR	Direct	0	0.3	5.8
18	Indian Porcupine	*Hystrix indica*	SMM	LR	Direct & indirect	0.5	1.9	1
19	Flying squirrel	*Petaurista spp*	SMM	LR	Direct	0.5	0.3	1
20	Indian otter	*Lutra spp*	SMM	LR	Direct	0.5	0.3	0
21	Chinese Pangolin	*Manis pentadactyla*	SMM	LR	Direct	0.5	0.3	0
22	Black giant squirrel	*Rutufa bicolor*	SMM	LR	Direct	0	0	2.9
23	Javan mongoose	*Herpestes javanicus*	SMM	LR	Direct	0.5	0	0
24	Civet	Species unknown	SMM	-	Direct	0	0.3	0
25	Hare	Species unknown	SMM	-	Indirect	0.5	0.3	0
26	Squirrel	Species unknown	SMM	-	Direct	7.1	6.1	0
27	Cat	Species unknown	SMM	-	Indirect	0	0	3.9
28	Fishing cat	Species unknown	SMM	-	Direct	0	0	6.8
29	Fruit bat	Species unknown	SMM	-	Indirect	0	0	1
30	Bat	Species unknown	SM	-	Direct	0.5	0.3	1
31	Rat	Species unknown	SM	-	Direct	0.5	0.3	0
32	Mouse	Species unknown	SM	-	Indirect	0	0	1
33	Bamboo rat	Species unknown	SM	-	Indirect	0	0	1.9

I: Idokan RF, O: Okkan R.F, Y: YenweR.F, NZ: North Zarmani R.F, SZ: South Zarmani R.F
LM: Large mammal, SMM: Small -Medium Sized Mammal, SM: Small mammal
LR: Lower Risk, V: Vulnerable, E: Endangered, DD; Data deficient

Table 3: Mammalian diversity and other associated parameters for survey regions of Myanmar

		Bago		Rakhine		AKNP	
S.no	Parameters	All category	Only large mammals	All category	Only large mammals	All category	Only large mammals
1	No of species	22	13	25	15	20	10
2	Individuals	212	189	311	278	103	76
3	Dominance_D	0.1895	0.2319	0.1635	0.1994	0.1166	0.1936
4	Shannon_H	2.054	1.752	2.182	1.887	2.494	1.884
5	Equitability_J	0.6644	0.683	0.6779	0.697	0.8324	0.8183

Section 6:
Biodiversity Assessment in Alaungdaw Kathapa National Park (AKNP), Myanmar

Surendra Varma

Asian Elephant Research & Conservation Centre
(A division of Asian Nature Conservation Foundation),
C/o Centre for Ecological Sciences,
Indian Institute of Science, Bangalore 560 012, India

Abstract
A survey of various aspects of flora and fauna was carried out in the Alaungdaw Kathapa National Park, Myanmar. Forest trails, line transects, waterholes, and other specific sites were surveyed for assessing the status of biodiversity. Villages within and outside the park were surveyed for assessing human-animal conflict issues and to quantify the animal species sighted by the villagers. The vegetation survey results showed that the stem density and total basal area (m^2/ha) were very low, but the species diversity and evenness was more in these forests. The results of the mode of observation of different animals indicated that most of the sightings (63%) were made through indirect method. The sighting frequency distribution of animal species was far from even and the nature of distribution was not very apparent. Although the villages were located close to the forest and rivers, the human-animal conflict was minimal. The threats to the park could be classified as poaching, poisoning of rivers, forest fires and forest produce collection. In spite of the exploitation of animal population, the forest is still relatively undisturbed and is a very suitable area for conservation of biodiversity.

Introduction

Myanmar is rich in natural resources including forest and wildlife and the country is in the unusually fortunate position of still having relatively extensive areas known for its outstanding beauty, areas which fulfil the criteria of both historical and scientific interest, natural landscapes undisturbed by developmental activities and large in size with great diversity of flora and fauna (Salter 1983, IUCN 1989, Htut 1993). Following these criteria the Alaungdaw Kathapa National Park (AKNP), situated in northern Myanmar, is suitable for a large area conservation concept. Ironically, no systematic investigation of the status of the forest and wildlife has been done.

Like many other regions of Myanmar, the terrain and the vegetation of AKNP are such that direct observations on animals is extremely difficult while observations based on tracks, defecation and other signs and information collected from local hunters and villagers provide only the basic information on the occurrence and status of wildlife. The area is significant for the conservation of many species. It is the last remaining contiguous habitat for the Asian elephants (*Elephas maximus* Linnaeus). Including elephants, the park has several species of large mammals, which come under endangered and vulnerable categories of the IUCN Red list status. Conserving these flagship species (Sukumar 1989) may eventually protect the overall biodiversity (Karanth 1995). With these objectives, a survey of various aspects of flora and fauna was carried out in AKNP.

Study area

The AKNP (22^o to 23^o N and 95^o to 96^o E) is a well-forested (Figure 1) mountainous region situated in the west of the lower Chindwin River and Myittha Valley (see Figure 1 of section 4). The park with an area of 1,606 km^2 comprises the Patolon and adjoining Taungdwin Reserved Forests. The park consists of Patolon and Taungdwin river valleys which are separated from each other by the north-south ridges. Many steep escarpments characterise the north–south parallel ridges. The elevation of the park varies from 200 to 1300 msl with an average of 1000 msl and Hlaingma Taung (1290 msl) is the highest peak of the park. The park is drained by a number of tributaries of Patolon River with Petpa Chaung and Taungdwin Chaung being perennial among them (Tun 1997, Hundley 1987).

Figure 1: Natural forest cover in the survey region

Major rainfall occurs between May and October but the heaviest showers are in August and September. Rainfall is affected by the western Chin Hills; it has an annual mean of 1500 mm, and is reported to have reduced to 773 mm only in some years. The temperature of the park varies from 10.7 °C to 41.5 °C and the relative humidity averages around 72 % (FAO 1982, Tun 1997).

Except for the selective logging of teak (*Tectona grandis* Linnaeus*)* in the past, the natural forest cover is least disturbed and the major forest types found here are Moist Upper Mixed Deciduous, Dry Upper Mixed Deciduous, Semi–Indaing, Pine and Evergreen (Tun 1997, Hundley 1987).

The wildlife is rich and prevalent here and it constitutes the Rhesus macaque (*Macaca mulatta* Zimmermann), sambar deer (*Cervus unicolor* Kerr), muntjac (*Muntiacus muntjak* Zimmermann), hog deer (*Axis porcinus* Zimmermann), gaur (*Bos gaurus gaurus* Smith), Tsaine (saing) or banteng (*Bos javanicus* Wagner) serow (*Naemorhedus sumatraensis* Blyth), elephant (*Elephas maximus* Linnaeus), Asiatic black bear (*Ursus thibetanus* Cuvier), leopard (*Panthera pardus* Mayer), tiger (*Panthera tigris* Linnaeus) and wild dog (*Cuon alpinus* Pallas). The park is also very rich in its bird diversity: many species of hornbills, woodpeckers, laughing thrushes, babblers, orioles, drongos, parakeets, barbets, pigeons, doves and others are known to occur here (Tun 1997).

Survey methods
General

Figure 2: Survey base; Magybin Rest House

Using Magyibin rest house (Figure 2) as a base, different survey routes were identified for sampling biodiversity. Survey routes were identified based on their direction and location from the base camp.

The routes were referred as Southwest (SW), Northwest (NW), Mindon, Kunze and Kanthat. The survey was part of a wildlife expedition carried out by the UK based Scientific Exploration Society.

The 14-membered expedition team (Figure 3a and b) was divided into subgroups, each subgroup headed by a group leader carried out various assignments of the survey. Grid maps of one inch or 1: 63,360 scale (84: J6, J7, J11 and J12) along with a number of Global Positioning System (GPS) instruments were used for the survey.

a

b

Figures 3a and b: Expedition team in the field

Vegetation Survey

The study was done using two different methods, Type I and Type II.

Type I: Existing forest trails were selected for sampling and at regular intervals of 30 or 60 minutes depending on the terrain, the nearest 10 trees (Figure 3) were identified with the help of a local Burmese guide. The Burmese names were translated into local (English) and scientific names whenever possible. The canopy and ground cover (%) and other features of the terrain were noted down. Whenever possible, the GPS location was noted and photographs taken were numbered.

Figure 4: Vegetation survey of tree species and percentage ground cover

Type II: The line transect method was followed. At every 90 minute interval, an area of 10 m radius was marked. Trees within this 10 m radius were identified (Figure 4) and counted. The girth measurements (BDH) were taken along with the information on canopy and ground cover (%) Apart from these two methods, microhabitat survey was also done by monitoring at regular intervals and the major forest types were also identified and noted down.

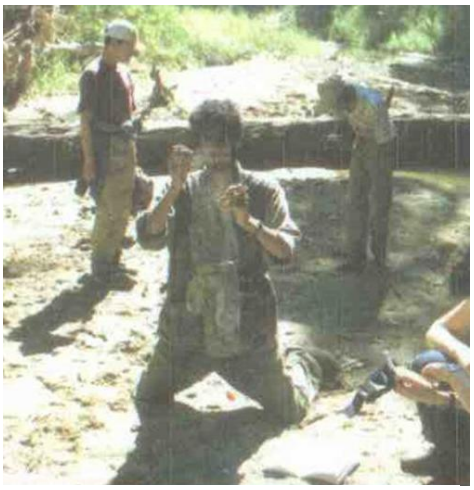


Figure 5: Drawing animal tracks using acetates

Animal survey

The animal survey was done through various methods.

Type I: The forest trails that were used for method 1 of the vegetation survey were simultaneously considered for animal survey. The starting and ending time of any forest or sampling route was noted. During this time, sightings of animals (mammals, birds, fish, reptiles, butterflies and other insects) were recorded through direct and indirect observations (call, tracks, sign, defecation and other evidences). At every sighting, the time of sighting, number of animals sighted, their tracks, call, defecation and other signs were recorded along with other features of the habitat. Whenever possible, GPS locations were noted and acetate transfers of tracks were drawn (Figure 5).

Type II: Another approach was selection of specific places like waterholes, watchtowers and animal observation posts. Image Intensifier (II) was used and observations were made by selecting a site within a 50 m radius, depending on the visibility of the location. The II works on available light without magnification. Observations were made between 7:30 p.m. and 9:30 p.m.

Type III: Apart from these methods, observations were also made by waiting for animals near rivers and streams (without II), visiting caves (Figure 6) and on journeys between camps by vehicle or while alighting from a vehicle. Signs of animals were also observed whilst in and around camp and while conducting transects.

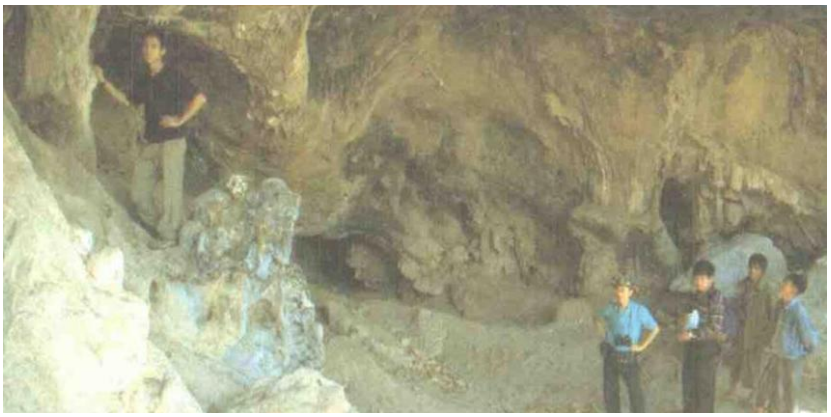


Figure 6: Visits to caves for surveys of bats and other animals

Village survey

The village survey (Figures 7a and b) extracted data on species sighted by the villagers during their visit to forest areas for collecting various forest products. Villages both within and outside the park were surveyed for human-animal conflict. A questionnaire was used and additional information on culture, lifestyle and family structure of the people and their approach to conservation was also collected.

Figure 7a and b: Villages visited during the survey

Data analysis

Vegetation survey

The data of vegetation study Type I was analysed for overall species diversity and diversity across different survey routes. It was also used to analyse the relative basal area, and total basal area, diversity and stem density. Although Burmese names were available for most of the plant specie (Hundley 1987) recorded, there was great difficulty in matching these names with scientific names. This constraint restricted the presentation of species wise (with scientific names) information and relative abundance across these two different methods that were followed.

Animal survey

Using biodiversity survey as an initial step, the frequency with which the sightings were made within a given time interval was calculated for various species belonging to butterflies, birds and mammals. The frequency with which 2, 3, 5…2000 animals can be observed in any 1 minute interval was plotted. The results were derived from the number of animals seen in each time interval by obtaining the average number of animals seen per minute from this data, and then looking at the frequency distribution of this variable, i.e., number of sightings per minute. Data

from South–west route was used for this exercise, as the data was very systematically collected for this route.

The data was pooled for the entire (SW) route, and the average time in which the sightings were made was calculated along with the number of sightings, frequency of occurrence of given species and the mode of observation (direct or indirect). Comparison of different time slots within the southwest route was also being made for number of sightings, average time in which the sightings were made and the mode of observation (direct and indirect). Comparison of pooled data of all routes was also done for some of the above-mentioned parameters.

Village survey

The analysis of the village survey data included relationship between distance to the forest and conflict with animals, water source and conflict, type of crops cultivated and conflict and the efficacy of methods to detect the animal problem. Species list of various animals were also derived from this approach.

Results

Vegetation survey

A total of 50 individuals of 30 species were identified by Type I method. The overall diversity index value was H' 3.14. Comparison of both SW and NW routes indicated that 24 individuals of 9 species of trees (Figure 8) were identified for the NW route, while 26 individuals of 21 species were encountered for SW. The estimated diversity value for SW route was 2.97 and for NW it was 1.8, suggesting that the SW route showed more diversity of species.

Figure 8: Example of type trees encountered during the survey

In Type II method, an area of 1 ha was sampled by the 32 point counts (10 metre radius) of 5 transects. A total of 166 individuals belonging to 68 species were encountered. A stem density of 165.2 trees/ha was estimated. The total basal area of all the individuals was 17.578 m^2/ha. The species diversity value was found to be 3.74 (Shannon index) and 0.96 (Simpson index).

There were more trees in 64 to 128 cm class interval with the frequency of girth and diameter being higher in this class interval. Under the girth class there were very few trees in 8 to 16 cm class interval and above 256 cm (Table 1). The results indicate that, stem density and total basal area m^2/ha are very low, but the species diversity and evenness were more in these forests. Number of stems encountered for each point count was also very low and only an average of 5.15 (SE=0.55) trees were found in each point. The microhabitat study showed that, most of the area in this park, more so the route covered by the survey team, was under bamboo forest. It can be seen from Figure 9 that 43% of the area was under bamboo alone, bamboo with mixed deciduous

was 23% and along the river it occupied 14 % of the area. Adding all this, nearly 80% of the route covered in the forest was bamboo forested.

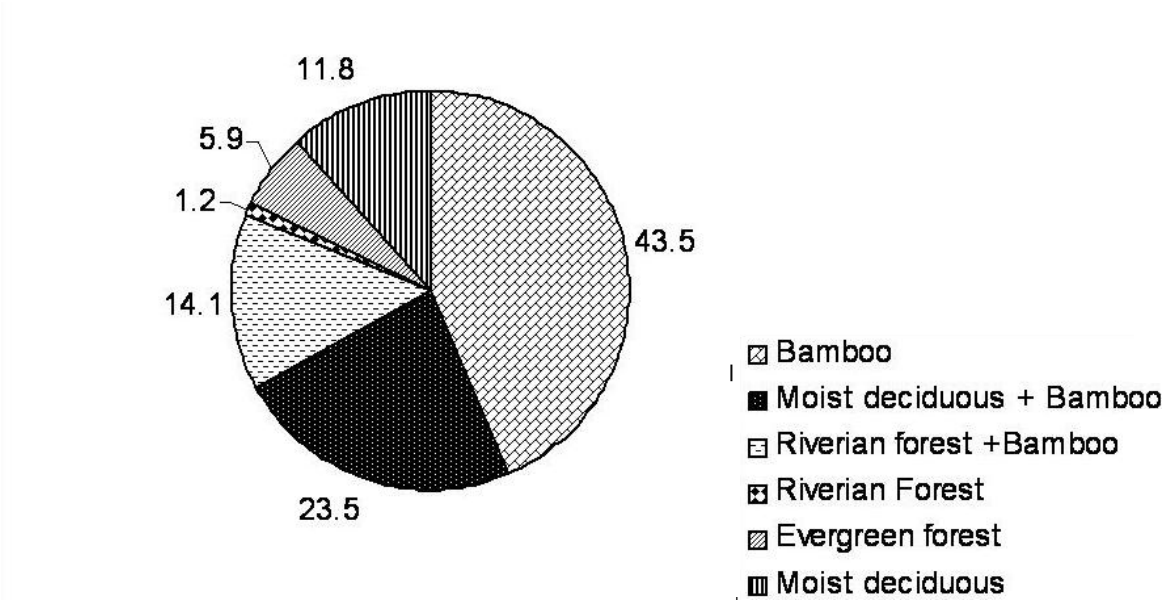


Figure 9: Status of forest for the routes surveyed

Animal survey

Pattern and frequency of sightings of different species of animals

A total of 13 species of butterflies, 22 species of birds and 18 species of mammals were sighted through the animal survey. The results from the mode of observation of different animals showed that most of the sightings were made through indirect mode. For SW route, 76% (n=78) of the time, animals were sighted indirectly, and among which 71% (n=43) of the sightings were through animal tracks. For NW route, 66% (n=35) of the time, animals were sighted through indirect mode, of which 71 % (n=25) were through tracks (Table 2).

There were differences in the sightings of different animal groups. Mammals were mostly sighted through indirect method and only 11 % of the sightings were direct. Butterflies, reptiles and birds were most often sighted directly. This pattern was similar for both the routes (Table 3).

Sighting intervals of different species of animals

During the survey, animal sightings were made at an average of every 8.4 (SE = 1.4) minutes in SW route. However, this average varied for different time slots. Difference in the number of sightings for all the time slots was also noticed (Table 4).

Distribution of frequency of sightings of the species

From the sighting frequency distribution (Figure 10), it can be noticed that the distribution is far from even and the nature of distribution is not very apparent. It can also be seen that around 0.2 animals/minute were sighted in 2 to 21 % of the total 1 minute intervals and about 12 % of the time no animals were sighted in a given 1 minute interval.

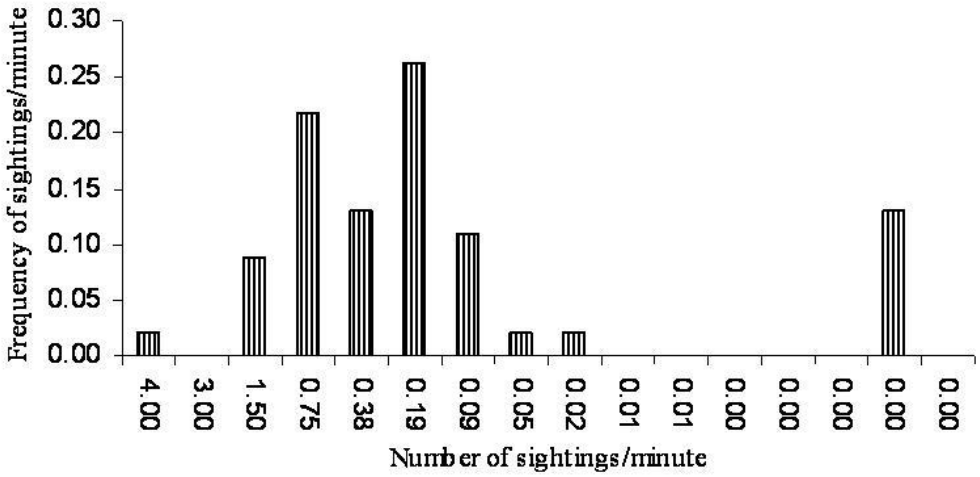


Figure 10: Distribution of frequencies of sightings of different animals

Mammalian diversity for AKNP

A total of 20 species were recorded for AKNP (Table 5), of which 82% were readily identifiable (Yin 1992, Yangon 1990). The overall large mammal diversity value (H') for the region was found to be 2.5. Under the IUCN Red list status, the survey showed that the park had one species of endangered large mammal, 3 species of vulnerable large mammals and one species of large mammal that fell under the data deficient category. In AKNP, mammals were mostly sighted through indirect method and only 15 % of the sightings were direct. The most frequently sighted mammal was gaur for all the routes, followed by sambar, wild dog, barking deer and leopard. In SW route, gaur was sighted more often followed by sambar and leopard. In NW route, the pattern of prey species sighted was the same as SW. But the most frequently seen predator was wild dog (Table 5) and all the other species were encountered at a low frequency. Many interesting observations were made during the animal survey. Within the 44 minutes walk, a total of 53 dung piles of gaur were encountered and it varied from 2 to 33 dung piles (an average of 10 dung piles/place).

The places wherein dung piles were seen were open (the canopy cover is zero), close to a river (less than a metre away from a river), and adjoined to the evergreen forests. The river along the SW route and NW route appeared to be ideal habitats for gaur where the open area along the river provided food and the forest cover provided shade for them during the day (when the temperature is high). The river appeared to be a very important location for most of the animals in this park, even for the predators as evident from the number of pugmarks of predators (Figure 11) seen along the river. Along the river, particularly during the dry season

Figure 11: Predator pug mark encountered during the survey

many species of prey were encountered (they visit the water body for water and for the grass cover along the river). This open area along the river may be an ideal hunting ground for species like the wild dog. It appeared that the leopards and wild dogs, the two major predators of the park, operate in two different locations of the park. Many pugmarks of leopard were noticed in the SW route and only one wild dog pug was seen in this route. Wild dog tracks were replaced by leopard tracks in the NW route and in this route not even a single leopard pugmark was seen.

Figure 12: a villager from Patolon carrying harvested grain to the village

People and biodiversity conservation

The fertile Myittha Valley located in the western side of the park is a heavily populated region. However, the only settlements within the reserved forests of Patolon and Taungdwin are the two small villages (Figure 12) of Zanabok and Pya. Along the Chindwin Valley, the main population centres are Kani, Monya and Yimmabin. Kabaing. The lower valley of the Patolon has many villages and many flat and fertile valleys bordering Taungdwin RF.

A Major portion of the population who lived close to the park was primarily agriculturists (Figure 13a and b), cultivating rice along the river and on the mountains and groundnuts along the river valley. Taunggya cultivation is practised in the hilly areas and the slopes. Apart from hunting and fishing, the villagers collect a variety of forest products, including timber for boat, shaw, thanaka, resin, gums and honey.

a

b

Figure 13a and b: Cultivation along the river valley (a) and on the mountain (b)

Alaungdaw Kathapa Shrine is located within the park which according to a legend, Maha Kassappa or Kathapa who was one of the ten Bodhisatvas chosen by Lord Gautama, died in a cave of rocky Paya gorge. Hence, the place is known as

Alaungdaw Kathapa. The cave and the shrine are visited by a large number of pilgrims during the dry season and it is estimated that 20,000 to 30,000 pilgrims visit the shrine annually (Tun 1997). Although the villages were located close to forest and rivers, the human-animal conflict, particularly with elephants is almost nil. The other animals such as wild boar, sambar, muntjac and occasionally mongoose (species not known), porcupine and monkeys (species not known) were reported to visit the croplands. The most frequently visiting animal to these villages was the wild boar, followed by sambar and muntjac.

No human casualty or household property damage has been reported. The animals are chased away by using domestic dogs and by making loud noises by blowing buffalo horns and bamboo. The threats to the park could be classified as poaching, poisoning of rivers, forest fire and forest produce collection. The illegal hunting by well-armed gangs with dogs was specially reported in the western part of the park. This includes hunting of elephants for ivory, other mammals such as sambar, gaur, and wild boar for meat. Rivers and streams are regularly poisoned with pesticides such as Endirn; an activity also reported very often in the western part of the park (Hundley 1987). The park is burnt during dry seasons by hunters, pilgrims, and other people. Apart from these activities large number of orchids and other forest products are also collected for sale in Yangon and other places.

Discussion

The current status of the forest and its wildlife is a reflection of the past exploitation of forest products in the region. As bamboo is seen everywhere, many questions can be asked to understand the type of forest found in this Park. Is this forest naturally a bamboo forest? Or has the forest been taken over by bamboo after extensive tree felling? Very interestingly, except for a few cut trees of teak (*Tectona grandies* Linnaeus) during the survey not many logging signs were noticed. The survey was done only for a short period of time with a more intensive survey of vegetation type, tree cover, regeneration and other aspects of population growth which also needed to be studied in order to understand the status of the forest.

The region was first exploited commercially by the Bombay Burma Trading Corporation under a concession originally granted by King Thibaw and subsequently extended by the British. During the Second World War, the forest was worked by a Japanese organisation, but after independence it was cared by the State Timber Board and then following nationalisation of the timber industry in 1963 it was taken over by the State Timber Corporation (Tun 1997). During the survey, the number of wildlife encountered and their signs inside the forest were very less. Many calls of birds could be heard, but the number of species counted was very less.

Another important point to be noted here is that that no sightings or sign of primate species was noticed and this could be due to the forest being heavily logged or hunted. The river appeared to be a very important location for the park, more so during the dry season. However, fish poisoning could be a major threat to wildlife and all along the Mindon River as fish poisoning was noticed by the survey team who found bloated fish carcasses along the river and this activity would have killed other animals, which directly or indirectly depend on the river. Even with the heavy exploitation of animal population, a strong religious attachment is preventing the hunting of these animals. The villagers close to the forest do want to save forests and wild animals, as the forests are meant to receive rain and the animals have other values and should be allowed to survive in the forest.

Along with these sentiments, a systematic management and a controlled system of patrolling many of these illegal activities have brought down exploitation of the natural resources to a considerable level (Hundley 1987). The park comprises the mountainous upper catchment basins of two tributaries of the Chindwin, and the water flow is essential to the well being of agricultural

communities in downstream (FAO 1982). The forest is still relatively undisturbed with a variety of forest types and is very suitable for conservation of natural forest ecosystems of the country.

Conclusions

Safeguarding rich and unique flora and fauna and landscapes free from commercial clearings and exploitation would be the greatest challenges of these times. It would be essential to set aside a national landscape such as the AKNP fully protected against exploitation and other forms of disturbance. The objective of the management of the National Park should be preservation of viable population of some of the wildlife. To achieve these objectives, the park needs to evolve a rational wildlife management agenda and an efficient safety mechanism of the area, successful patrolling along the forest entrance and stopping of illegal extraction of forests.

As suggested by FAO (1982), the most urgent need of the park management is the protection of wildlife from being hunted. Intensive patrolling is necessary particularly during the dry season when pilgrims travel through the park on their way to Alaungdaw Kathapa Shrine. The park is rich in wildlife, since there is no human settlement within the park, it is an area where wildlife could be protected and its long-term survival could be assured without any danger of conflict with human beings (FAO 1982).

References

FAO. 1982. Proposed Alaungdaw Kathapa National Park, Preliminary Master Plan UNDP/FAO Nature Conservation and National Parks BUR/8-/006, FAO of the United Nations, Rangoon. 42 pages.

Htut, Y. 1993. Management of Wild Elephants in Myanmar. Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar. 4 pages.

Hundley, H.G. 1987. List of Trees, shrubs, herbs and principal climbers. Forest Department, Myanmar. Fourth revised edition. 352 pages.

IUCN. 1989. Burma, Conservation of Biological diversity, World Conservation Monitoring Centre. pages 1-13.

Karanth, U. 1995. Estimating Tiger Panthera tigris populations from Camera - Trap data using capture – recapture models. Biological conservation 71: 333-338.

Prater, S.H. 1980. The Book of Indian Mammals, Bombay Natural History Society, Bombay. Third edition. 324 pages.

Salter, R.E. 1983. Summery of Currently available information on internationally threatened Wildlife Species of Burma. Working People's Settlement Board, FAO of the United Nations, Rangoon, Burma. 28 pages.

Sukumar, R. 1989. The Asian Elephant: Ecology and Management. Cambridge Studies in Applied Ecology and Resource Management. Cambridge University Press, Cambridge. 251 pages.

Tun, N. 1997. Alaungdaw Kathapa National Park (Brief Notes), Report submitted to the Wildlife and Nature Conservation Division, Ministry of Forestry, Yangon, Myanmar. 17 pages.

Yin, U.T. 1992. Wild Mammals of Myanmar, Yangon Gazette Ltd, Yangon.329 pages.

Table 1: The frequency of girth and diameter class of trees' species sampled in AKNP

Sl.No.	Class intervals (cm)	Number of individuals Girth	Diameter
1	<2	0	0
2	2-3.9	0	2
3	4-7.9	0	32
4	8-15.9	6	36
5	16-31.9	37	32
6	32-63.9	32	51
7	64-127.9	51	13
8	128.255.9	35	0
9	>256	5	0

Table 2: Animal sightings through different modes

Location	Direct	Indirect			
		Tracks	Signs	Defecation	Total sightings
All routes	61	70	6	20	157
South-west	19	46	2	11	78
North-west	18	26		10	54

Table 3: Frequency of sightings of different species of animals

	Species	Number of Species	Total Sightings	Direct	Indirect			
					Tracks	Signs	Defecation	
North-west	Butterflies	7	9	9				
	Birds	7	7	7				
	Mammals	13	38	2	26		10	
Total		27	54	18				36
South-west	Butterflies	12	8	8				
	Birds	8	7	7		2		
	Mammals	11	57	11	34	2	10	
Total		32	73	27				46
All routes	Butterflies	13	24	24				
	Birds	22	24	20		4		
	Mammals	20	110	13	74	3	20	
Total		59	162	61				101

Table 4: Average time and sightings of different species in different time slots

Hours	From	To	Sightings	Mean (SE) sighting time (in minutes)
3.19	10	13.19	38	4.8 (1.02)
1.3	14	15.3	13	6.4 (3.36)
58	11.08	12	4	10.4 (5.7)
1	13.3	14.3	2	30.0 (16.7)
1.45	14.45	16.3	9	15.0 (4.6)
2	9	11	8	13.3 (4.3)
2	11.3	13.3	6	15.7 (9.11)

Table 5: Frequency of sightings of mammals

S.no	Species	Scientific name	IUCN Red list status	Mammal category	Frequency of sightings %		
					All routes	South – West	North – West
1	Elephant	Elephas maximus	E	LM	5.83	10.34	0
2	Gaur	Bos gaurus gaurus	V	LM	24.27	25.86	35.71
3	Dhole	Cuon alpinus Pallas	V	LM	7.77	5.17	17.86
4	Himalayan black bear	Ursus thibetanus	V	LM	0.97	0	0
5	Malayan Sun bear	Helarctos malayanus	DD	LM	0.97	0	0
6	Sambar	Cervus unicolorr	LR	LM	16.5	17.24	21.43
7	Leopard	Panthera pardus	LR	LM	6.8	10.34	3.57
8	Barking deer	Muntiacus muntjak	LR	LM	5.83	8.62	3.57
9	Wild boar	Sus scrofa	LR	LM	3.88	5.17	3.57
10	Monkey	Species unknown	-	LM	0.97	0	3.57
11	Mongoose	Herpestes spp.	LR	SMM	5.83	8.62	3.57
12	Indian Porcupine	Hystrix indica	LR	SMM	0.97	1.72	0
13	Flying squirrel	Petaurista spp	LR	SMM	0.97	0	0
14	Black giant squirrel	Ratufa bicolour Sparrman	LR	SMM	2.91	0	0
15	Cat	Species unknown	-	SMM	3.88	0	7.14
16	Fishing cat	Species unknown	-	SMM	6.8	6.9	0
17	Bat	Species unknown	-	SM	0.97	0	0
18	Bamboo rat	Species unknown	-	SM	1.94	0	0
19	Fruit bat	Species unknown	-	SM	0.97	0	0
20	Mouse	Species unknown	-	SM	0.97	0	0

LM: Large Mammal, SMM: Small - Medium Sized Mammal, SM: Small Mammal
LR: Lower Risk, V: Vulnerable, E: Endangered, DD: Data deficient

Section 7:
Elephant Research, Conservation and Management Study Tour and Capacity Building Programme for Personnel from the Ministry of Forestry, Myanmar

U Wan Htun[1], U Maung Maung Kyaw[2], U Myint Maung[3] and Surendra Varma[4]

[1]Assistant manager (Veterinary surgeon),
Myanmar Timber Enterprise (MTE)
Yangon, Myanmar

[2]Park Warden,
Yakhine Yoma Elephant Range
Yakhine Yoma, Myanmar

[3]Park warden,
Tamanthi Wildlife Sanctuary,
Tamanthi, Myanamr

[4]Asian Elephant Research & Conservation Centre
(A division of Asian Nature Conservation Foundation),
C/o Centre for Ecological Sciences,
Indian Institute of Science, Bangalore 560 012, India

Introduction

A study tour for Myanmar forest department and Myanmar timber enterprise staff was organized by Asian Elephant Research and Conservation Centre. The objective of the program was to study the elephant habitat through Geographical information system, mapping elephant corridors, elephant census methods, and elephant conservation and management issue such as elephant human conflict and poaching in south India. Two park wardens and one veterinary surgeon participated in the program. The two park wardens manage two different elephant habitats such as Tamanthi (northern Myanmar) and Yakhine Yoma (western Myanmar). The assistant manager (Veterinary surgeon) is in charge of a number of captive elephants in Myanmar and is also involved in capturing problem elephants in Myanmar. The program was conducted from 24th October to 6th November 1999. This report presents a justification for the program, bio-data of the team members, lay-out of the program, method followed to conduct the program and results obtained and observations made.

Team Members and their experience

1) Dr. Wan Htun (B.V.S Ygm): (Team leader)
Assistant manager (Veterinary surgeon), Myanmar Timber Enterprise

2) U Maung Maung Kyaw (B.Sc Forestry): (Member)
Park Warden, Yakhine Yoma Elephant Range

3) U Myint Maung (B.Sc Physics): (Member)
Park warden Tamanthi Wildlife Sanctuary

Dr. Wan Htun is an experienced veterinary surgeon in camp elephant management. He has been working in Myanmar Timber Enterprise since 1981 and solving problems such as human-elephant conflict and translocation of wild elephants.

U Maung Maung Kyaw is an experienced park warden working in forest department, Myanmar since 1987. Participated in elephant census program and other wildlife related activities

U Myint Maung is an experienced park warden with 14 years of service since 1985, in Forest Department, Myanmar. He also has participated in elephant census organized by the Asian Elephant Specialist Group in Yakhine Yoma and Pegu Yoma in Myanmar.

Justification

After India, Myanmar has a very good population of Asian Elephants in both wild and captivity. It has more area under elephant habitat than India and could support a long-term viable population of elephants. Unlike any other Asian country, pressure on the habitat and elephant population is not much in Myanmar. However, problems such as human elephant conflict and poaching of elephant for its ivory have been reported in the recent past, though habitat fragmentation is not a severe problem. Given this situation, India's experience in managing elephants and its habitat (as habitat fragmentation, human elephant conflict and elephant poaching are some of the key elephant management and conservation issues in India) has more relevance in current and future management and conservation plans for elephants in Myanmar.

More importantly, AERCC (formerly known as AECC), through one of its projects on status survey, population evaluation and preparation of a conservation plan for Asian elephants in Myanmar, has gained considerable experience studying elephants in Central, Western and Northern regions of Myanmar. The experience gained from the studies and a need for giving a

comprehensive training program on elephant research, management and conservation to Myanmar Forest Department (which manages the elephant habitats and elephants in the country) has motivated this program.

The program was designed to be a study tour to compare the management practices adopted and strategies followed and to be followed, to solve various elephant conservation issues at three protected areas of southern India. These three parks have been identified as, they are part of one large unit of elephant habitat (covering more than 1500 km^2 area), however, administrated by three different State Forest Departments with different policies on similar conservation problems. For example, a policy adopted by Kerala State on a tree species Sandal wood was responsible for number of persons from this state becoming sandal wood smugglers and eventually elephant and other animal poachers. The policy adopted by these different States for similar conservation issues have different effects on management and conservation of the species itself. These geographically one, but politically separated protected areas, with different strategies provided an ideal place to understand various issues of elephant management for the visiting Myanmarese delegation.

Lay-out of the study tour

The delegates were introduced to 3 major topics such as habitat, human elephant conflict and elephant poaching. The program included formal and informal discussions and talks on various issues such as park management, captive elephant management, mapping of elephant habitats and corridors, habitat management, and human elephant conflict with park wardens, NGO personnel and a veterinary surgeon. Field studies on ground survey for habitat mapping, survey along the electric fence and elephant proof trench (EPT) to study the efficacy of these elephant barriers, visit to villages (which are within and close to the parks), questionnaire surveys on human elephant conflict. Visit to anti-poaching camps to study the poaching problems, visit to elephant camp and animal dispensary to study captive elephant management and line transect walking and vehicle transect methods to estimate elephant population densities.

The program was coordinated by a Research Officer from the Asian Elephant Research and Conservation Centre, who accompanied the delegation to introduce and discuss various topics related to elephant research, conservation and management issues. One retired Chief Wildlife Warden, three deputy conservators of forests (park wardens), three NGO leaders and members, 2 veterinary surgeons, 2 range forester officers and 6 research scholars spoke to the delegates on various aspects. One of these protected areas has 28 captive elephants and these elephants are used generally for tourist rides and patrolling of the forest. An opportunity was given to the delegates to study the captive management while they were undergoing study on the park management and other related issues.

Each day, before the study, the program coordinator introduced and wherever required gave field demonstrations of the program to the delegates. The methods used in this program was to identify the management issues being faced in southern India protected areas such as Bandipur National Park, and Wayanad and Mudumalai Wildlife Sanctuaries.

GIS mapping

Figure 1a: Demonstration of generating GIS Map

GIS mapping (Figures 1 a and b) is conducted to assess the habitat, identify the location of elephant corridor, elephant proof trench (EPT) and electric fence, villages and anti poaching camps and other features. GIS map for Bandipur National Park was generated. To develop a map, the following procedures were adopted. To map a specific area, a tracing paper was over laid on 1:50,000 scale topographic map, as initial step, latitude and longitude grids were drawn on the tracing paper. The reserved forest boundaries, water bodies, metalled and un-metalled roads, plantation areas, towns, villages and camps visited by the team were traced on the topo-map.

The G.P.S locations recorded during the field surveys were also to be put on the topo-map. Then the survey routes and visited locations were also marked. Finally, the comparison between the topo-map and satellite image was analysed for habitat changes over a period of time. All the information collected on the topo-map and GPS were digitized for the final mapping of the study area using Arc Info and represented through ArcView for the final out put.

Figure 1b: Discussions on ground survey using GIS

Human – Elephant conflict

Survey along the elephant barriers and villages:

In order to understand and to evaluate the status of human elephant conflict, the team members carried out questionnaire survey in villages within and outside the reserves and close to fence and EPT. The survey investigated the number of elephant visits, season and reason of visit, crop cultivated and damaged, status of the problem and alternative methods to prevent the problem. To investigate the efficacy of electric fence and elephant proof trench (EPT), the team walked along these barriers, during which time a GPS reading was taken at every 15 minutes interval. Starting and closing time of the walk, status of the barriers, cause of damage, damage and frequency of damage were also noted down.

Elephant poaching

The status of elephant poaching and the strategy followed to counter the problem were studied by visiting anti-poaching camps and discussing the problem with park wardens. The anti-poaching camps were evaluated by man power, age class, experience, facilities provided, mode and distance of patrolling, nearest village, illegal activities reported from the village and other related information. GPS locations of the camps were taken. The team obtained answers from the staff of elephant camp and anti-poaching camps. It was evaluated to know the effectiveness of the operations.

Population count and habitat assessment

Vehicle count was done to briefly assess the elephant habitat. At the same time, animals seen during the drive were also counted. GPS locations were taken at every 15 minutes intervals together with brief habitat assessments. Walking transect survey was done in dry deciduous and scrub forests, two permanent transects were used for this purpose. Observations recorded during the survey were: starting and closing time of transect walk, time of animal (particularly of large mammals) sighting, sighting distance and the angle of the animal from the line, and age sex classification.

Captive elephant management

Captive elephant management study was done through observations on feeding practice in base camp, visit to working elephant camps (maintained as anti-poaching camp) and questionnaire survey with the elephant keepers at work site. Discussion with Veterinary Doctor in base camp dispensary was also made. Details of elephant management system, grazing period, food supplement and feeding system were collected through discussion with the range officer (in charge of the camp), elephant keepers, personnel concerned with camp elephants and also through personal observations.

Discussions with Researchers

The team members attended the talks given by the researchers from the Bombay Natural History Society and the Centre for Ecological Sciences on various aspects of research carried out by these organizations.

Figure 2a: Survey of Electric Fence

Observations

Human- elephant conflict: During the survey along the electric fence (Figures 2a and b) in Bandipur National Park, totally 30 breakage's were found for the 11 km fence, out of these 2 were done by villagers for cattle entry. Survey along the trench revealed one earthfilled point made by elephants, a leveled 15 meters portion due to sandy drainage and 4 unfinished earthwork on account of rocky beds. The rest (23 broken points) could have been identified as man-made crossing for cattle. Visit to 3 villages (a total of 7 villages located close to trench), showed that all 3 villages felt the trench was effective. When the survey team inquired the effectiveness

of the fence at three villages (a total of 6 villages located close to the fence), two villages answered as "not effective" due to improper installation on the riverbeds.

Figure 2b: Survey of Electric Fence using GPS

In Waynad Wildlife Sanctuary, it was found that the trench was effective. The survey team surveyed the two villages located close to a trench both villages endorsed the effectiveness of the trench. Two villages located close to the fence, felt the fence is effective. However, they asked for more watchers to be assigned along the fence. Golur village located within the forest has neither fence nor trench to protect their life and properties, expressed their willingness to transfer them outside the park.

Figure 3: Status of elephant proof trench

The results of the trench (Figure 3), fence and village surveys showed that both the trench and fence should be properly maintained. The villages also asked for sufficient watchers to be posted along the two barriers. The three villages suggested rapid action to be taken to relocate their villages elsewhere, outside the park. It is also noticed that, It is impossible to solve those problems by Park authority alone. A regional development committee consisting of village elders and decision-making bodies should be formed and eco-development schemes implemented in the immediate future.

Elephant Poaching

The working elephant camp (mainly established for anti – poaching –Figure 4- and patrolling operations) is situated about 15 km, ½ hour drive from base camp. It constitutes five males and two female elephants and 14 men (mahouts and helpers). Out of 14 elephant keepers, 8 of them have 30 years of service, others have 20 years in forest and elephant service. The facilities given by forest department include raincoats, uniforms, sweaters (once a year), walkie-talkies and one gun for each camp. Rations are provided for permanent elephant keepers and incentives are given

for temporary staff. The camp elephants are used for patrolling; they cover a distance of 5 to 6 hours per day. Working hours is from 0900 am 1700 hours. While patrolling, sign of intruder movement, other illegal activities and animal sighting are noticed. Information such as illegal activities reported from the nearby villages, number of persons who have been arrested at various times are living in the villages about 500 m to 1 km from the camps are also recorded. It was noticed that, the camp staff is not given enough facilities to work in the place. These two conditions are in one way responsible for the continuing poaching activities in this region.

Figure 4: Anti-Poaching Camp in middle of the forest

Animal and habitat survey

While conducting the vehicle survey at the tourism zone of Bandipur National Park for the animal count and habitat assessment, the following animals were sighted: spotted deer (4 sightings - 192 animals), peacocks (3 sightings - 4 birds), Grey jungle fowl and terrapin (one sighting each). Most commonly sighted animal in this habitat was spotted deer and the habitat was found to be deciduous forest, with more open grassland and bamboo. During line transect walk in Mudumalai Wildlife Sanctuary (Figure 5a and b) for direct method of counting large mammals, no animals were sighted. Only 2 elephant dung and a track mark in dry deciduous forest were seen. In scrub

5a: Line Transect Survey (scrub forest)

5b: Line Transect Survey (deciduous forest)

forest, 3 spotted deer, 2 black napped hare, 1 peacock and 1 wild boar were counted.

Captive elephant management

Feeding practice in working season: In Mudumalai Wildlife Sanctuary elephants (Figure 6) are allowed to free range from 5:00 PM to 9:00 AM, after their working time. The male elephants are tied up and food is given. Formula and constituent of food supplements used in Mudumalai Wildlife Sanctuary are as follows

Figure 6: a captive elephant and its mahout from the camp

For 49 to 68 years old working elephants

Horse gram	5 Kg
Ragi	18 Kg
Jaggery	100 gm
Coconut	8 pieces for
Rice	for pregnant and lactating female
Salt	200 gm

Elephants are fed two times a day at 9 a.m. and 5 p.m. Resting elephants are fed about ½ of working elephant ration. Ration ratio varied depending upon age classes. The discussion with the veterinary doctor (Figure 7) helped to understand the estimation of elephant body weight, pregnancy period and inter calving period of elephants in India. Other information such as working capacity, working hours, age identification, common disease and their treatment, expenditure for treatment and food supplements of elephants in India were also obtained.

Figure 7: Discussions with the Veterinary Officer of the elephant camp

The formula used to estimate elephants in India is

12.7*chest girth+neck girth – 4281

The pregnancy period is 19 to 22 months, average 19 months (22 months in Myanmar)
Working hours 9.00 am to 5.00 p.m. (in Myanmar 06.00 to 10.00 a.m. 2.00 to 6 p.m. under shade)

Age identification (through ear folding)
The ear folding starts at the age of 10 Years, at 20 years the folding become one and above 30 years it become 2 inch.

Age identification (through dentition)
1st molar 2-3 years, 2nd molar 4-6 years, 3rd 9-15 years, 4th 18-20 years, 5th molar 40 – 50 years, 6th molar 60 years and above.

Common diseases reported in the camp
1, Haemorrhagic Septicaemia
2, Warm infections – Strangyl spp
Ascaris spp
Bots
Fiasiola
3, Trypanosomiasis
4, Filariasis
5, Anthrax
6, Foot and mouth
7, Rinderpest
8, Pneumonia
9, Injuries
10, Emanciation and malnutrition
11, Infertility
12, General debility

Management & organization of elephant camp
In Mudumalai Wildlife Sanctuary, all 28 elephants are kept together as one group directly and controlled by a Range Forest officer. To obtain a proper management, elephant teams should be reorganized. One elephant team should consist of 5 to 6 elephants only. If large number of elephants are put together in one group and allowed to graze in the same place, fodder may become insufficient, disease will be heavily transmitted and proper management cannot be conducted. The suggestions for feeding practice: all male and female elephants should be allowed to graze freely in grazing yard both day and night under proper anti-poaching program. If elephants are tied up and fed by hand feeding system for long, variety of food cannot be made available every day and elephants may suffer from nutrient deficiency.

To maintain the camp yearly 31.5 lakh rupees is needed, which includes 30 lakhs for salary and other expenses of the camp elephant staff and 1.5 lakh for medical expenses. It was noticed that records of proper treatment given are maintained. Some of the diseases reported (for example rinderpest and foot and mouth) in Mudumalai are not reported in Myanmar elephants. It's also noticed that, overall camp management (including diet and veterinary care) is under the control of the range officers and not under the veterinary surgeon. As the veterinary surgeon is more qualified in medical management of elephants, the supervision and the management of elephant should be under the veterinary surgeon. More importantly the money spend for medical expenses (1.5 lakh) is not sufficient as most of the drugs are very expensive and some of the diseases take long time to be cured.

Appendix 1:

I. Walking survey along the fence in Bandipur National Park (Distance Covered 11 km).

Sl. No.	Time of breakage	GPS location	Forest type	Distance from village	Remarks
1	14:30	N. 11°39’ 35.5” E. 76° 38’ 39.9”	Dry mixed deciduous	Data not available	
2	14:34	----			By elephant
3	14:37				
4	14:40				
5	14:42				
6	14:44				
7	14:45	N. 11°39’ 51.7” E. 76°39’ 04.9”	DMD with shrubs		
8	14:46				
9	15:01				
10	15:08		DMD with shrubs		
11	15:10				
12	15:11				
13	15:14				
14	15:15				
15	15:16				
16	15:17	N. 11°39’ 46.9” E. 76°39’ 42.5”			
17	15:26		DMD with shrubs	Data not available	By elephant
18	15:27				
19	15:28				
20	15:29				
21	15:30				
22	15:31				
23	15:34	N. 11°39’ 46.1” E. 76°40’ 7.8” / 1001m			
24	15:37				
25	15:39	N.11°40’ 11.7” E. 76°40’ 14.2”/1040m			
26	16:00	N. 11°40’ 11.7” E. 76°40’ 34.8” / 950m			
27	16:10	N. 11°40’ 24.8” E. 76°40’ 25.1” / 820m			Not broken, but no power supply
28	16:17	N. 11°40’ 42.0” E. 76°40’ 17.5” /1065m			Broken by people
29	16:57	N. 11°40’ 43.1” E. 76°40’ 03.1” / 1065m			
30	17:15	N. 11°40’ 36.7” E. 76°39’ 59.5” / 1079m			Broken

31	17:23	N. 11°40’ 33.7” E. 76°39’ 39.6” / 976m	
32	18:00	N. 11°41’ 16.8” E. 76°38’ 39.6” / 726m	Electricity is in order
33	18:30	N. 11°45’ 32.9” E. 76°38’ 12.3” / 915m	End of the fence

II: Walking survey along the trench in Bandipur National Park (distance covered: 7 km)

Sl. No.	Time of breakage	GPS location	Forest type	Distance from village	Remarks
1	10:06	N. 11°42’ 21.7” E. 76°38’ 37.8”	Degraded, shrubs, soil is rocky surrounded by paddy field, near the temple	Data not available	
2	10:15		Degraded, shrubs, soil is rocky		Broken earth filled
3	10:20	N. 11°42’ 19.8” E. 76°38’ 30.6” /986m			
4	10:27				
5	10:30				
6	10:35	N. 11°42’ 17.8” E. 76°38’ 21.0” / 986m	Lantana cover, near the main road		
7	10:40				Broken, boulder at the bed
8	10:41		Lantana cover		Broken by people
9	10:42				
10	10:45	N. 11°42’ 10.6” E. 76°38’ 16.5” / 883m	Lantana cover Near teak plantation		Broken
11	10:54				Broken by elephant
12	10:57	N. 11°42’ 11.1” E. 76°38’ 2.7” / 954m			Broken by people (earthfilled)
13	11:03	N. 11°42’ 13.0” E.76°38’54.1” 1007m			
14	11:06-11:09		Lantana cover	Data not available	Broken by people (earthfilled)
15	11:11	N. 11°42’ 12.7” E. 76°37’ 54.1” / 1007m			Unfinished digging
16	11:14				
17	11:15				
18	11:17	N. 11°42’ 15.4” E. 76°37’ .2” 995m			20 feet of trench totally filled with sand flow
19	11:20				Broken by people (earthfilled)
20	11:30				Broken by people (cattle crossing)
21	11:41	N. 11°41’ 51.0”			Good (corner of

		E. 76°37’ 37.1” / 1000m	the trench)
22	11:46		Broken by people
23	11:47		Interrupted trench, due to alteration of landscape after the water flow
24	11:49		Broken by man
25	11:51	N. 11°41’ 47.1” E. 76°37’ 38.4” / 1078m	Under repair
26	12:01		Broken by people
27	12:02		Under repair
28	12:12	N. 11°41’ 39.3” E.76°38’0.8” 915m	Under repair
29	12:15		Under repair
30	12:16		Under repair
31	12:17		Under repair
32	12:22	N. 11°41’ 32.9” E. 76°38’ 12.3” / 915m	End of the trench

III: Questionnaire survey in the village on trench/fence efficacy in Bandipur National Park.

Village Name		**Ardanakadan**	**Melkamanhalli**	**Mangala**	**Chenikatti colony**	**Agathala**	**Barambat**
1.	0.5 km	0.3 km	1 km	2.5 km	3 km	0.5 km	1 km
2.		Two seasons	Through the year	10 –20 times per year	Daily	Daily	Daily
3.	June to July	April to June & Nov.	March to Nov.	June to Nov.	March to Nov.	March to Nov.	June to Dec.
4.	Crops	Crops	Water & crops	Water & crops	Crops	Water & crops	Water & crops
5.	Ragi, sorghum, cotton, horse gram	Ragi, sorghum, horse gram, cotton, beans	Ragi, sorghum, horse gram, sugarcane, cotton, beans, sunflowers	Ragi, horse gram, sugarcane, beans, groundnut	Ragi, sorghum, horse gram, groundnut Sunflowers	Ragi, sorghum, horse gram, cotton, sunflower	Ragi, paddy, sugarcane, cotton, sunflower, groundnut, sorghum, horse gram
6.	Ragi, sorghum	Ragi, sorghum, cotton during flowering time	Ragi, sorghum, sugarcane	Ragi, sugarcane	Ragi, sorghum	Ragi, sorghum	Paddy, sugarcane
7.	Reduced (Fence)	Reduced (fence)	Reduced (in some place) Trench	Reduced (Fence)	Not effective (Fence)	Not reduced (fence)	Not effective (Trench)

8.	Elephants are intelligent and they break through			All crop lands are fenced by Forest department	Fence is not closed near river side; elephants can enter from outside the fence. Fenced the crop land about 1 km	Solar fence for the boundary of crop land <6 km	More deep and maintain properly
9.	N.11° 39’ 29.0” E. 76°39’ 20.4” /960m	N. 11°38’ 36.9” E. 76°39’ 20.8” / 985m	N. 11°42’ 0.5” E. 76°38’ 30.0”	N. 11°38’ 55.0” E. 76°40’ 10.9” / 927m	N. 11°39’ 07.8” E. 76°39’ 34.9” /1040m	N. 11°38’ 51.1” E. 76°39’ 04.6” / 1040m	N. 11°45’ 36.5” E. 76°34’ 10.8”

1. Distance from trench/fence; 2. No. of elephant visits/ year; 3. Reason; 4. Season of elephant visit; 5.Crops cultivate; 6. Crops damaged; 7. Problems increase or decrease after fence/trench; 8. Alternatives; 9. GPS Location

V: Survey along the trench in Wayanad Wildlife Sanctuary:

Sl.No.	Time of breakage	G.P.S. location	Forest type	Distance from village	Remarks
1	10:40		Teak plantation	Near the village	
2	11:10	N. 11°45’ 00.5” E. 76°14’ 12.7” /1242m		15m	Good trench
3	11:24				Land sliding
4	11:25				Land sliding
5	11:31	N. 11°44’ 36.3” E. 76°13’ 37.3”		Very near	Repaired

V: Survey along the fence in Wayanad Wildlife Sanctuary:

Sl.No.	Time of Breakage	G.P.S. location	Forest type	Distance from village	Remarks
1	11:52	N. 11°43’ 28.1” E. 76°17’ 47.7” / 822m	Teak plantation	Very near	
2	12:00	N. 11°40’ 18.8” E. 76°18’ 29.4” / 1341m			
3	12:02				Broken by people
4	12:04				
5	12:06	N. 11°40’ 14.3” E. 76°18’ 32.7” / 1341m			Corner of the fence and new studied by car
6	12:17				Broken by people
7	12:20	N. 11°40’ 40.4” E. 76°19’ 22.2” / 1341m			Not broken
8	12:42		Grassland with DMD		Pass across fence gate
9	12:45	N. 11°41’ 10.1” E. 76°18’ 47.2” / 993m	Teak plantation		Plantation point
10	13:50	N. 11°41’ 09.0” E. 76°18’ 31.9” / 871m	Bamboo’s, DMD with scrubs		Good fence

VI: Questionnaire survey in villages on trench/fence efficacy in Wayanad Wildlife Sanctuary

Village Name	**Pukalamalam A**	**Pukalamalam B**	**Golur (no trench/fence)**	**Pilakkavu**	**Vellakkode**
Distance from Trench/Fence	15 M	Very close	Inside	1 km	15 M
No. of elephants per year and	No numbers	15 – 20	15 – 20	10 – 15	40
season when visited	Throughout the year	Rainy season	Mostly summer	March – June	Throughout the year
Why they come	Crops	Crops	Water, crops	Water, crops	Water, crops
Crops cultivated	Banana, Pepper, Coffee	Banana, Arecanut, Coconut, Pepper, Ginger	Paddy, Banana, Ginger, Mustard	Paddy, banana, arecanut, tobacco	Paddy, Banana, Arecanut, Pepper, Coffee
Crops damaged	Banana (Stopped cultivating coconut)	Coconut, Banana, Arecanut	Paddy, Banana	Coconut, Paddy, Banana, Arecanut	Paddy, Banana, Coconut
Problems increase or decrease after fence/trench	Reduced (Trench)	Efficient (Trench)	Use explosives	Reduced (Fence)	Reduced (Fence)
What alternatives	Trenches good if maintained well.	Stone walls to prevent caving in		Fence good watcher for 10 km required	Relocation
G.P.S. Locations	N. 11° 44’ 51.1” E. 76°14’ 5.6” / 1129m	N. 11°44’ 36.3” E. 76°33’ 37.3” / 1095m	N. 11°43’ 28.1” E. 76°17’ 47.7” / 822m	N. 11°40’ 40.4” E. 96°19’ 22.2” /134m	N. 11°4’ 9.0” E. 76°18’ 31.9” /87m

VII: Visit to anti- poaching camps

Sl. No	Name of captive elephant camp	Game hut (A)	(B)
1	Camp Name	Game hut	Chikkahala
2	No. of people	14 Men	Uniform staff = 2 Anti-poaching watcher =8
3	Age classes	20 to 50 yrs (20yrs=4, 40yrs=5, 50yrs=4, 30yrs=1)	18 to 30 yrs
4	Experience	3 men are more experience (30 yrs) others are 10 to 20 yrs experience	18 yrs =3, 35 to 40yrs=2, 30yrs = 5, every Sunday, group is changed
5	Facilities provided	Rain coat, blanket, uniform and shoes, sweaters, one walkie-talkie (Once a year)	8 are born and brought up in the forest. Anti-poaching watchers are daily wages workers and they get rations. 2 permanent staff get raincoats, blankets, uniform, shoes and sweaters.
6	Incentive provided	Not given, ration provided (Permanent staff have no incentive, no ration)	Not given
7	Mode of patrolling	By elephant	On foot
8	Distance of patrolling	5 to 6 km radius	15 to 20 km, average 10 kms
9	Starting time & closing time	9 am to 5 p.m.	8 am to 5 p.m. sometimes till 7 p.m.
10	What they look for	Animals, forest fires, people's movement and illegal activities	Animals, forest fires, poachers and other disturbances
11	Nearest village and the distance	Nagamvalli village / 1.5km	Mandakarea and Pannankolli villages for 6 km Mutanga and Barambat villages have poachers. (about 26 km)
12	Illegal activities reported from the village	Reported	Reported
13	Name of person arrested or accused	No. of persons for illegal items at various times	Available at office
14	Facilities provided are enough or not	Not enough	Not sufficient, this camp is difficult and remote to patrol
15	Suggestion	Need more salary, wireless good guns, housing is not sufficient for elephant and man	More salary, uniforms, blankets and other facilities
16	G.P.S. Location	N. 11°36' 20.0" E. 76°30' 40.1" /963m	N. 11°38' 32.8" E. 76°30' 38.1" /963m

VIII: Survey on anti poaching camps and status of captive elephant management

Sl. No.	**Name of captive elephant camp**	**Game hut**
1	Number of elephants	7
2	Sex	5 male 2 female
3	Age class	Male: 44 yrs,35 yrs, 30 yrs,21 yrs,12 yrs. Female: 7 yrs, 5 yrs.
4	Purpose of captive elephant camping	Patrolling for anti-poaching
5	Condition of grazing land	Good
6	Distance of the grazing land	1.5 km
7	Time of grazing	9:00 p.m. to 5:00 pm for males, they are not allowed to graze at night. Females graze both day and night (6p.m. to 8 a.m.)
8	Working hours	9 a.m. to 5 p.m.
9	No. mahouts	7
10	No. helpers	7
11	No. others	----
12	Do they like to stay at anti-poaching camp	If enough water is provided, they want to stay for long at anti-poaching camp.
13	G.P.S. Location	N. 11°38’ 32.8” E. 76°30’ 38.1” / 963m

X: Vehicle survey for habitat and animal study (location – Bandipur National Park, tourism zone).

Sl. No.	Sighting time	Number	Species	Sex	Forest type	Remarks
1	06:52	----	----	----	Near the plantation, bamboo	
2	06:54	50	Spotted deer	----	----	
3	06:57	10	Spotted deer	----	----	
4	06:58	70	Spotted deer	13 male 57 female	Open forest, grassland	
5	07:00	1	Peacock	----		
6	07:07		----	----	Open forest, dry deciduous bamboo,	
7	07:15	2	Peacock	----	----	
8	07:22	-----	-----	----	Open forest, grassland, good water, teak, dry deciduous	
9	07:25	----	----	----	----	
10	07:30	62	Spotted deer	10 male 52 female	-----	
11	07:34	----	----	----	-----	
12	07:37	----	----	----	Open forest, grassland, , dry deciduous	
13	07:42	----	----	----	pond	----
14	07:43	1	Turtle	----	pond	----
15	07:45	1	Peacock	----	Near water	----
16	07:46	1	Grey jungle fowl	----	Bamboo, bushes	----

X: Line transect survey for estimating large mammal density (dry deciduous forest)

Sl. No	Starting time	Species	No. of animals	Sighting distance	Sighting angle	Transect direction	G.P.S. Location
1	08:13					130°	N. 11°36’ 0.8” E. 76°31’ 14.2” /886m
2	08:17	Elephant (dung)				130°	
3	08:20	Elephant (dung)				130°	
4	08:30	Elephant (foot print)				130°	
5	08:50					130°	N. 11°35’ 43.9” E. 76°31’ 47.5” / 903m

XI: Line transect survey for estimating large mammal density (scrub forest):

S. No.	Sighting time	Species	No. of animals	Sighting distance (m)	Sighting angle	Transect direction	G.P.S. Location
1	17:05					90°	N.11°34’27.3” E.76°39’ 32.2” / 971m
2	17:15	Spotted deer	1	50	135°	90°	
3	17:30	Spotted deer	2	30	155°	90°	
4	17:32	BNH*	2	15	90°	90°	
5	17:42	Peacock	1	22.5	40°	90°	
6	18:03	Wild boar	1	20.5	70°	90°	
7	18:10					90°	N.11°34’ 29.2” E.76°40’ 33.9” / 899m

BNH: Black napped hare;

XII: Daily itinerary of the Myanmarese delegation

	26-10-99
Place	Bandipur National Park
6.30	Arrived at Project Tiger Bandipur reception travelled towards the tourism zone in the National Park
6.45 – 6.52	Mr. Varma gave a brief outline of the history of the park and the method of data collection for counting elephants and other animals through vehicle count.
6.52 – 7.46	Went around the tourism zone and counted about 192 spotted deer, 4 peacocks, 4 jungle fowls and a terropin. Noticed the main habitat to be grassland with bamboo in the tourism zone.
7.46 – 8.15	Visited Hangala village.
8.22	From Hangala village, the land use pattern is agricultural lands on both sides of the Gopalswamy Betta road.
8.30	Stopped enroute for a brief explanation of the human-elephant conflict by Mr. Varma – visited habitat in Gopalswamy Betta
10.50	Along the way, noticed changes in the land type every fifteen minutes using the GPS.
	27-10-99
Place	Bandipur National Park
9.50	Mr.Varma, spoke to the villagers and two forester staff about the trench that covers the Park near the foot hills of forest.
10.00	Went to the starting point of the trench near the Melkammanahalli village.
10.10 – 11.23	Surveyed, 2 types of trench, one that was dug up three years ago and the second one is 10 years old. The base of the trench is one meter wide and the top is three meters wide and the height of the trench is two meters. Thorny shrubs are grown along the sides of the trench. Along the old trench, 23 spots the trench was damaged. One spot was highly damaged, probably due to forceful water flow. The other 22 were probably damaged due to cattle and elephants. Recorded 9 GPS points along the old trench. The readings were done every fifteen minutes of walking.
11.30 – 12.22	Surveyed the 10 years old trench that ended near the forest gate. Found 9 broken places along the trench out of which four were being repaired.
12.25	Met the Forest Range Officer near the main gate of the Park. Had a discussion with him about the trench and the fence.
13.00	At the guest house, Mr. Varma explained about elephant corridors and their importance.
14.00 – 15.30	Met senior retired Chief Wildlife Warden Mr. M.K. Appayya and other officials. Discussed on management and veterinary care of elephants in the Park.
13.55 – 16.50	Met the Park Warden and the Veterinary surgeon in the room and discussed about the veterinary care and management of elephants in the Park. Discussed more about the contagious disease that occurred in the Park.
17.00 – 18.30	Surveyed villages Karamuly, Ardanakandan and Melkammanalli to understand the effectiveness of the fence and the trench using a questionnaire having nine questions.
	28-10-99
Place	Bandipur National Park
8.00 – 8.30	Mr. Varma spoke about the importance of research and its effectiveness in

	elephant management.
8.30 – 8.50	Visited Mangala village
8.50 – 9.03	Questioned the villagers on the effectiveness of the fence and trench with a questionnaire The villagers in Mangala village stated that elephants generally come down to crop raid 10-20 times in a year between January and November. After the fence and the trench, their crop raiding visits have decreased. They also suggested that the forest department put up extra fence around their crops, a km away from the boundary of the crop fields. The villagers also want to hold licensed guns.
9.22 – 9.30	Arrived at Chenikatta colony for questionnaire survey. These villagers also gave some suggestions similar to Mangala villagers.
9.40 – 11.00	Drove from Chenikatta colony to Tiger Ranch private land, to study the Eco-tourism.
11.00 – 11.40	Visit to Agathala. The villagers suggested a solar fence for about 6 kms to safeguard their crop.
12.00 – 12.35	Arrived at Barmbat village, the villagers said that the existing trench was not effective and there was a need for 4-5 km of a new trench with proper drainage and management.
13.05 – 13.37	Traveled to Wayanad. Along the way the forest type is deciduous forests with bamboo and teak plantation.
15.45 – 17.30	Arrived at Wayanad Wildlife Sanctuary Warden's office, discussion on park management.
	29-10-99
Place	Wayanad Wildlife Sanctuary
8.22 – 10.10	Left Muthanga forest guesthouse and went to Chedleth forest range office. Along the journey, paddy fields, moist deciduous forests, bamboo and teak plantations were noticed.
10.40 – 11.15	Walked along the elephant proof trench and examined damaged spots. Visited number of villages along the trench.
11.15 – 11.31	Questionnaire survey, along the villagers and found out that the trench had reduced human-elephant conflict in their area. However, the villagers suggested that the trench be maintained properly.
12.50	Visit to Golur village – located inside the forest, questionnaire survey about status of the human elephant conflict – no trench or fence is provided and willing to move out the forest
15.30	Visit to Pulpally village, meeting with NGO personnel, gave talk in Vijay Higher Secondary School on elephants in India and Myanmar
19.30 –20-30	Discussion on the role of NGO's in identifying poachers, opening dialogue with them to solve or develop strategies for poaching problem, discussion on a case study and an experience on speaking to poachers.
21.30	To rest house
	30-10-99
08.00	Meeting with the Assistant Wildlife Warden, Muthanga range, about range management.
09.00 to 11.00	Discussion with NGO leader on various activities of Wayand Prakruthi Samithi Sangam
12.00	Survey along the electric fence. Fence is installed lost 2 years ago
12.20	Arrived at Pellakavu village, villager told that fences can reduce man elephant conflict. But they want to go out of the sanctuary if they get

	adequate compensation.
12.55	Arrived at Puthur village – human animal conflict is severe, 6 villagers were attacked and killed by wild elephants within four years and villagers want to go out of the sanctuary.
14.00	Arrived at Vellakodu, and were informed that fence could reduce man elephant conflict problems but the villagers want to go out of the sanctuary.
16.00	Met park warden and discussed about park management and other issues.
	31-10-99
08.15	Left Muthanga Range office to Tamilnadu .
10.45	Arrived at Mudumalai wildlife sanctuary in Tamil Nadu State.
12.30	Meet park-warden.
16.30 to 17.20	We met park warden Mr. A. Udhayan in Theppakadu Wildlife sanctuary. Discussed about management of Mudumalai Wildlife sanctuary. The five management priorities are 1. Protection 2. Habitat improvement 3. Tourism 4. Tribe settlements 5. Research.
17.30	Studied management of captive elephants.
	01-11-99
06.35	Mr. Varma explained about vehicle survey and walking survey methods (direct methods)
06.55	Counted animals by vehicle
08.13 to 08.50	Carried out direct counting of animals by walking survey under the supervision of Mr. Varma. According to him in Mudumalai WLS, the animals are counted by direct transect walking method, each transect line is covered 2 times per month and 144 times per year.
10.00 to 10.20	Travel to an anti-poaching camp
10.47	Arrived at anti-poaching camp and asked 17 questions related to the poaching problem and methods followed to stop the issue. It was learned that the facilities provided are not enough for their living. They need more salary and housing facilities.
12.00 to 12.25	Left game-hut anti-poaching camp and to Chikkahalla anti-poaching camp
16.45 to 18.03	Carried out direct counting of animals of walking survey by transect line method at scrub forest. Two different sightings of spotted deer, one sighting of hare, peacock, and wild boar were made.
20.00 to 22.00	Talks and discussions by CES, Indian Institute of Science and Bombay Natural Society researchers at IISc field station Masinagudi.
	02-11-99
09.00	To elephant camp at Theppakadu
09.10	Met Vet. Surgeon
09.30 to 14.00	Discussed with Dr. Asokan concerning captive elephant management and their treatment. Dr. Asokan also explained estimating method of elephant body, food supplement methods, age identification method and future out looks of his elephant camp.
19.30	Visited Theppakadu, discussion on wild elephant management and elephant corridor with N.G.O. personnel
	03-11-99
8.00	Departure to Bangalore
16.00-17.00	Discussion with Prof. Sukumar, AERCC
	04-11-99
10.00-12.30	Report writing at AERCC

14.00-17.00	Developing GIS map of Bandipur National Park
	05-11-99
10.00-15.00	Report writing
	06-11-99
8.30	Departure to Yangon

Appendix 2:

Profiles of captive elephants kept in AKNP

1	Name	Kan Sein
2	Sex	Male
3	Age	32 years
4	Length*	3.15
5	Height	2.56
6	Body girth	3.88
7	Neck girth	2.45
8	Trunk length	2.5
9	Tusk girth	0.3/0.3
10	Tusks (L / R)	0.5/0.5
11	Tail	1.4
12	Ear Right (W/L)	0.67/0.8
13	Ear Left (W/L)	NA
14	Leg Front (L/R)	1.3/1.3
15	Leg Back (L/R)	1.32/1.29
16	Leg Height Front (L/R)	1.5/1.5
17	Leg Height Back (L/R)	1.75/1.58
18	Weight **	2000
19	Food***	10 rice, .5 tamarind and .1 salt
20	Work/hr	7-10 am and 4-6 pm
21	Disease	Development of malignant tumour
22	Frequency of occurrence	Permanent
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	Mange Aye
27	Age	27 years
28	Education	4 th standard
29	Marital status	Married
30	Family	3 daughters
31	Salary****	975 / month
32	Accommodation availability	No
33	Working as Oozi since	18 years
34	Job status	Permanent
35	Promotion	Chief Oozi
36	Started work with animal at age	4 years
37	Why became an Oozi?	Took over after a person resigned
38	Feelings towards the elephant	Likes it a lot
39	Feeding***	Free ranging and fed in the camp
40	Assistant available	No

1	Name	Than Aung Tun
2	Sex	Male
3	Age	22 years
4	Length*	2.62
5	Height	2.13
6	Body girth	3.25
7	Neck girth	2.2
8	Trunk length	2.14
9	Tusk girth	0.29/0.26
10	Tusks (L / R)	0.39/0.4
11	Tail	1.18
12	Ear Right (W/L)	0.39/0.73
13	Ear Left (W/L)	0.63/0.74
14	Leg Front (L/R)	1.4/1.39
15	Leg Back (L/R)	1.23/1.25
16	Leg Height Front (L/R)	1.12/1.1
17	Leg Height Back (L/R)	0.98/1.2
18	Weight **	1800
19	Food***	11.25
20	Work/hr	7-10 am and 4-6 pm
21	Disease	NA
22	Frequency of occurrence	NA
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	NA
27	Age	NA
28	Education	NA
29	Marital status	NA
30	Family	NA
31	Salary****	NA
32	Accommodation availability	NA
33	Working as Oozi since	NA
34	Job status	NA
35	Promotion	NA
36	Started work with animal at age	NA
37	Why became an Oozi?	NA
38	Feelings towards the elephant	NA
39	Feeding***	NA
40	Assistant available	NA

1	Name	Than Moe Oo
2	Sex	Male
3	Age	22 years
4	Length*	3.12
5	Height	2.24
6	Body girth	3.66
7	Neck girth	2.41
8	Trunk length	2.23
9	Tusk girth	No tusks
10	Tusks (L / R)	NA
11	Tail	1.27
12	Ear Right (W/L)	0.7/0.77
13	Ear Left (W/L)	0.6/0.77
14	Leg Front (L/R)	1.37/1.37
15	Leg Back (L/R)	1.14/1.14
16	Leg Height Front (L/R)	1.18/1.17
17	Leg Height Back (L/R)	1.15/1.19
18	Weight **	1900
19	Food***	7.5 rice, .25 tamarind and .05 salt
20	Work/hr	7-10 am and 4-6 pm
21	Disease	No illness
22	Frequency of occurrence	NA
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	Chit Saung
27	Age	37 years
28	Education	4th standard
29	Marital status	Married
30	Family	2 girls, 1 boy
31	Salary****	975 / month
32	Accommodation availability	No
33	Working as Oozi since	25 years
34	Job status	Permanent
35	Promotion	NA
36	Started work with animal at age	8 years
37	Became an Oozi. Why?	NA
38	Feelings towards the elephant	Likes it a lot
39	Feeding***	Free ranging and fed in the camp
40	Assistant available	No

1	Name	Ma Lu
2	Sex	Female
3	Age	18 years
4	Length*	2.71
5	Height	2.22
6	Body girth	3.34
7	Neck girth	2.4
8	Trunk length	1.75
9	Tusk girth	No tusks
10	Tusks (L / R)	NA
11	Tail	1.2
12	Ear Right (W/L)	0.6/0.76
13	Ear Left (W/L)	0.62/0.73
14	Leg Front (L/R)	1.23/1.3
15	Leg Back (L/R)	1.15/1.5
16	Leg Height Front (L/R)	1.9/1.9
17	Leg Height Back (L/R)	1.1/1.1
18	Weight **	1700
19	Food***	7.5 rice, .25 tamarind, .5 salt and free ranging
20	Work/hr	7-10 am and 4-6 pm
21	Disease	NA
22	Frequency of occurrence	NA
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	Htay Aung
27	Age	22 years
28	Education	4 th standard
29	Marital status	Single
30	Family	4 sisters, 1 brother and parents
31	Salary****	600 / month
32	Accommodation availability	No
33	Working as Oozi since	18 years
34	Job status	Permanent
35	Promotion	NA
36	Started work with animal at age	3 years
37	Became an Oozi. Why?	NA
38	Feelings towards the elephant	Likes it a lot
39	Feeding***	Free ranging and fed in the camp
40	Assistant available	No

1	Name	Zaw Ma
2	Sex	Female
3	Age	13 years
4	Length*	2.65
5	Height	1.96
6	Body girth	3.25
7	Neck girth	1.83
8	Trunk length	1.64
9	Tusk girth	No tusks
10	Tusks (L / R)	NA
11	Tail	1.1
12	Ear Right (W/L)	.48/.50
13	Ear Left (W/L)	.53/.58
14	Leg Front (L/R)	1.2/1.2
15	Leg Back (L/R)	1.2/1.2
16	Leg Height Front (L/R)	1.2/1.2
17	Leg Height Back (L/R)	1.2/1.2
18	Weight **	800
19	Food***	5 rice, .25 tamarind and 0.5 salt
20	Work/hr	7-10 am and 4-6 pm
21	Disease	No illness
22	Frequency of occurrence	NA
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	Aung San Win
27	Age	23 years
28	Education	4 th standard
29	Marital status	Single
30	Family	4 brothers, 1 sister and parents
31	Salary****	600 / month
32	Accommodation availability	No
33	Working as Oozi since	18 years
34	Job status	Permanent
35	Promotion	NA
36	Started work with animal at age	5 years
37	Became an Oozi. Why?	NA
38	Feelings towards the elephant	Likes it a lot
39	Feeding****	Free ranging and fed in the camp
40	Assistant available	No

1	Name	Moe Moe
2	Sex	Female
3	Age	13 years
4	Length*	2.65
5	Height	2.27
6	Body girth	3.24
7	Neck girth	1.9
8	Trunk length	1.9
9	Tusk girth	No tusks
10	Tusks (L / R)	NA
11	Tail	1.22
12	Ear Right (W/L)	0.56/0.55
13	Ear Left (W/L)	0.52/0.55
14	Leg Front (L/R)	1.8/1.4
15	Leg Back (L/R)	0.98/0.99
16	Leg Height Front (L/R)	1.4/1.33
17	Leg Height Back (L/R)	1.35/1.35
18	Weight **	1000
19	Food***	7.5 rice, .25 tamarind and 0.5 salt
20	Work/hr	7-10 am and 4-6 pm
21	Disease	No illness
22	Frequency of occurrence	NA
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	Naing Min
27	Age	20 years
28	Education	4th standard
29	Marital status	Single
30	Family	3 sisters and 2 brothers
31	Salary****	600/month
32	Accommodation availability	NA
33	Working as Oozi since	3 years
34	Job status	Permanent
35	Promotion	NA
36	Started work with animal at age	3 years
37	Became an Oozi. Why?	NA
38	Feelings towards the elephant	Likes it a lot
39	Feeding***	Free ranging and fed in the camp
40	Assistant available	No

1	Name	Ma Kaw
2	Sex	Female
3	Age	18 years
4	Length*	2.87
5	Height	2.17
6	Body girth	3.18
7	Neck girth	2.18
8	Trunk length	1.92
9	Tusk girth	No tusks
10	Tusks (L / R)	NA
11	Tail	1.16
12	Ear Right (W/L)	0.61/0.69
13	Ear Left (W/L)	0.61/0.67
14	Leg Front (L/R)	1.24/1.17
15	Leg Back (L/R)	1.14/1.19
16	Leg Height Front (L/R)	1.02/1.02
17	Leg Height Back (L/R)	0.98/0.93
18	Weight **	1700
19	Food***	7.5 rice, .25 tamarind and 0.5 salt
20	Work/hr	7-10 am and 4-6 pm
21	Disease	No illness
22	Frequency of occurrence	NA
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	Wan Aung
27	Age	49 years
28	Education	4th standard
29	Marital status	Married
30	Family	1 son and 4 daughters
31	Salary****	975/month
32	Accommodation availability	No
33	Working as Oozi since	20 years
34	Job status	Permanent
35	Promotion	NA
36	Started work with animal at age	11 years
37	Became an Oozi. Why?	No reply
38	Feelings towards the elephant	Likes it a lot
39	Feeding***	Free ranging and fed in the camp
40	Assistant available	No

1	Name	Lu Aung
2	Sex	Female
3	Age	17 years
4	Length*	2.89
5	Height	2.18
6	Body girth	3.4
7	Neck girth	2.4
8	Trunk length	1.89
9	Tusk girth	Small but not cut
10	Tusks (L / R)	NA
11	Tail	1.18
12	Ear Right (W/L)	0.55/0.62
13	Ear Left (W/L)	0.58/0.62
14	Leg Front (L/R)	1.18/1.29
15	Leg Back (L/R)	1.07/1.07
16	Leg Height Front (L/R)	1.1/1.05
17	Leg Height Back (L/R)	0.95/0.95
18	Weight **	1700
19	Food***	7.5 rice, .25 tamarind and .05 salt
20	Work/hr	7-10 am and 4-6 pm
21	Disease	Back injury, rest for 7 months
22	Frequency of occurrence	Injury reoccurs when the elephant comes to work
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	Khin Maung Win
27	Age	27 years
28	Education	NA
29	Marital status	Married
30	Family	3 sons and 1 daughter
31	Salary****	975/month
32	Accommodation availability	No
33	Working as Oozi since	17 years
34	Job status	Permanent
35	Promotion	NA
36	Started work with animal at age	NA
37	Became an Oozi. Why?	No reply
38	Feelings towards the elephant	Likes it a lot
39	Feeding***	Free ranging and fed in the camp
40	Assistant available	No

1	Name	Shwe Kaing Moe
2	Sex	Female
3	Age	12 years
4	Length*	2.66
5	Height	2.01
6	Body girth	3.1
7	Neck girth	1.9
8	Trunk length	1.63
9	Tusk girth	NA
10	Tusks (L / R)	NA
11	Tail	1.13
12	Ear Right (W/L)	0.56/0.6
13	Ear Left (W/L)	0.56/0.6
14	Leg Front (L/R)	1.14/1.17
15	Leg Back (L/R)	1.05/1.12
16	Leg Height Front (L/R)	1.02/1.99
17	Leg Height Back (L/R)	0.91/0.96
18	Weight **	1550
19	Food***	5 rice, 0.25 tamarind and .05 salt
20	Work/hr	7-10 am and 4-6 pm
21	Disease	Hepatitis, 10 months rest
22	Frequency of occurrence	Mulint 50 cc/day for 7 days
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	Aung Sann Lin
27	Age	19 years
28	Education	4th standard
29	Marital status	Single
30	Family	4 brothers and 1 sister
31	Salary****	600/month
32	Accommodation availability	No
33	Working as Oozi since	18 years
34	Job status	Daily wages
35	Promotion	NA
36	Started work with animal at age	3 years
37	Became an Oozi. Why?	No reply
38	Feelings towards the elephant	Likes it a lot
39	Feeding***	Free ranging and fed in the camp
40	Assistant available	No

1	Name	Yan Aung
2	Sex	Male
3	Age	10 years
4	Length*	2.1
5	Height	1.9
6	Body girth	2.59
7	Neck girth	1.68
8	Trunk length	1.56
9	Tusk girth	0.21/0.18
10	Tusks (L / R)	0.42/0.46
11	Tail	1.16
12	Ear Right (W/L)	0.44/0.54
13	Ear Left (W/L)	0.45/0.54
14	Leg Front (L/R)	1.1/1.1
15	Leg Back (L/R)	1.12 /1.1
16	Leg Height Front (L/R)	0.92 /0.92
17	Leg Height Back (L/R)	0.86/0.86
18	Weight **	1400
19	Food***	5 rice, 0.25 tamarind and .05 salt
20	Work/hr	7-10 am and 4-6 pm
21	Disease	No illness
22	Frequency of occurrence	NA
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	Maung Aye
27	Age	25 years
28	Education	4 th standard
29	Marital status	Single
30	Family	3 sisters and 2 brothers
31	Salary****	600/month
32	Accommodation availability	No
33	Working as Oozi since	1 year
34	Job status	Temporary
35	Promotion	NA
36	Started work with animal at age	3 years
37	Became an Oozi. Why?	No reply
38	Feelings towards the elephant	Likes it a lot
39	Feeding***	Free ranging and fed in the camp
40	Assistant available	No

1	Name	Poe Ei San
2	Sex	Female
3	Age	8 years
4	Length*	2.3
5	Height	1.74
6	Body girth	2.7
7	Neck girth	1.65
8	Trunk length	1.52
9	Tusk girth	NA
10	Tusks (L / R)	NA
11	Tail	1
12	Ear Right (W/L)	0.46/0.48
13	Ear Left (W/L)	0.42/0.47
14	Leg Front (L/R)	1.11/1.11
15	Leg Back (L/R)	1.0/0.9
16	Leg Height Front (L/R)	0.9/0.92
17	Leg Height Back (L/R)	0.83/0.86
18	Weight **	1400
19	Food***	2.5 rice, 0.25 tamarind, 0.5 salt and free ranging
20	Work/hr	7-10 am and 4-6 pm
21	Disease	No illness
22	Frequency of occurrence	NA
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No
26	Oozi	Kyin Maung Win
27	Age	18 years
28	Education	4th standard
29	Marital status	Single
30	Family	5 girls, 3 boys and parents
31	Salary****	600/month
32	Accommodation availability	No
33	Working as Oozi since	3 years
34	Job status	Permanent
35	Promotion	NA
36	Started work with animal at age	NA
37	Became an Oozi. Why?	No reply
38	Feelings towards the elephant	Likes it a lot
39	Feeding***	Free ranging and fed in the camp
40	Assistant available	No

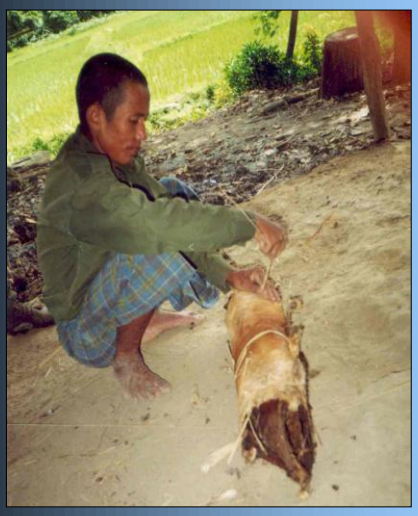
1	Name	Pan Htay Lwin
2	Sex	Male
3	Age	18 years
4	Length*	2.55
5	Height	2.15
6	Body girth	3.4
7	Neck girth	1.95
8	Trunk length	2.05
9	Tusk girth	0.1/0.25
10	Tusks (L / R)	0.5/0.5
11	Tail	1.35
12	Ear Right (W/L)	50/71
13	Ear Left (W/L)	50/71
14	Leg Front (L/R)	1.05/
15	Leg Back (L/R)	0.9/0.9
16	Leg Height Front (L/R)	1.47/1.57
17	Leg Height Back (L/R)	1.28/1.28
18	Weight *	900
19	Food***	2.5 rice, 5 salt and 25 tamarind
20	Work/hr	7-10 am and 4-6 pm
21	Disease	Dryness of pad once a year
22	Frequency of occurrence	Seldom bloat
23	De-worming	Every month
24	Veterinary history	Available
25	Behavioural problem	No problem
26	Oozi	Kyint Ma Tun
27	Age	18 years
28	Education	4th standard
29	Marital status	Single
30	Family	3 brothers and 5 sisters
31	Salary****	600/month
32	Accommodation availability	No
33	Working as Oozi since	7 years
34	Job status	Permanent
35	Promotion	NA
36	Started work with animal at age	2 years
37	Became an Oozi. Why?	No reply
38	Feelings towards the elephant	Likes it a lot
39	Feeding***	Free ranging and fed in the camp
40	Assistant available	No

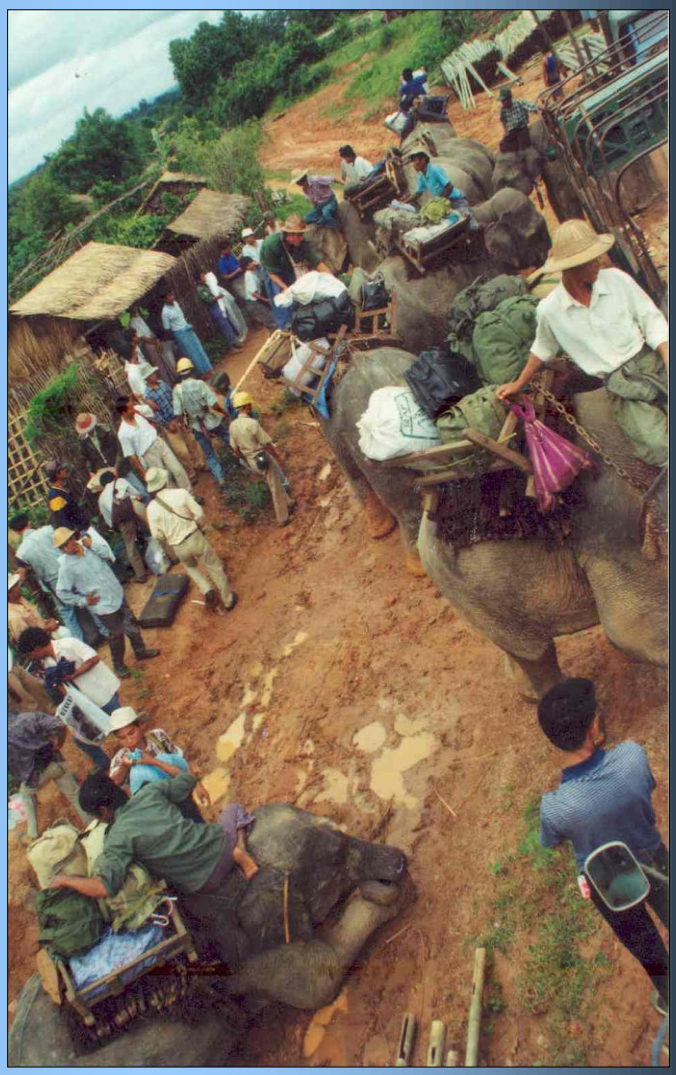
* Body measurements; except ear width and length, all are in meters

** The weight measured are in viss units (one viss = 1.63 kg)

*** Feeding –Elephants are released into the forest for free ranging, rice given in the morning working hours and salt and tamarind given in the evening

**** The Currency is in kyats (300 kyats=1US $)





Myanmar still has a large area under forest cover, and is rich in biodiversity however; there are hardly any studies or even simple surveys of species distribution for most wildlife species. The Ministry of Forestry of the Government of Myanmar initiated a project on Asian Elephant and other large mammals in Bago and Rakhine Yoma, with the assistance of the IUCN Asian Elephant Specialist Group (AsESG). This project is supported by Rotterdam Zoo, The Netherlands and the MacArthur Foundation, USA, and was executed by the Asian Elephant Conservation Centre (AECC) at the Indian Institute of Science. After these two surveys, with the technical support from the Asian Elephant Research Conservation Centre (formerly known as AECC), the UK based Scientific Exploration Society carried out Myanmar Wildlife Expedition in Alaungdaw Kathapa National Park (AKNP). Including the Asian Elephants, this document provides some base line information of various aspects of fauna and flora of the country.