# Biosphere Expeditions

**Experience conservation in action**

# Expedition report

---

## Surveying elephants and helping to solve human-elephant conflict in and around Wasgamuwa National Park, Sri Lanka.


**Expedition dates:** 4 to 30 September 2005

**Report published:** April 2006


**Authors:** Prithiviraj Fernando
Centre for Conservation and Research

Jennifer Pastorini
Centre for Conservation and Research & consultants for Sri Lanka Wildlife Conservation Society

Matthias Hammer (editor)
Biosphere Expeditions


£10 / €15 where sold

# Abstract


The Asian elephant is an endangered species and the main challenge confronting its conservation is conflict with humans. The north-central part of Sri Lanka, where Wasgamuwa is situated, is an important area for elephant conservation. Due to the opening up of extensive tracts of land for irrigated agriculture over the past few decades, as over most of Sri Lanka, human-elephant conflict has become a threat to the survival of elephants in this region. While the toll on elephants makes it an important conservation issue, the impact on humans makes it an important socio-economic and political issue. One of the main constraints in developing and implementing a successful conservation and management plan, in Sri Lanka as well as the rest of Asia, has been the lack of baseline data on elephant ecology, behaviour and human-elephant conflict. Management activities without consideration of elephant biology have failed effectively to address the human-elephant conflict and may in fact be detrimental to the survival of elephants.

The 2005 Biosphere expedition to Sri Lanka was conducted in collaboration with the Sri Lanka Wildlife Conservation Society. The main aim of the expedition was to help conduct and initiate research activities that would help conserve the wild elephant in Sri Lanka as well as mitigate the human-elephant conflict. With this intent, a number of research activities were undertaken by team members during the period of 4 – 30 September 2005. The activities ranged from making direct observations on elephants to obtaining information through examination of elephant sign, assessment of elephant management activities and survey of human- elephant conflict in the area.

The different activities conducted during the expedition provided conclusive proof that a considerable number of elephants, both lone adult males and (mixed) herds, ranged outside the protected area. It also suggested that elephant densities may in fact be higher outside the protected area than within. The data also demonstrated that none of the electric fences functioned properly. In addition and paradoxically, there is evidence that proper maintenance and enforcement of the fence would in fact be detrimental to elephant conservation.

In conclusion, this project run by Biosphere Expedition and the Sri Lanka Wildlife Conservation Society was a success yielding some excellent data as a basis for continued research that will provide baseline data on elephants to further their conservation in Sri Lanka as well as in the rest of Asia.

# Contents

# 1. Expedition Review

M. Hammer (editor)
Biosphere Expeditions

## 1.1. Background

Biosphere Expeditions runs wildlife conservation research expeditions to all corners of the Earth. Our projects are not tours, photographic safaris or excursions, but genuine research expeditions placing ordinary people with no research experience alongside scientists who are at the forefront of conservation work. Our expeditions are open to all and there are no special skills (biological or otherwise) required for participation. Our expedition team members are people from all walks of life, of all ages, looking for an adventure with a conscience and a sense of purpose. More information about Biosphere Expeditions and its research expeditions can be found at www.biosphere-expeditions.org.

This report deals with an expedition to Sri Lanka that ran from 4 to 30 September 2005. It surveyed the forests, jungles, grass plains and water holes around and within the Wasgamuwa National Park for elephants and helped to build a database of individual movements and associations. It interviewed villagers outside the Park about elephant crop raiding behaviour, and assessed and recorded any damage done. Expedition team members also spent some time in tree hides, attempting to observe and record elephant herds at water holes.

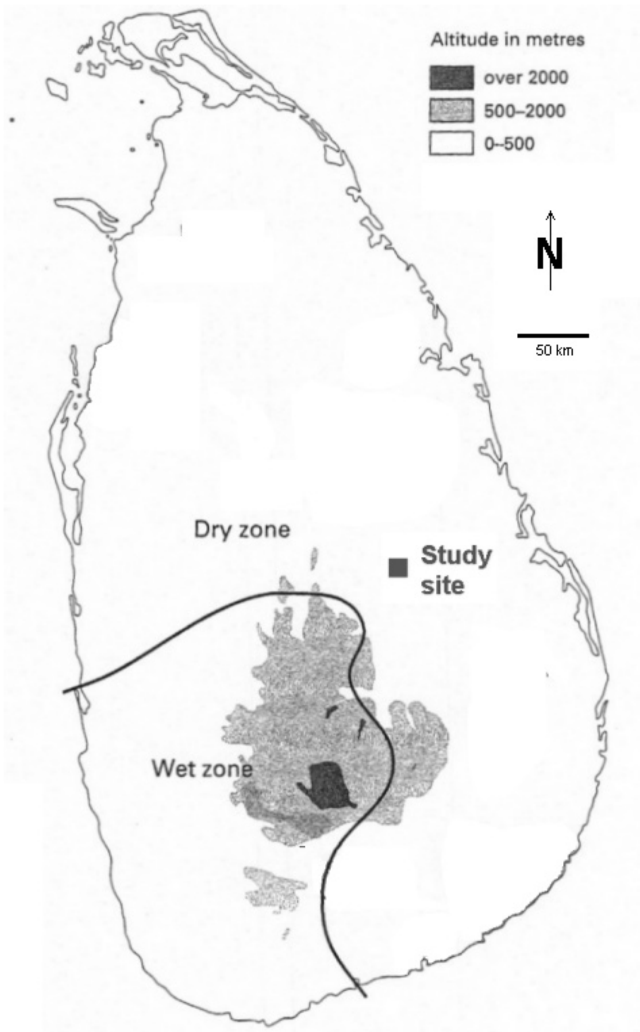
Human activities in Sri Lanka are a serious threat to the endangered elephant subspecies. In recent years, an average of 100-150 elephants and 60 people have died annually in Sri Lanka due to intense human-elephant conflict, and many more elephant deaths go unrecorded in the jungle. Almost all of these animals are shot, poisoned or wounded by farmers in defence of or in retaliation for damaged crops, property and life. The human-elephant conflict has become a major socio-economic and political issue in areas shared by humans and elephants. If efforts are not made to resolve these issues soon, there undoubtedly will be a drastic drop in the Sri Lankan elephant population, probably leading to the eventual extinction of several important regional populations. Furthermore, these losses would be a major obstacle to developing and implementing a long-term strategy to conserve and manage Sri Lanka's elephants in the wild. Research is thus urgently required to establish the diversity and abundance of wildlife ? in particular, estimates of elephant densities, their habitat use and their impact on humans with whom they share this habitat. This information is critical to determine the conservation measures that need to be implemented for the long-term survival of wildlife as well as local livelihoods.

The expedition study area is considered to have one of the largest populations of elephants in Sri Lanka, numbering over 800 individuals, but very little is known about their ecology or their conservation status. The aim of the expedition was to ascertain elephant numbers and ecology in the region and contribute to much needed human-elephant conflict resolution.

## 1.2. Research Area

Sri Lanka, an island off the southern tip of the Indian subcontinent the size of Ireland, has a tropical climate and supports one of the highest densities of Asian elephant in the world. The island has also been identified as one of the planet's eighteen biodiversity hotspots (a recent survey conducted in the wet zone rain forest discovered 140 species of frogs unknown to science).

There is great variation in habitat types within the country. The island has two distinct climatic zones: the dry zone and the wet zone, with a central mountain massif with several peaks towering above 2,600 metres. There are two seasons of monsoonal rains that provide precipitation to different parts of the country. These geographic and climatologic characteristics contribute to a unique diversity of climates and habitats within the confines of a very small area. The island has habitats that range from coral reefs and vast golden beaches and coastal sand dunes, to savannah, scrub jungle, dry evergreen forests, wetlands, mangrove forests, lowland rainforests, montane and cloud forests and grasslands.




Map of Sri Lanka showing mountains, dry and wet zones, and study site.

Sri Lanka has about 19 million people ? a population size comparable to that of Australia living in a country the size of Ireland. Nearly 93 percent of the population is literate and 78 percent of the population is rural. About a third of the land area is under permanent cultivation, and marginal lands are increasingly brought into agricultural production. Natural forest cover is less than 22 percent (down from about 90 percent in the $19^{th}$ century), and deforestation continues at an annual rate of 1.1 percent, mainly because of a high demand for fuel wood, timber, farmland, infrastructure projects and agricultural land-clearance schemes.

However, the outlook is not entirely bleak. The significant conservation achievements of Sri Lanka derive partly from the religious reverence for all life that majority Buddhist and minority Hindu communities show in their day-to-day lives, and today nearly 13 percent of the land is protected. The elephant, due to historical and religious reasons and the awe and wonder in which many in the country hold the animal, has a special place in Sri Lankan conservation history. The country has a vibrant tradition of conservation NGOs as well as voluntary and civil action.

The research area is located about 200 km from the capital Colombo. The Wasgamuwa region, where the expedition was based, is located in the dry zone Central Province of Sri Lanka. The most prominent landmark is the Wasgamuwa National Park and the adjoining Himbiliyakade Forest Reserve. The research area is very rich in wildlife, but does not have full protection yet. Vital research therefore needs to be carried out and the results presented to national conservation agencies in an effort to protect this tract of forest and jungle. By doing this the expedition's research helped to promote the establishment of the first trans-climatic zone National Park in Sri Lanka.

### 1.3. Dates

The expedition ran over a period of four weeks and was divided into two two-week slots, each composed of a team of international research assistants, guides, support personnel, local scientists and an expedition leader. Slot dates were 4 - 16 September | 18 - 30 September.

### 1.4. Local Conditions & Support

The total research area lay within the confines of the Central and North Central Province forests of Sri Lanka, and base camp was within the dry zone. The climate ranges from a low of $14^{o}$C in the wet zone mountains to a high of $34^{o}$C in the dry zone jungles, where the average temperature is in the region of $25^{o}$C - $32^{o}$C. The weather during the expedition was unusually hot and dry with the odd shower and humid day. These conditions made the work significantly more demanding for those not accustomed to the climate.

Expedition base

The expedition was based in the Matale district on the edge of the village of Pussellayaya, close to the Himbiliyakade Forest Reserve. It consisted of a tent camp with a central house with a kitchen and a small library. There was a permanent shower and toilet block and an outside dining area under canvas cover. Team members stayed in single or double tents around the central house.

There were some modern amenities such as showers, porcelain toilets and a finite amount of solar-generated electricity. A generator was available for emergency power supply. All meals were prepared for the team and vegetarians could be catered for.

Field communications

Where possible, two-way radios were used for communication between research teams. The expedition also had a GSM phone for emergency calls (although this was unreliable) and staff carried mobile phones. There was also a satellite phone for e-mail and the expedition leader sent an expedition diary via satellite to the Biosphere Expeditions HQ every few days. This diary was distributed to all expedition team members and also appeared on the Biosphere Expeditions website for friends and family to access.

Transport & vehicles

All expedition team members made their own way to the assembly point near the capital Colombo in time. From there onwards and back to the assembly point all transport, vehicles and bicycles were provided for the expedition team by the Sri Lanka Wildlife Conservation Society. Maintenance and reliability of vehicles and bicycles on the expedition was an issue and several vehicle breakdowns and a bike accident occurred.

Medical support & insurance

The expedition leader was a trained first aider, and the expedition carried a comprehensive medical kit. Further medical support was available through a doctor and a small medical clinic about 15 minutes from base camp. For any serious injury the closest large hospital was in Kandy, about two and a half hours by car from base camp. Additionally, there are smaller regional hospitals at Mahiyangana and Matale, which are about one hour and two hours away by car respectively. All team members were required to carry adequate travel insurance covering emergency medical evacuation and repatriation.

There were some medical incidences during the expedition. There was a fall from a bicycle resulting in hand and face lacerations. These were treated by expedition staff initially, then by a local doctor and finally minor surgery was required once the expedition team member had returned home. There was also a collapse due to heat exhaustion, resulting in minor lacerations. These were treated in the local hospital.

## 1.5. Local Scientists

Dr. Prithiviraj Fernando, a native Sri Lankan, is a research scientist at the Center for Environmental Research and Conservation at the Columbia University in New York. His PhD thesis at the University of Oregon was titled 'Genetics, Ecology and Conservation of the Asian Elephant' and included a phylogeographic study of the Asian elephant and a study of the social structure based on observational data, radiotelemetry and genetics. The genetics component was based on the amplification and sequencing of mitochondrial DNA from dung and was one of the first studies to apply this technique to a large field sample. He has recently returned to Sri Lanka and is now engaged in working on conservation of elephants and other species. His main interests are in the development and application of molecular tools to the management and conservation of large mammals and in developing an elephant conservation strategy in Sri Lanka integrating field research, community based problem solving and training for local conservation scientists.

Dr. Jennifer Pastorini studied biology at the University of Zürich (Switzerland) focusing on anthropology and zoology. After finishing her PhD in Zürich, she went on to two postdocs in the USA (Texas State University and Columbia University in New York) and a third postdoc at the University of Cambridge (England). Jenny's primary research interests are phylogenetics and evolution, where she is using molecular methods (DNA sequences) to develop phylogenies. She has mainly worked on the lemurs of Madagascar and has also done genetic research on other primates, carnivores, snakes, frogs and toads. More recently, she has become involved with the conservation of elephants in Sri Lanka through Dr. Prithiviraj Fernando.

## 1.6. Expedition Leader

This expedition was led by Marian Sutton. Marian is a graduate of the University of Leeds with an MSc which included ecological research on the savannah at Laikipia District in Kenya. She is particularly interested in ecology and environmental change. Marian holds a Mountain Leader Award and when not with Biosphere Expeditions freelances as a guide for walking holiday and trekking companies as well as working on biological surveys in the UK. Independent travel has been part of her life since she was old enough to have her own passport, including trips to North Africa, Latin America, India and Nepal. Her other interests include horse riding, sailing, bushcraft and visiting museums and galleries.

## 1.7. Partner Organisation in Sri Lanka

The Sri Lanka Wildlife Conservation Society (SLWCS) is the first organization to be established outside Sri Lanka for the sole purpose of helping to conserve and preserve the dwindling biodiversity of Sri Lanka. SLWCS is a fully incorporated non-profit, tax-exempt organization based in the USA a fully registered voluntary social service non-governmental organization with the Ministry of Social Welfare in Sri Lanka. For the past nine years the SLWCS, through its Saving Elephants by Helping People (SEHP) project, has been addressing issues dealing with human-elephant conflicts (HEC). The SLWCS is best known for its pioneering effort to fence elephants "out" rather than "in" in national parks. SLWCS's efforts are an incremental learning process and the Society is constantly monitoring, re-assessing and modifying its conservation and research goals to meet these challenges by applying an adaptive management approach. Currently, the SEHP project integrates ecological research, applied conservation, community participation, community development and sustainable economic development. The education and sustainable economic development of rural communities is imperative, especially if both elephants and humans are to share space over the long-term. The overall vision of SLWCS is to develop a new model for sustainable conservation with the following goals: 1) the protection of biodiversity in priority areas, 2) the promotion of sustainable use of biodiversity, and 3) the strengthening of rural institutions and promoting cooperative governance and community involvement in conservation. More information is available on the Society's website at www.slwcs.org.

## 1.8. Expedition Team

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of all ages, nationalities and backgrounds. They were:

4 – 16 September 2005

Karin Borchert (Germany), Neil Bowman (UK), Mary Cover (UK), Sam Elson (UK), Carole Mahoney (UK), Rosemary Milne (UK), Chelane & Juanetta Paizes (South Africa), Martyn Roberts (UK), Andrew Sansom (New Zealand), Rachael Varney (UK), Barbara von Linde-Suden (Germany).

18 – 30 September 2005

Neil Bowman (UK), Herbert Connor (USA), Sandra Feldhaus (Germany), Marlene Goldmann (USA), Wun Thye (Gerry) Ho (Republic of Singapore), Damien Holliday (UK), Carole Mahoney (UK), Elke Raubenheimer (Germany).

Staff (throughout the above period):

Field Scouts: Harsha Gammanpila (leader), Upul, Thushara, Ratnayake, Jayatilleka, Dushantha, Veroni, Sandamali, Anuradha.

Ecoteam ran the tented camp and catering, led by Jayasakara. Roy was head cook and also in charge of extensive and skilled shopping. Janika and Prabat assisted around the camp and kitchen whilst Somatilaka was recruited by Ecoteam to run the evening lighting system of torches and lamps

Drivers: Lionel, Sampath and Darshan.

### 1.9. Expedition Budget

Each team member paid towards expedition costs a contribution of £1150 per person per two week slot. The contribution covered accommodation and meals, supervision and induction, a permit to access and work in the area, all maps and special non-personal equipment, all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses like telephone bills, souvenirs, etc., nor visa and other travel expenses to and from the assembly point (e.g., international flights). Details on how this contribution was spent are given below.

| **Income** | £ |
|---|---|
| Expedition contributions | 30,142 |
| | |
| **Expenditure** | |
| Base camp and food<br>includes all meals, base camp equipment & set up, gas, wood | 1,111 |
| Transport<br>includes fuel, vehicle hire & maintenance | 864 |
| Equipment and hardware<br>includes research materials & gear etc., purchased in UK & Sri Lanka | 2,634 |
| Biosphere Expeditions staff<br>includes salaries, travel and expenses to Sri Lanka | 2,989 |
| Local staff<br>includes salaries, travel and expenses, gifts | 2,539 |
| Scientific services, logistics & accommodation<br>Payment to SLWCS, Wasgamuwa National Park, etc. | 3,722 |
| Team recruitment Sri Lanka<br>as estimated % of PR costs for Biosphere Expeditions | 6,400 |
| | |
| **Income – Expenditure** | 9,883 |
| | |
| **Total percentage spent directly on project** | 67% |

### 1.10. Acknowledgements

This study was conducted by Biosphere Expeditions, which runs wildlife conservation expeditions all over the globe. Without our expedition team members (listed above) who provided expedition contributions and gave up their spare time to work as research assistants, none of this research would have been possible. The Sri Lanka Wildlife Conservation Society, especially Chandeep Corea, Ravi Corea and Harsha Gammanpila, their support team and staff (also mentioned above) were central to making it all work on the ground. Thanks to all of you and the ones we have not managed to mention by name (you know who you are), for making it all come true. Biosphere Expeditions would also like to thank Land Rover, Cotswold Outdoor, Globetrotter Ausrüstung and Gerald Arnhold for their sponsorship and/or in-kind support.

### 1.11. Further Information & Enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular, including pictures, diary excerpts and a copy of this report, can be found on the Biosphere Expeditions website www.biosphere-expeditions.org.

Copies of this and other expedition reports can be accessed via at www.biosphere-expeditions.org/reports.

Enquires should be addressed to Biosphere Expeditions HQ in the UK at the address given on the website.

# 2. Elephant Survey

Prithiviraj Fernando and Jennifer Pastorini
Centre for Conservation and Research

## 2.1. Introduction

The range of the Asian elephant (*Elephas maximus*) has decreased to approximately 15% of its historical extent (Olivier 1978, Sukumar 1989). Elephants used to be distributed from the Euphrates-Tigris rivers in present day Iraq to the Yangtze-Kiang in China (Olivier 1978). The species is now restricted to fragmented habitats in 13 south and south-east Asian states and listed as an endangered species by the IUCN (IUCN 2002). While the underlying cause of this decline is habitat loss from conversion of natural landscapes to human-dominated landscapes that exclude elephants, in different parts of their range the proximal threats have varied from capture for domestication and hunting for ivory, to conflict with people. Ecologically, elephants are an 'edge species' preferring the ecotone between forest and disturbed habitat, which makes conflict inevitable (Fernando et al. 2005, Fernando 2006). Consequently, anthropogenic activity has had a major influence on the distribution and abundance of elephants in Sri Lanka as well as over the rest of their range.

One of the main constraints in attempting to conserve elephants in Sri Lanka is the lack of baseline data on wild animals. Although the people of Sri Lanka have had a long and close association with elephants dating back several millennia, this relationship has been with captive elephants. Most scientific knowledge on elephants is based on studies of African savannah elephants, and it has been assumed that Asian elephants have very similar behaviour and ecological requirements. However, the habitat of African savannah elephants and Asian elephants is fundamentally different. Whereas African savannah elephants live in open grasslands and have been subject to little human activity, Asian elephants are forest animals and have over thousands of years adapted to anthropogenic changes in the Asian landscape (Fernando 2000). Consequently, the ecology and behaviour of Asian elephants is very different to African savannah elephants. Our work has shown that ideas about elephant ecology , for example, that elephants undertake long distance seasonal migrations, live in highly complex multi-tiered social systems and that grass is the main component of their diet, all originating from studies of African elephants, are not applicable to Asian elephants in Sri Lanka (Fernando and Lande 2000, Gunawardene et al. 2004, Weerakoon et al. 2004).

The lack of information on Asian elephants imposes severe constraints on developing management and conservation plans for them. Consequently, in Sri Lanka as well as across the elephant's range, the main strategy for their conservation has been to attempt and limit elephants to protected areas through translocation and erection of electric fences. However, such practices conducted without consideration of elephant biology and ecology and without monitoring may actually be detrimental to elephant conservation (Fernando 1997).

One of the main reasons so little is known about Asian elephants scientifically is that they are very difficult to study owing to the habitats they occupy and behavioural adaptations they have made in reaction to constant conflict with people. Therefore, to study them we have to use indirect methods such as radio tracking, dung analysis and genetic analysis. Logistic difficulties in working with wild Asian elephants necessitates such studies to be conducted over the long term, i.e., over time periods of decades, to gain a full understanding of the ecology and behaviour of elephants and to assess how management actions impact them. Such studies require stable long-term funding, which unfortunately is not available from most conservation funding agencies.

The project initiated by the Sri Lanka Wildlife Conservation Society (SLWCS) and Biosphere Expeditions in Wasgamuwa attempts to break new ground and provide funding for research through 'volunteer' programmes. If successful, such programmes can sustain research over a long term and provide a stable funding base, which will encourage the undertaking of long-term studies that can provide critical data necessary for conservation of the Asian elephant.

This project initiated a number of research activities to collect data on the distribution, ecology, behaviour and social organization of elephants and the patterns and intensity of human-elephant-conflict (HEC).

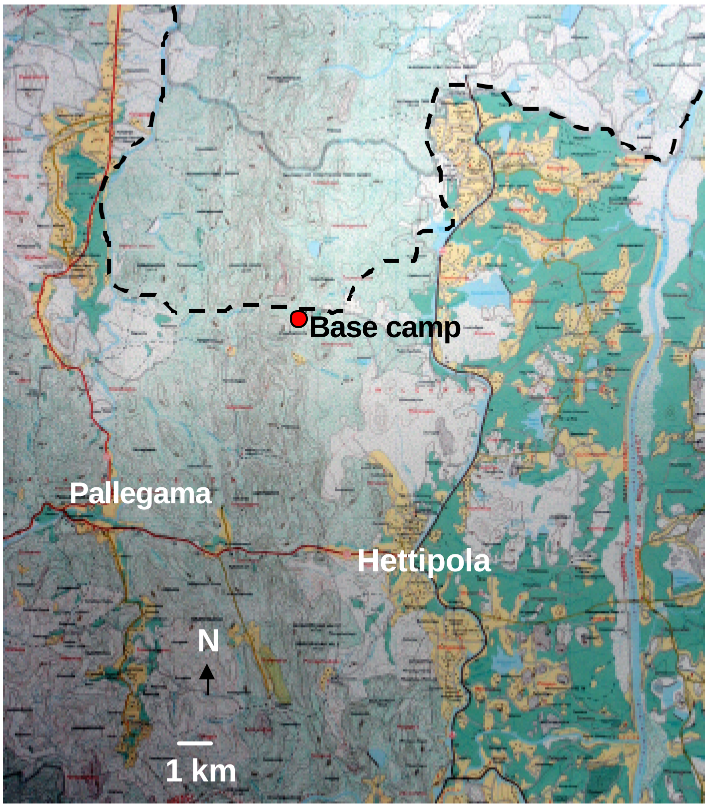



**Fig. 2.1a.** Map of study area
Black dashed line indicates border of Wasgamuwa National Park.

## 2.2. Elephant Identification

### 2.2.1. Introduction

The basis of studies on social organization is the identification of individuals. Once most of the elephants in an area can be individually recognized, their interactions can be studied. This enables the elucidation of different levels of social organization among both females and males, reproductive strategies, etc. Like humans, elephants are highly variable in their morphology, useful in identifying individuals. Elephants have a sexually dimorphic social structure with adult females and young forming groups with the males leaving such groups upon reaching adulthood (sexual maturity?) and thereafter leading solitary lives or forming transient groups. We catalogued both adult males and herd members.

### 2.2.2. Methods

The identification of individual elephants was based on photographic cataloguing. Digital pictures of elephants were taken and a data sheet completed for the identifying features The data collected will be the basis of a photographic catalogue, which will allow the identification of individual elephants again in the future. The elephants were named, with members of the same group given names starting with the same letter.

The following notes were taken for each elephant in the field:

- date
- time
- team
- location
- GPS reading
- sex (male, female or unknown)
- age (infant, juvenile, subadult or adult)
- numbers of animals in group
- numbers of pictures taken
- for each ear:
    - primary fold (inside, outside or absent)
    - secondary fold (inside, outside or absent)
    - numbers of holes
    - mark holes and tears in a diagram
- tail tuft:
    - absent, sparse of full
    - outside hair longer, inside hair longer or same length
- tail length (short, medium or long)
- eye colour (red or white)
- for each tusk if absent, tush or tusk
- mark other special characters in the diagram

Elephants were identified in the afternoons inside the Park (driving along roads) and around a tank outside the Park, in close proximity to the research camp.

Back in camp, pictures taken were sorted and the best ones chosen to print for the catalogue. Of special value were pictures showing the overall stature, the ears, the tail and other special features of the elephant.

## 2.2.3. Results

We were able to identify a total of 36 elephants. Outside the Park we identified three females from the same group ("M") and one single male. Inside the Park 32 elephants were identified, consisting of 19 females and 13 males. The females were assigned to three different groups ("S", "C" and "E"). Group size ranged from 16 to 48 elephants. Of the identified males, five were found alone and six males were part of a group. Table 2.2.3a gives a summary of the elephants identified.

**Table 2.2.3a.** Elephants identified during the study.

| Location | # Elephants | Sex | Adult | Subadult | Unknown |
|---|---|---|---|---|---|
| Inside Park | 32 | 19 females | 16 | 1 | 2* |
| | | 13 males | 9 | 4 | 0 |
| Outside Park | 4 | 3 females | 2 | 1 | 0 |
| | | 1 male | 1 | 0 | 0 |

* The size of the animal was not recorded

## 2.2.4. Discussion

The identification of elephants was very successful with a total of 36 individuals being identified during the expedition. The numbers of elephants identified in different age groups and sexes and whether in or outside of the Park does not correspond to their abundance, but improves the ease of identification. Elephants inside the Park are more habituated to people hence it is easier to get good observations of them, whereas it is more difficult to get good observations of those outside the Park. Similarly, males are in general easier to identify as they tend to have more distinct characteristics, are usually solitary or in small groups and can be approached more closely. In conclusion, we can say that the activity produced some excellent data to start the elephant ID catalogues, which will form the basis for future studies on elephant behaviour and social organization.

## 2.3. Tank Monitoring

### 2.3.1. Introduction

Sri Lanka does not have any natural lakes of significance. However, especially the dry zone of the country is dotted with hundreds of thousands of fresh water reservoirs termed 'tanks' that are rain-fed or are formed by damming streams and rivers. The primary purpose of these tanks is the supply of irrigation water for cultivation. Most of the tanks date back thousands of years and many have been recently renovated.

While little data are available on actual use of water resources by elephants, these animals are generally thought to be closely associated with water. Consequently, one of the main activities undertaken to increase carrying capacity of protected areas is to develop more water bodies. This activity was undertaken to document the use of perennial water resources by elephants as an indicator of the importance of such water bodies for elephant survival. In addition, investigation of elephant sign around tanks provides a way of monitoring the presence or absence of elephants in areas outside the protected areas.

### 2.3.2. Methods

Six different tanks outside the protected area, located around the base camp (Fig. 2.3.2a) were monitored for elephant sign. The monitoring was done by walking the perimeter of the tank (approximately 5 m from the edge of the water) and looking for elephant dung that was deposited around the tank.

The age of each dung pile was estimated based on colour, presence or absence of odour, surface moistness, presence of insects, mushrooms and germinating plants.

Dung piles were classified into the following categories:

- less than one day old
- 1 to 3 days old
- 4 to 10 days old
- more than 10 days old

We measured the circumference of up to three boli per dung pile using a measuring tape. The size of the dung boli gives an estimate of the size of the elephant (Table 2.3.2a). Each dung pile was assigned to an age/sex class based on the average circumference of the measured boli.

**Table 2.3.2a.** Assignment of age class according to dung size.

| Age Class | Circumference of dung boli |
|---|---|
| Infant | 01 – 20 cm |
| Juvenile | 21 – 35 cm |
| Subadult Male or Adult Female | 36 – 50 cm |
| Adult male | > 50 cm |

After measuring the boli, they were broken up and macroscopically examined for seeds and other identifiable fragments of food. Once recorded the entire dung pile was broken up and dispersed to prevent recounting on subsequent visits.

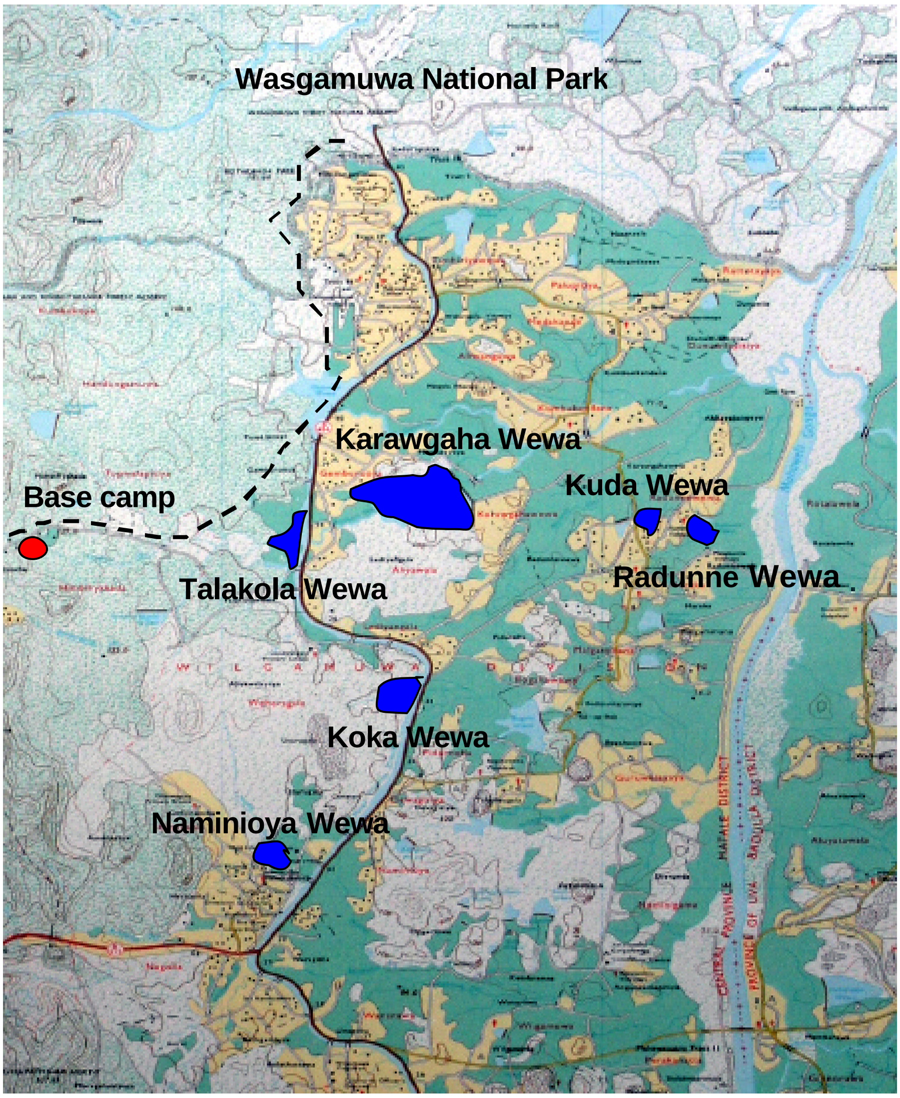



**Fig. 2.3.2a.** Map showing the six tanks monitored in this study

## 2.3.3. Results

Two tanks (Kuda Wewa and Radunne Wewa) had no dung piles on the first two days they were visited. Therefore, they were not subsequently monitored. The other four tanks were visited either three or four times in September 2005 during the expedition period.

Karawgaha Wewa had six and one dung piles during the first two visits. No dung was found on the third visit. The Koka Wewa had one to 20 dung piles during the four visits. On the fourth visit nine fresh dung piles from the night before were found. The Naminioya Wewa is obviously visited by elephants most often with a total of 164 dung piles. The Thalakola Wewa had two to nine dung piles during the four visits. Table 2.3.3a summarizes the number and age of dung piles found per visit at each tank.

**Table 2.3.3a.** Number and age of dung piles found each day at each tank.

| Tank | Date | Age <1 | [days] 1-3 | 4-10 | >10 | Total |
|---|---|---|---|---|---|---|
| Karawgaha Wewa | 5.9.05 | 0 | 0 | 3 | 3 | **6** |
| | 12.9.05 | 0 | 0 | 0 | 1 | **1** |
| | 21.9.05 | 0 | 0 | 0 | 0 | **0** |
| | Total | 0 | 0 | 3 | 4 | **7** |
| Koka Wewa | 6.9.05 | 0 | 0 | 0 | 9 | **9** |
| | 10.9.05 | 0 | 0 | 0 | 1 | **1** |
| | 20.9.05 | 0 | 2 | 18 | 0 | **20** |
| | 26.9.05 | 9 | 2 | 2 | 2 | **15** |
| | Total | 9 | 4 | 20 | 12 | **45** |
| Naminioya Wewa | 7.9.05 | 0 | 4 | 3 | 8 | **15** |
| | 14.9.05 | 0 | 6 | 34 | 0 | **40** |
| | 23.9.05 | 0 | 19 | 38 | 0 | **57** |
| | 27.9.05 | 8 | 13 | 31 | 0 | **52** |
| | Total | 8 | 42 | 106 | 8 | **164** |
| Thalakola Wewa | 8.9.05 | 0 | 0 | 0 | 9 | **9** |
| | 11.9.05 | 0 | 0 | 0 | 3 | **3** |
| | 22.9.05 | 1 | 0 | 1 | 0 | **2** |
| | 25.9.05 | 1 | 5 | 1 | 0 | **7** |
| | Total | 2 | 5 | 2 | 12 | **21** |
| Radunne Wewa | 9.9.05 | 0 | 0 | 0 | 0 | **0** |
| | 13.9.05 | 0 | 0 | 0 | 0 | **0** |
| | Total | 0 | 0 | 0 | 0 | **0** |
| Kuda Wewa | 9.9.05 | 0 | 0 | 0 | 0 | **0** |
| | 13.9.05 | 0 | 0 | 0 | 0 | **0** |
| | Total | 0 | 0 | 0 | 0 | **0** |
| **Total** | | **19** | **51** | **131** | **36** | **237** |

Circumferences of a total of 237 dung piles were measured. Most dung piles (73%) were of subadult male or adult female size. Of the 237 measured dung piles, 43 could be assigned to a juvenile and eight to an infant (Fig. 2.3.3a). Only five adult males seem to have visited the tanks.

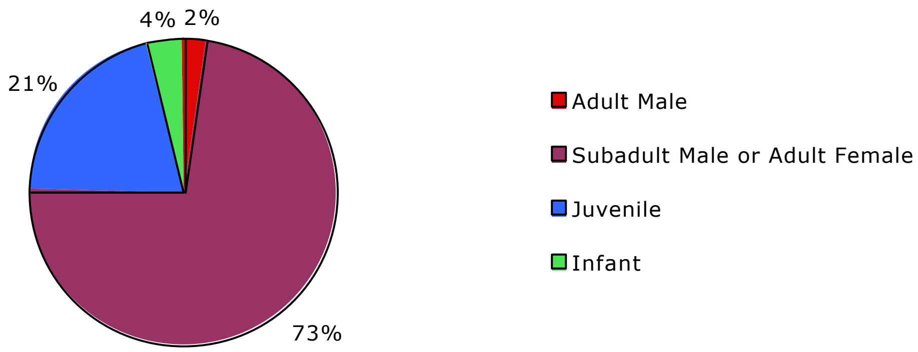



**Fig. 2.3.3a.** Age categories of elephants based on dung piles found around tanks.

The Naminioya Wewa had 42 dung piles from juveniles or infants. The Koka Wewa had eight and the Thalkola Wewa had one small dung pile (Fig. 2.3.3b). Adult males have used the Thalakola Wewa and the Naminioya Wewa.

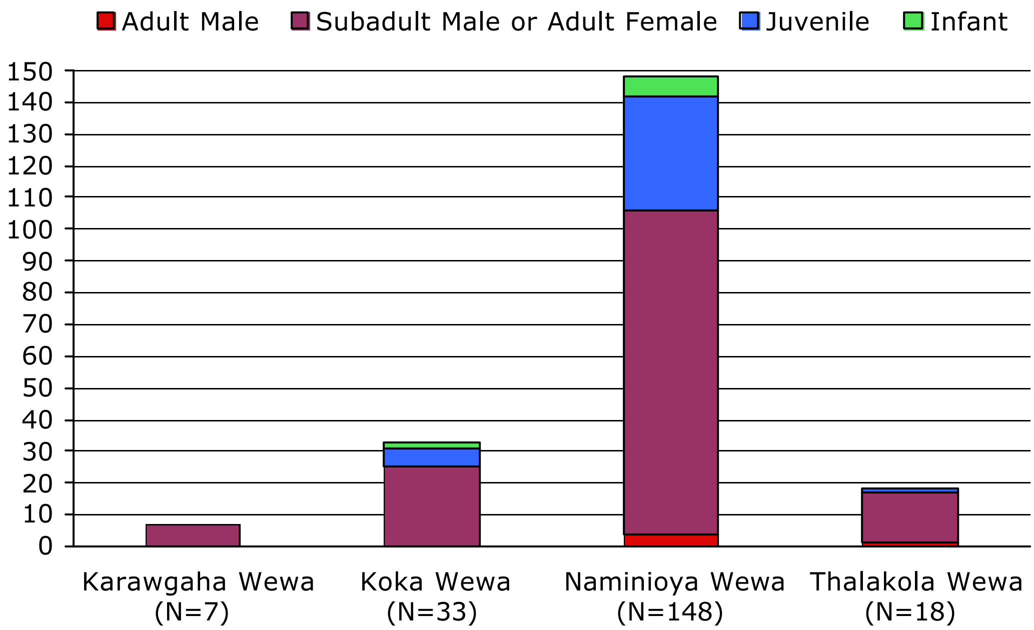



**Fig. 2.3.3b.** Age classes of elephants found around tanks. Age estimates based on dung circumference.

Table 2.3.3b shows the results of the macroscopic dung analysis for each tank. The most common seed found was maila (*Bauhinia racemosa*). A total of 86 of the 237 dung piles (36%) contained maila seeds. Paddy (rice) (*Oryza sativa*) was found in 18 dung piles. We also found garbage (e.g., plastic bags) in seven dung piles.

**Table 2.3.3b.** Identified seeds and fragments found in dung piles at four different tanks. The number of dung piles per tank is given below its name.

| | Karawgaha (N=7) | Koka (N=45) | Naminioya (N=164) | Thalakola (N=21) | Total (N=237) |
|---|---|---|---|---|---|
| Maila | 3 | 14 | 61 | 8 | 86 |
| Rice | 4 | 3 | 7 | 4 | 18 |
| Coconut | 0 | 1 | 5 | 0 | 6 |
| Pumpkin | 1 | 1 | 1 | 0 | 3 |
| Jackfruit | 0 | 0 | 3 | 0 | 3 |
| Corn | 0 | 0 | 3 | 0 | 3 |
| Melon | 1 | 1 | 0 | 0 | 2 |
| Eggplant | 0 | 2 | 0 | 0 | 2 |
| Cucumber | 0 | 0 | 1 | 1 | 2 |
| Manioc | 0 | 0 | 2 | 0 | 2 |
| Ladiesfinger | 0 | 1 | 0 | 0 | 1 |
| Banana | 0 | 1 | 0 | 0 | 1 |
| Pineapple | 0 | 1 | 0 | 0 | 1 |
| Garbage | 0 | 2 | 4 | 1 | 7 |
| Unknown seeds | 0 | 6 | 9 | 0 | 15 |

## 2.3.4. Discussion

The tank-monitoring data conclusively prove the existence of significant numbers of elephants ranging outside the protected area. The Namimi Oya tank, which had the highest number of elephant sign was the furthest from the Wasgamuwa Park, with an intervening area settled by people. The pattern of elephant sign observed suggests that most of the elephants visiting Namini Oya were not from the Park but were animals that were ranging outside the Park. Of special importance was the finding of dung piles classified as juvenile and infant. As elephants have a sexually dimorphic social structure with adult females and young associating in groups and adult males being solitary, the finding of dung from juvenile and infants conclusively proves the existence of herds in the area. While the dung piles reflected a lower number of adult males, it could be a sampling artefact and continued collection of data will enable a more definitive analysis to be made.

Elephants with paddy and seeds of other cultivated crops in their dung are likely to be crop raiders. Therefore, the data suggest that there was on-going crop raiding in the area. The finding of dung with garbage highlights a widely prevalent problem in Sri Lanka of open garbage dumps and elephants feeding at such sites regularly. Feeding of elephants at such garbage dumps can cause transmission of human and domestic animal diseases to elephants.

## 2.4. Road Transects

### 2.4.1. Introduction

The standard way of assessing elephant abundance is through line transects on foot. However, conducting line transects is very time-consuming and requires highly trained personnel. In addition, conducting line transects within protected areas was difficult due to logistical reasons. Therefore, we developed a variation of it based on travelling in a vehicle along roads at very slow speed and recording the dung on either side. While this method cannot be used to estimate elephant densities, due to the many inherent biases, it is suitable to provide information on elephant absence or presence and when repeated, assuming the biases to remain constant, could provide an indication of seasonal variation of elephant use of different areas or habitats.

### 2.4.2. Methods

Road transects were conducted by travelling in a vehicle at approximately 5 km/h or slower with a minimum of two observers in the back who looked for dung on either side of the road/trail. The driver and one observer in the front looked for dung on the trail. Road transects were conducted both inside and outside the Park. The start and end point for each transect was noted and exactly the same road was driven again after an interval of a few days. Hand-held Garmin e-trex GPS units were used to record locations.

When a dung pile was observed the vehicle was stopped and the distance travelled along the road was recorded using the GPS odometer function. The distance of each dung pile to the middle of the road was estimated to provide an indication of habitat visibility. If the distance was more then 10 m, a laser range finder was used to obtain a better estimate. The age of each dung pile (<1 day, 1-3 days, 3-10 days, >10 days) was estimated through observation from the vehicle. The habitat in which the dung pile was found was noted using the following habitat categories:

- grass
- grass & scrub
- scrub
- tall forest
- teak plantation
- paddy field
- village

Four different road transects were used outside the Park (Fig. 2.4.2a). Roads A and B were 3600 m and 5800 m respectively in length and each was driven eight times. Road C was 4200 m in length and monitored three times. Road D was 7200 m long but since we found no dung on the first visit, it was discontinued.

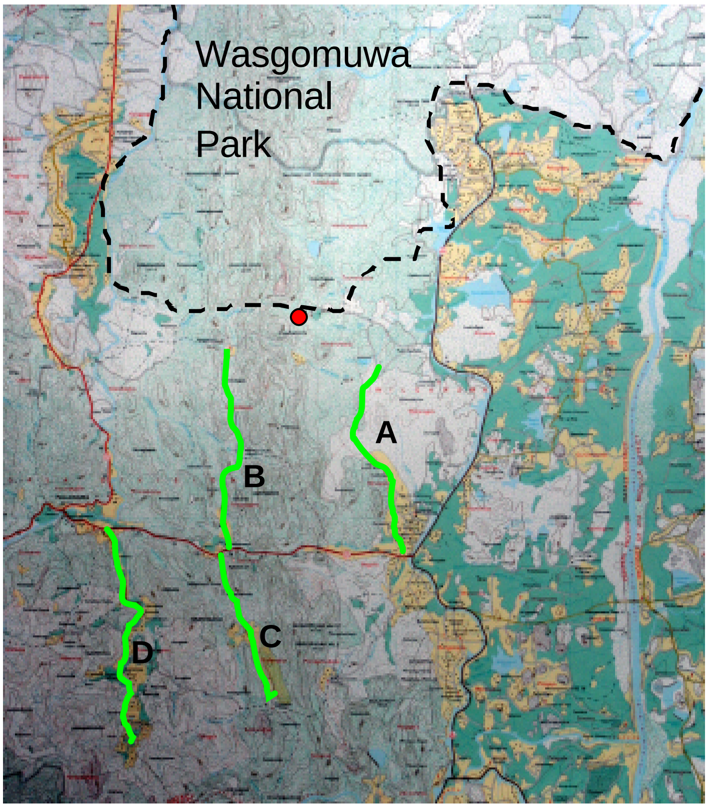



**Fig. 2.4.2a.** Map showing the four roads (A-D) used for the road transects.

We used several roads inside the Wasgamuwa National Park for road transects. One round of road transects took 3 – 4 days and covered up to 43 km of road. This round was done three times from 11 - 14, 19 - 23 and 26 - 28 September 2005.

2.4.3. Results

Road Transects Outside the Park

Road A provided 49 to 93 dung piles per transect. The average distance of dung piles from the road ranged from 6.7 to 9.0 m (Fig. 2.4.3a). The first part of the road (to 3000 m) led through scrub/grass mosaic and the end of the road through paddy/village habitat.

Along Road B 14 to 21 dung piles were found per transect. The average distance of the dung piles to the centre of the road was 2.7 to 5.0 m (Fig. 2.4.3b). Dung was concentrated in two areas: 1200 to 2200 m and 4500 m to the end of the road. The habitat along road B consisted of forest/scrub mosaic as well as village areas. The village areas consisted of permanent settlements and home gardens.

During the three road C transects, 43 to 48 dung piles were found at an average of 3.1 to 3.7 m from the road (Fig. 2.4.3c). Dung piles were only found on the first 1800 m of the road.

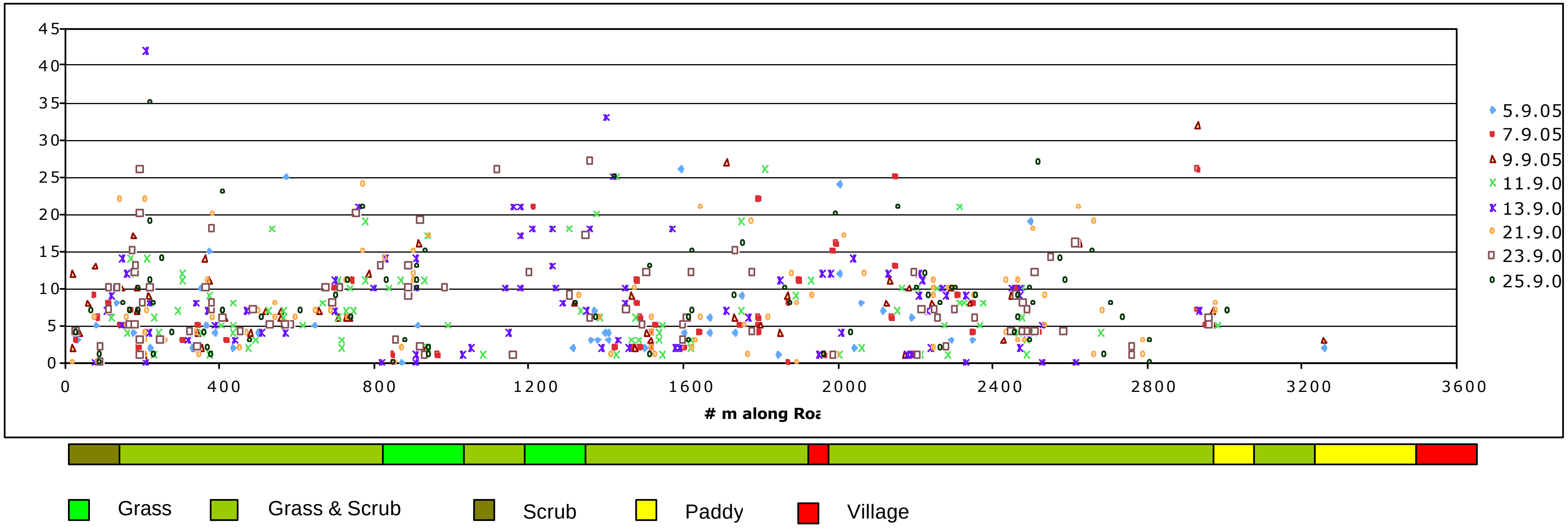



**Fig. 2.4.3a.** Distance and relative position of dung piles found during eight road transects along Road A.

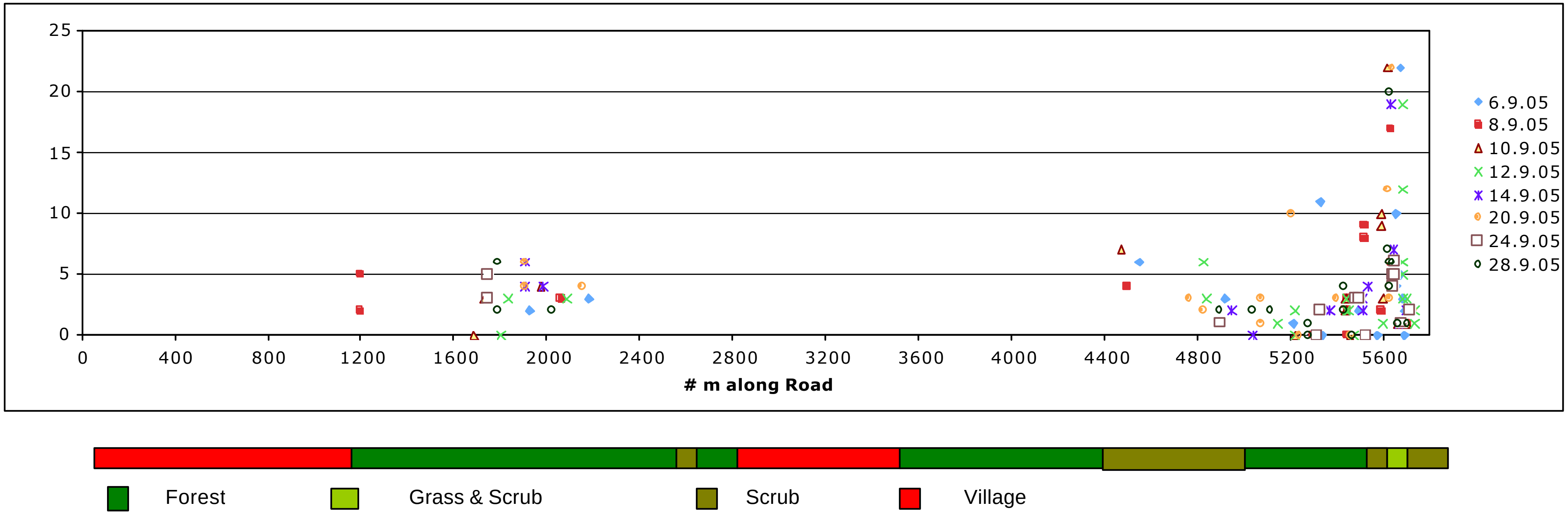



**Fig. 2.4.3b.** Distance and relative position of dung piles found during eight road transects along Road B.

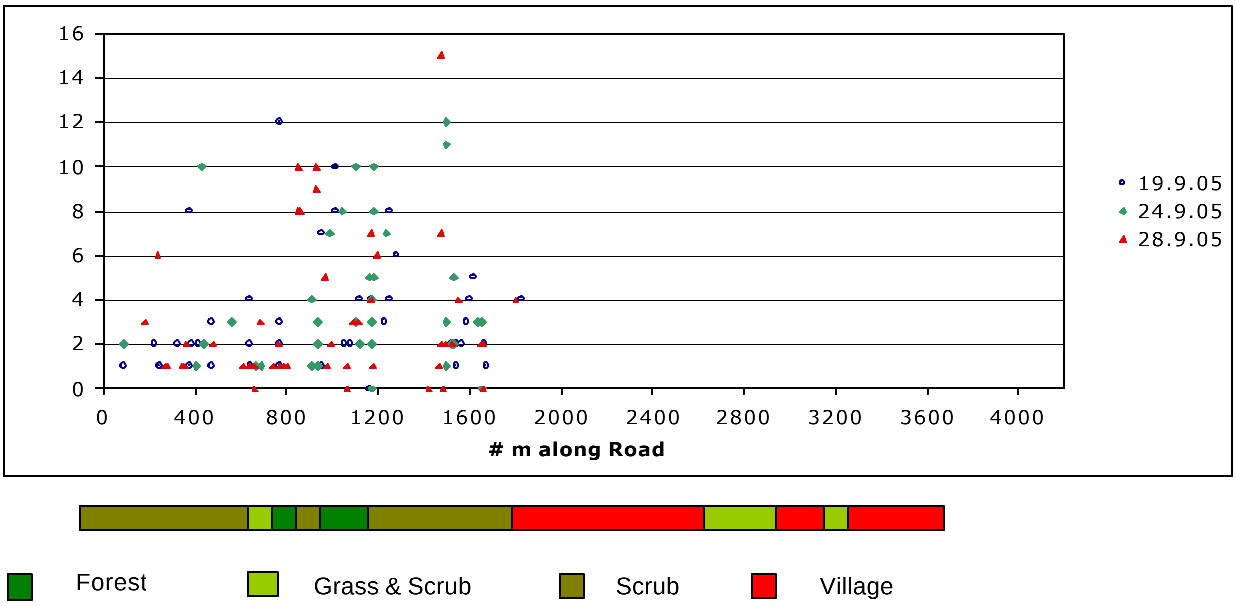



**Fig. 2.4.3c.** Distance and relative position of dung piles found during three road transects along Road C.

Fresh dung piles (up to three days old) were found on every road transect along Road A (Fig. 2.4.3d). On 11 Sep. the number of dung piles increased markedly.

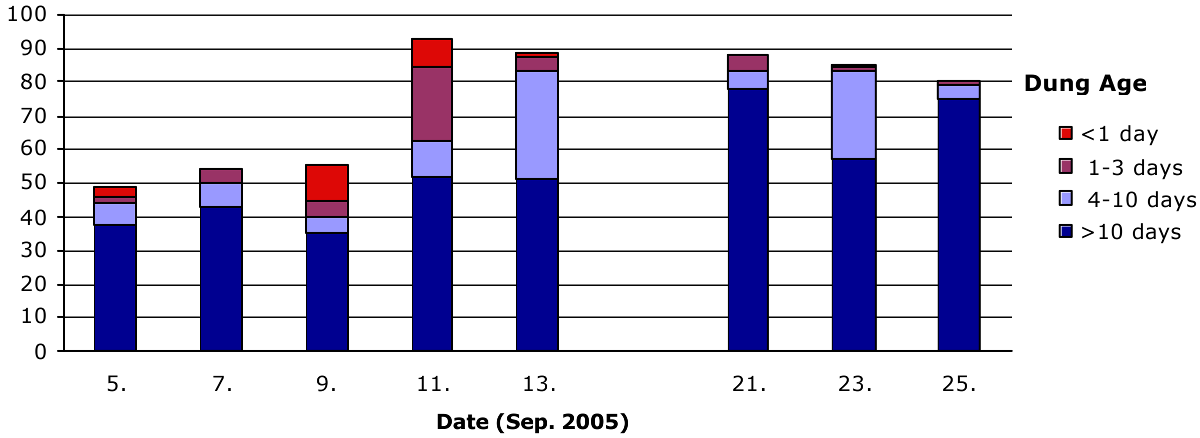



**Fig. 2.4.3d.** Age of dung piles found on eight transects along Road A.

Along Road B fresh dung piles were found during the first five road transects (Fig. 2.4.3e). The last three road transects provided no fresh dung piles.

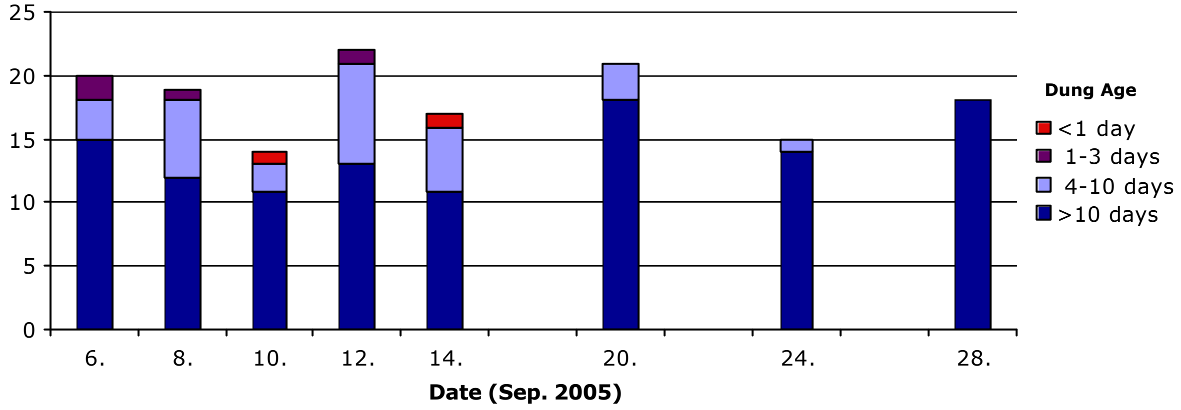



**Fig. 2.4.3e.** Age of dung piles found on eight transects along Road B.

Road C was monitored three times on a 4-5 days interval. Only more then 3 days old dung was found during these transects (Fig. 2.4.3f).

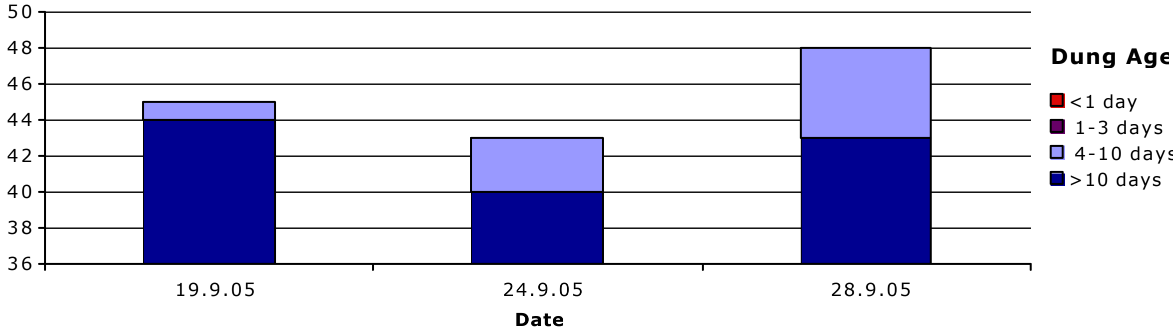



**Fig. 2.4.3f.** Age of dung piles found on 3 transects along Road C.

Figures 2.4.3g-i show the results for the recorded types of habitat for Roads A-C. Some variation was observed in defining the habitat types by the different survey groups and by the same groups on subsequent days. Almost all dung samples were found in forest, scrub, grassland or combinations thereof, with a very few in paddy land and none within villages.

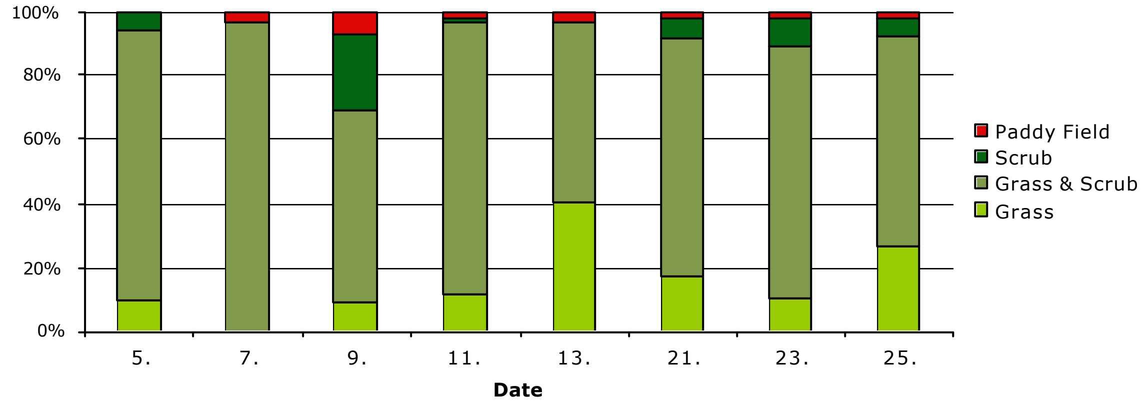



**Fig. 2.4.3g.** Habitat type in which dung piles were found on eight transects along Road A.

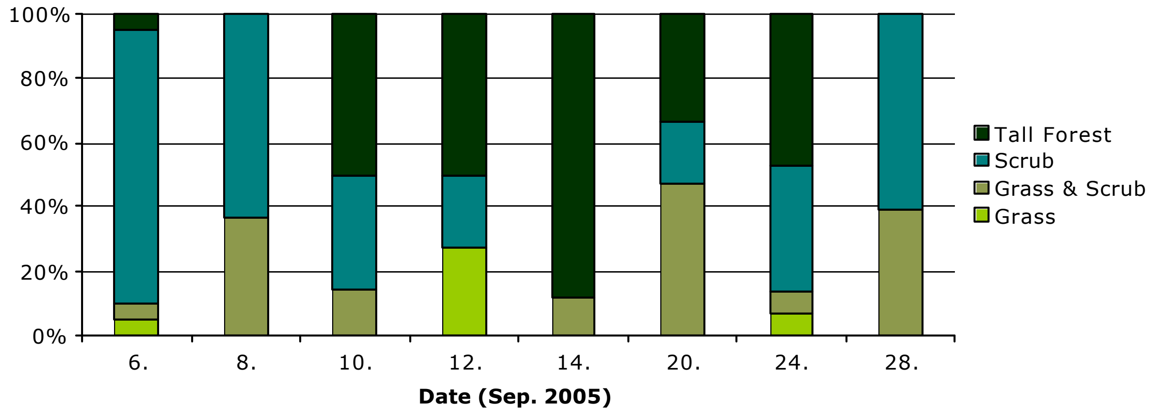



**Fig. 2.4.3h.** Habitat type in which dung piles were found on eight transects along Road B.

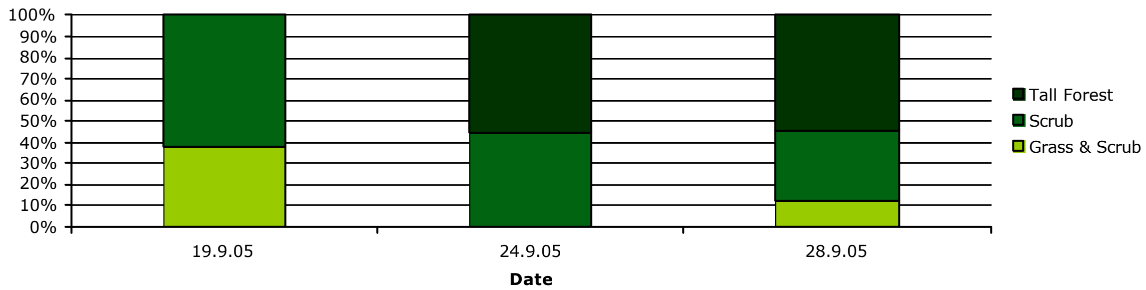



**Fig. 2.4.3i.** Habitat type in which dung piles were found on three transects along Road C.

Road Transects inside the Park

Overall 168 to 244 dung piles were found on each round of transects inside the Wasgamuwa National Park. Fresh dung piles were found during all three rounds of road transects (Fig. 2.4.3j). The drop in the number of dung piles (at least 50 dung piles fewer) on the second round is most likely explained by investigator error.

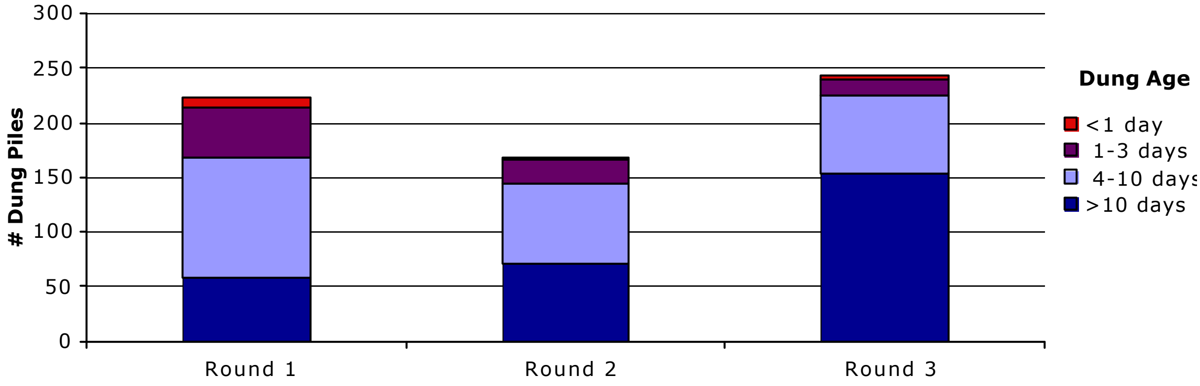



**Fig. 2.4.3j.** Age of dung piles found on three transects on different roads inside the Park.

The habitat types in which dung samples were observed is given in Fig. 2.4.3k. As seen outside the Park, there is some variation among the frequency of each habitat. Again, this is most likely to be explained by investigator error.

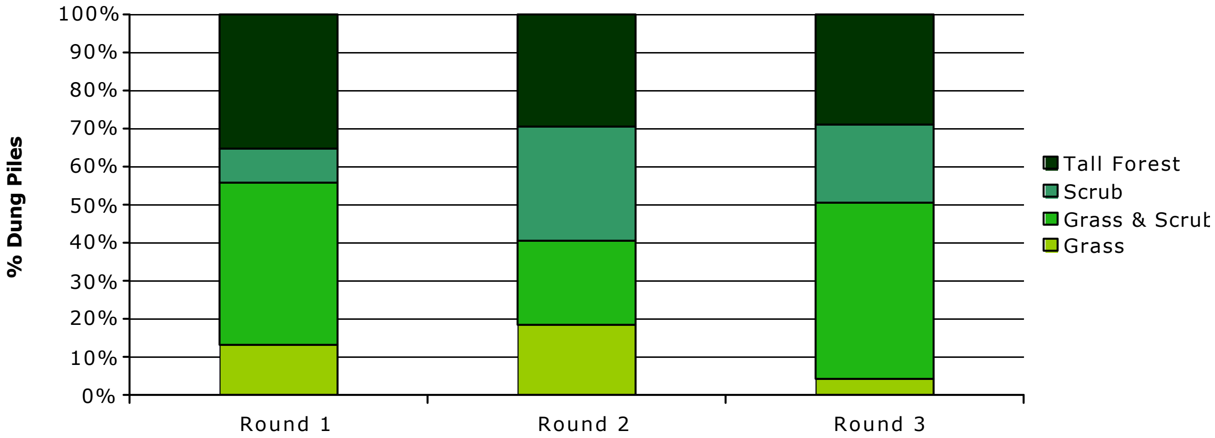



**Fig. 2.4.3k.** Habitat type in which dung piles were found on three transects inside the Park.

Comparison of road transects inside and outside the Park

For each road fragment, the average number of dung piles and the average length of the road through all transects were taken into account. We also included Road D with no dung piles into the data set. A total of 20.8 km of roads were covered outside the Park and 41.4 km inside the Park. Outside the Park we found 138 dung piles and inside the Park 212 dung piles. Hence, outside the Park there were 6.6 dung piles per 1 km of road and inside the Park there were 5.1 dung piles per 1 km of road (Table 2.4.3a).

**Table 2.4.3a.** Amount of road driven and number of dung piles found during all road transects.

| Area | Road | N | # Dung Piles | # m Road | # Dung/km |
|---|---|---|---|---|---|
| Outside | A | 8 | 74.13 | 3617.75 | |
| | B | 8 | 18.25 | 5805.00 | |
| | C | 3 | 45.33 | 4193.33 | |
| | D | 1 | 0 | 7200.00 | |
| | **Total** | **1-8** | **137.71** | **20'816.08** | **6.62** |
| Park | **Total** | **3** | **212.00** | **41'366.67** | **5.12** |

## 2.4.4. Discussion

On Road A, dung piles were found quite regularly over the first 3000 m, where the habitat was a mixture of scrub and grass. Beyond that only a few dung piles were found in the paddy/village habitat, suggesting that elephants mostly avoided the permanent cultivation and settlements. On Road B, dung piles were found in two distinct areas. The presence of permanent habitations appeared to be a more important determinant of elephant presence/absence than other habitat types. On Road C, there also appeared to be a strong correlation with human settlements and avoidance by elephants.

The dung accumulation results suggest that elephants were ranging across these areas. The sudden increase in dung observed on Road A suggests that a herd had passed through. While the difference in frequency of transects introduces some bias towards the older ages of dung, it was still sufficient to indicate more or less consistent use of the area by elephants throughout the survey period. Similarly, the transects within the Park suggest that elephants were ranging in the Park throughout the time that the transects were conducted. Consequently, it suggests that there were separate elephant groups ranging inside and outside the Park during the survey period.

The data also suggest that observer error needs to be taken into account as in the apparent 'drop' in the number of dung piles on 10 Sep. along Road B, suggesting that the group missed some dung piles. Therefore, training of observers and dedicated workers are important components of this technique.

Some variance was observed in defining habitat types attributable to investigator error. Definitions of habitat types such "scrub" or "grass & scrub" or "grass" appeared to be most at fault. There was not much variation for the paddy field category because it was clearly identifiable. Similarly, on transects inside the Park, some observer error in defining habitats was observed. Despite the variation in habitat definitions, there was no dung in human-dominated areas, clearly demonstrating avoidance of such areas by elephants.

The comparison of the dung found per km inside and outside the Park found a higher density of dung outside. As elephants clearly stayed away from 'human' areas, if there is any bias of elephant use of roads between the two areas, it could be expected that elephants would more likely use roads and roadside habitats within the protected area than outside. Therefore, the finding of higher dung densities outside the Park, even with a possible negative bias, suggests that there are significant numbers of elephants outside the protected area.

## 2.5. Trail Transects

### 2.5.1. Introduction

Similar to road transects, we also conducted 'trail transects' that consisted of walking a footpath and recording the number of dung piles observed. Trail transects were conducted only outside the Park and on the boundary of the Park. Trail transects allowed us to look at elephant presence/absence over a larger area.

### 2.5.2. Methods

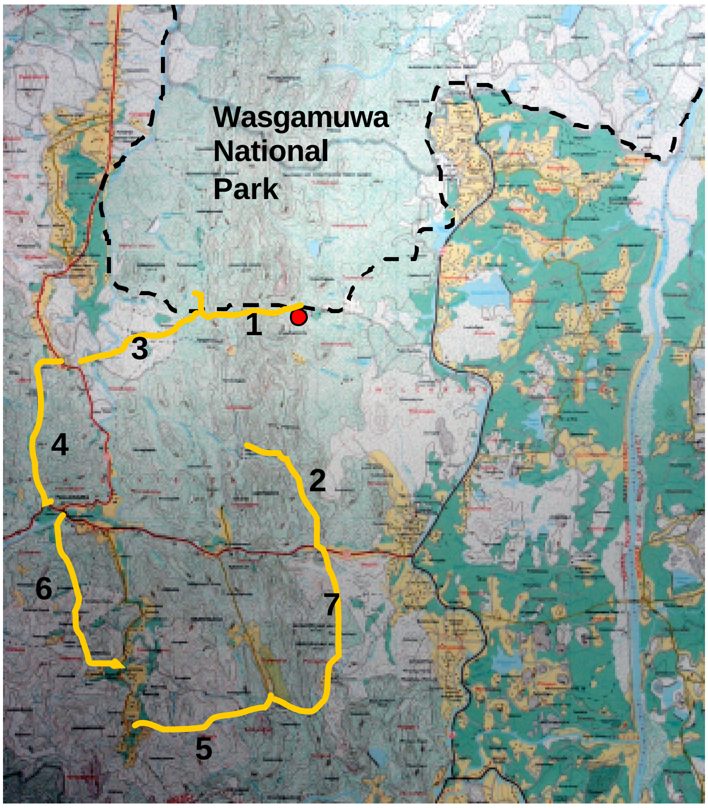



**Fig. 2.5.2a.** Map showing the seven trails used for the walked transects.

Seven trail transects were walked all over the Wasgamuwa area (Fig. 2.5.2a) to check for presence of elephants. Trail #1 was walked seven times and Trail #2 was walked four times. All other trails were walked only once.

The GPS position for each dung pile was recorded and the age of the dung was estimated (<1 day, 1-3 days, 3-10 days, >10 days). The boli were measured to estimate the size of the elephant (see 2.3.2. Methods of Tank Monitoring for details). Seeds and other traces of food in the dung were noted. On the two trails that were surveyed more than once, recorded dung piles were destroyed to ensure that they were not recorded again during the next trail transect.

2.5.3. Results

A total of 265 elephant dung piles were found on all trails (Fig. 2.5.3a). On three out of the six trails walked only once, fresh (fewer then 4 days old) dung piles were observed (N=12). Trails #1 and #2 were walked several times and provided a number of dung piles that could be recorded.

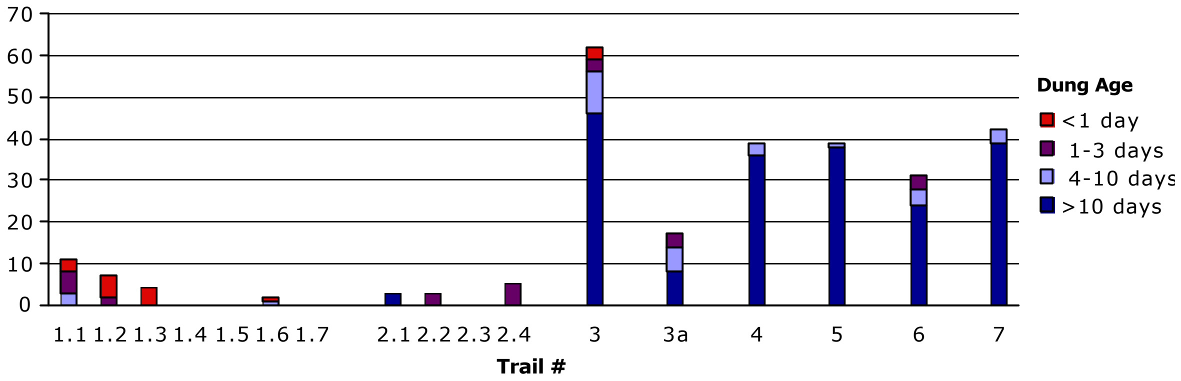



**Fig. 2.5.3a.** Number of dung piles and their estimated age found among the different trail transects. Transects 1 and 2 were walked more then once and the repeat number is indicated by the decimal digit (1.1, 1.2, etc.).

A total of 14 juvenile dung piles were found among four trails, proving the presence of herds outside the Park (Fig. 2.5.3b). Trail #6 had dung piles mostly from adult males.

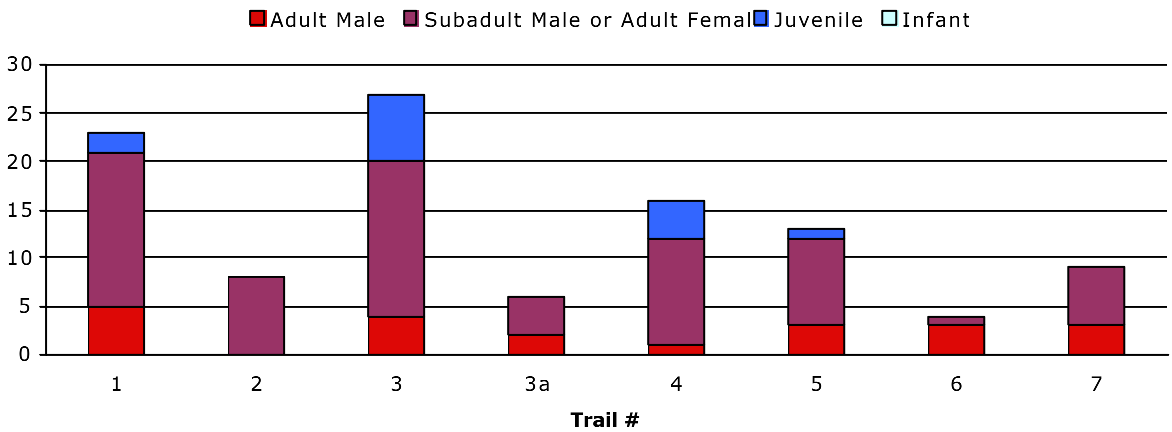



**Fig. 2.5.3b.** Age classes of elephants found among the trails. Age was estimated with dung circumference.

Of the 106 dung piles whose circumference could be measured, 20% were from adult males, 67% of the dung piles were either from adult females or subadult males and 13% of the dung piles originated from juveniles (Fig. 2.5.3c).

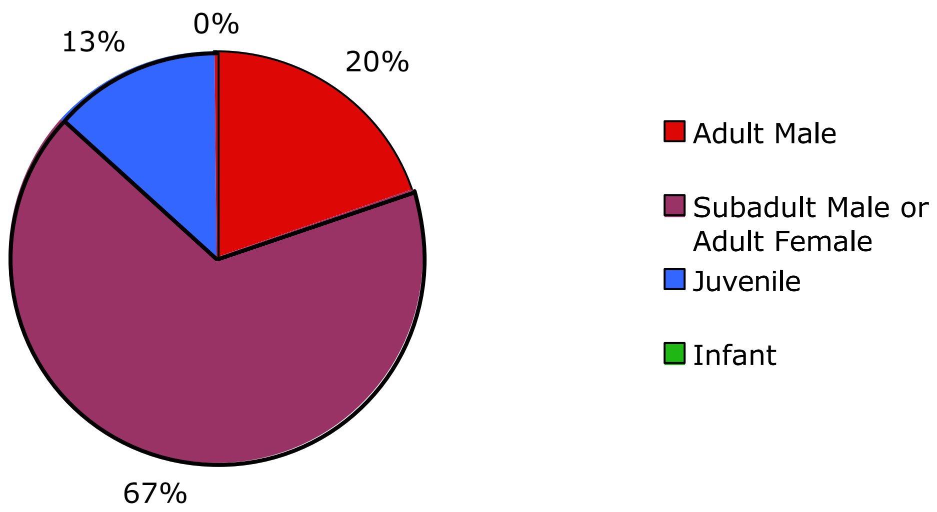



**Fig. 2.5.3c.** Age categories of elephants based on dung piles found along all trail transects.

Only a few dung piles contained identifiable food items. Jackfruit seeds (*Artocarpus integrafolis*) were found in 13 dung piles. Maila, cucumber and rice were recorded in one dung pile each.

2.5.4. Discussion

The trail transects also provided conclusive evidence of elephants outside the protected area and that they remained in the area through the time of survey and were not simply passing through. The dung piles were measured to find out the age of the elephants roaming in the area. While no dung from infants was detected, the presence of dung from juveniles conclusively proves the occurrence of herds in the area.

## 2.6. Fence Monitoring

### 2.6.1. Introduction

Electric fencing has been one of the few barriers against elephants that have been successful. Currently hundreds of kilometres of electric fences are being used in Sri Lanka. In Wasgamuwa, two types of electric fence were in use. Two fences, Weheragala and Pusselyaya, were set up by SLWCS and were intended to protect villages from elephant depredation. They were constructed along the boundary of the villages and the villagers are by and large responsible for their maintenance. The other fence constructed by the Department of Wildlife and Conservation (DWLC) was on the boundary of the protected area and intended to restrict elephants to the protected area. It was maintained by the DWLC.

### 2.6.2. Methods

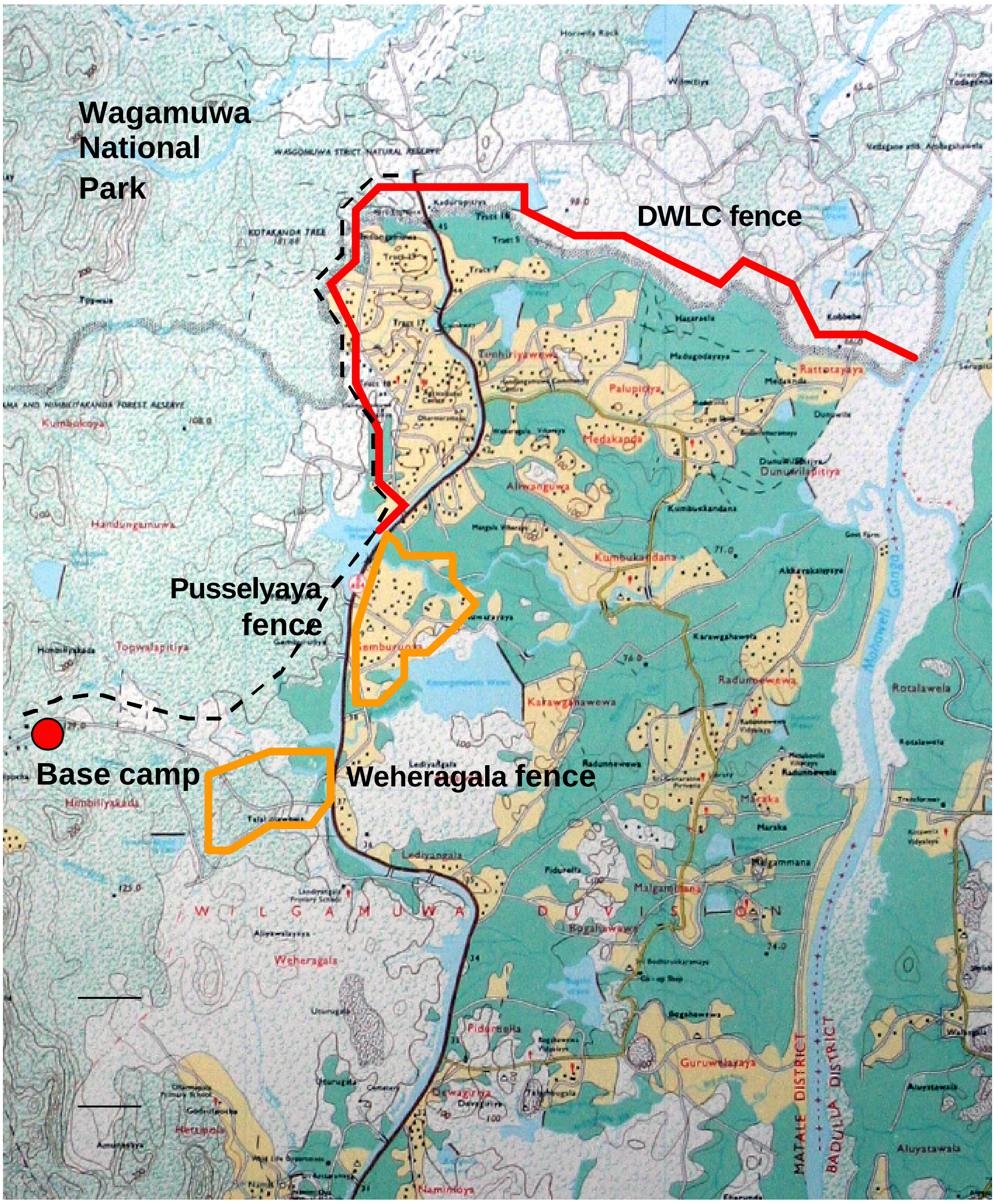



**Fig. 2.6.2a.** Map with the three monitored electric fences.
The DWLC fences marked in red and the two SLWCS fences marked in orange.

The Weheregala fence spanned 181 posts and the Pussellayaya fence 336 posts. The DWLC fence had 745 posts; and as it was much greater in length and access was difficult in some areas, we monitored it in three sections. The location of the three fences is shown in Figure 2.6.2a.

All three fences were monitored four times. We walked along the fence and recorded all damage, recording if posts were broken or uprooted and if the wires were loose, broken or missing. We also recorded if plants were growing under the fence and touching the wire, as this decreases the fence voltage, reducing its effectiveness. The posts along the fence were numbered, which allowed us to use the post number to locate the damage. After the first two weeks a voltage meter was used to measure the voltage on the fence.

We also recorded the presence of elephant dung and footprints along the fences. We measured the dung piles, checked them for seeds and estimated their age as we did for the tank monitoring (see methods 2.3.2). We also measured the diameter of footprints to get an impression of the size of the elephants roaming near the fence (Table 2.6.1a). Whether elephant sign was found inside or outside the fence was recorded.

**Table 2.6.2a.** Assignment of age class according to footprint diameter.

| Age Class | Diameter of Footprint |
|---|---|
| Infant | <15 cm |
| Juvenile | 15 – 30 cm |
| Subadult Male or Adult Female | 31 – 38 cm |
| Adult Male | >38 cm |

## 2.6.3. Results

### State of the fences

Fig. 2.6.3a indicates the numbers of fallen fence posts for each of the three fences. The Pussellayaya fence had 12 – 15 uprooted posts (ca. 4%). The Weheragala fence had 13 uprooted posts on the first day and later it had 44 – 53 fallen posts (ca. 13%). The large discrepancy in the number of fallen posts in the Weheragala fence on the first and subsequent inspections was due to confusion on the part of the observers when a post was determined to be knocked down and not due to an actual subsequent increase. The DWLC fence had 35 – 39 uprooted posts, which is about 5% of all posts in this fence.

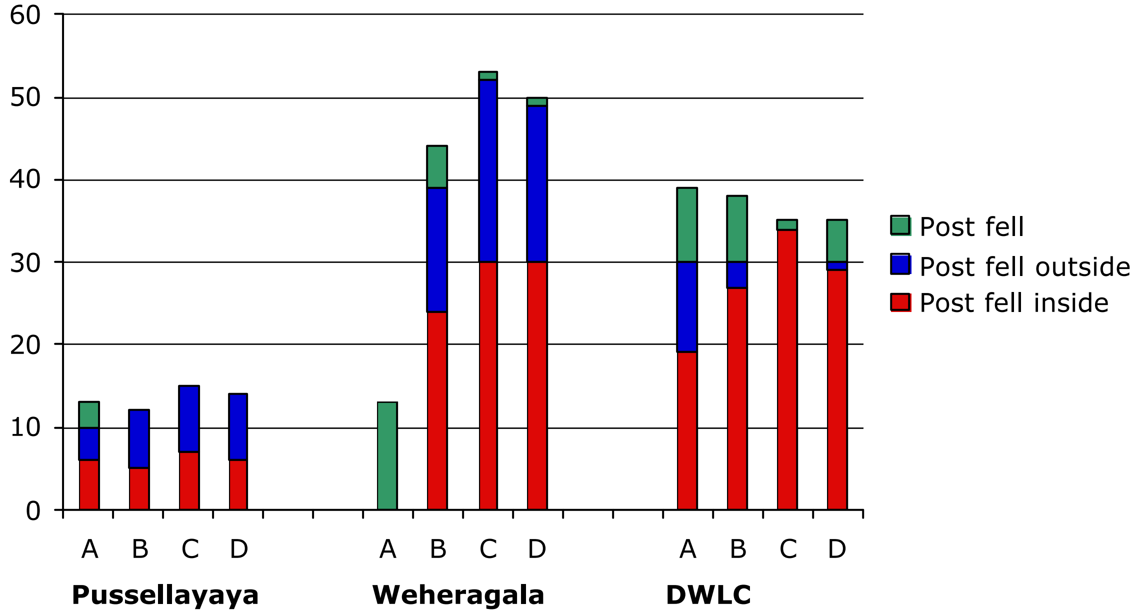



**Fig. 2.6.3a.** Number of fallen posts during each check (A, B, C, D) on the three fences. The direction in which the post fell is also given.

On some occasions branches of trees had fallen on the fences or were found to be touching the fence (Fig. 2.6.3b).

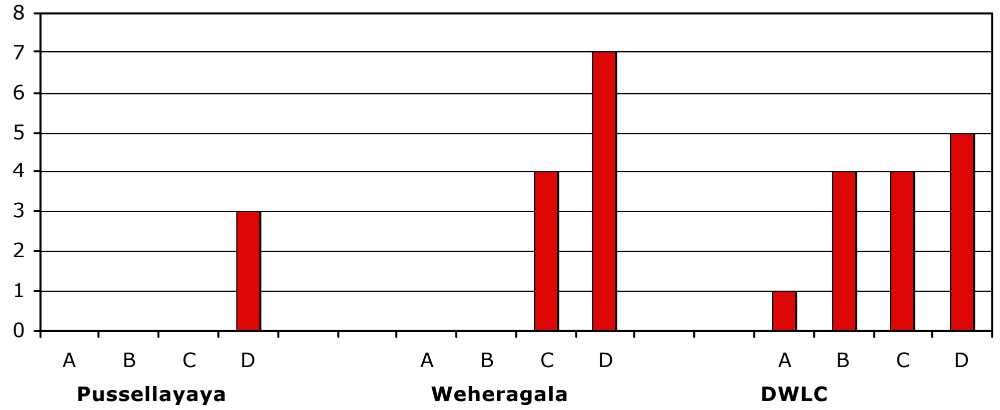



**Fig. 2.6.3b.** Number of items found to have fallen on the fence.

Notes were taken on the state of the fence wire (Fig. 2.6.3c). On the two SLWCS fences, 32 – 44% of the fence wire was loose. On the DWLC fence up to 9% of the wire was loose.

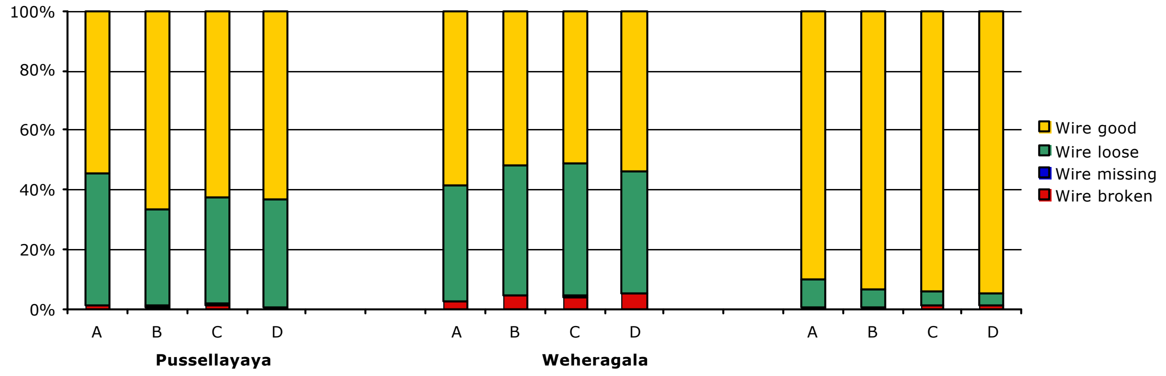



**Fig. 2.6.2c.** Percentage of loose, missing or broken wire found on each trip (A, B, C, D) on the three monitored fences

Plants growing up and coming into contact with the wire were observed in all three fences. While there was some observer variation in recording, at Weheragala up to 40% and at the Pussellayaya fence up to 29% of the fence was found to be in contact with plants (Fig. 2.6.3d). At the DWLC fence around 19% of the fence was in contact with plants.

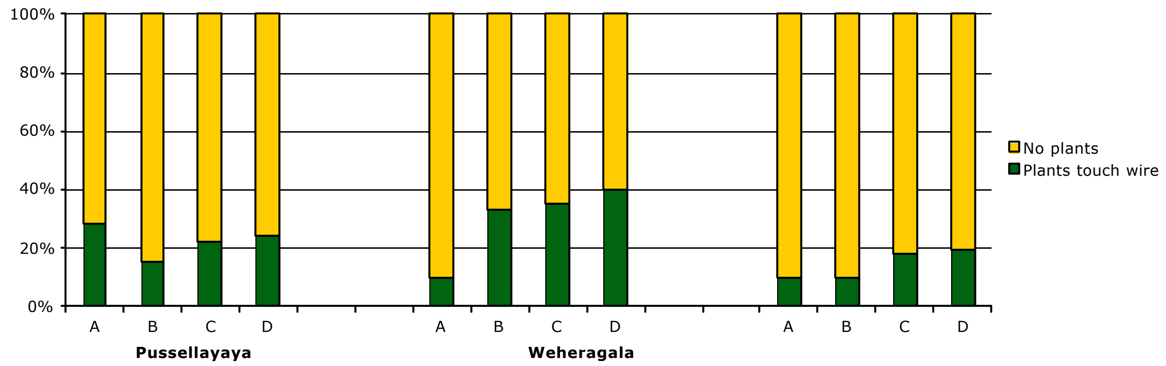



**Fig. 2.6.3d.** Portion of fence that was in contact with plants.

The voltages on the fences were recorded from the second week on (Fig. 2.6.3e). The Pussellayaya fence had no power at all during the first two visits. Sections of it were fixed in September and on the last visit its maximum power was 11 kV. The Weheragala fence had a maximum of 0.7 kV. The DWLC fence had a maximum power of 8 to 8.4 kV. On the first trip its minimum power was 2.4 kV, which is the only time that no part of a fence was completely without voltage in all the three fences.

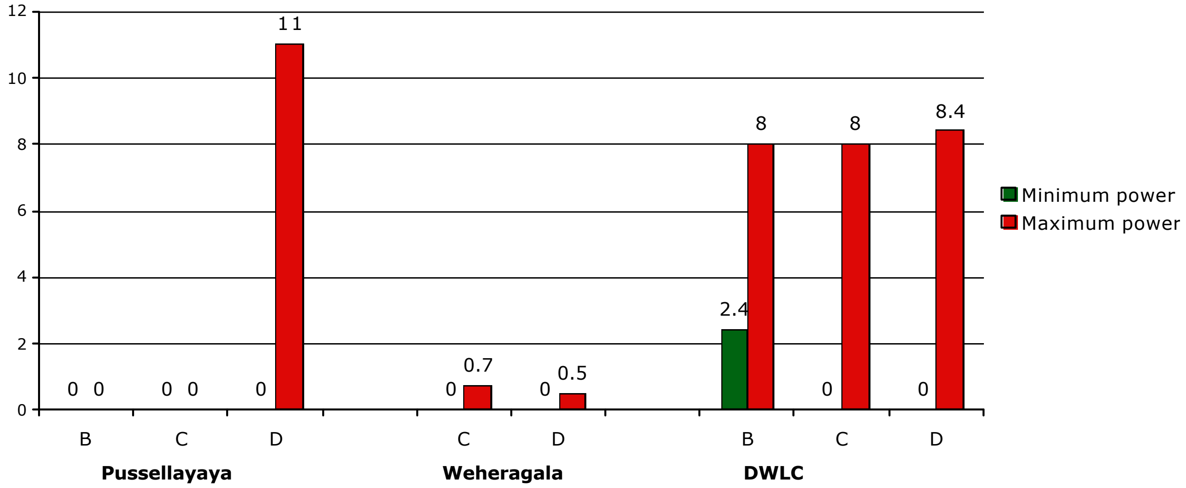



**Fig. 2.6.2e.** Diagram showing the minimum and maximum amount of power found on each round along the fences.

## Elephant sign along the fences

Dung piles and footprints along the fence were used as an indicator of elephant presence along the fence. Table 2.6.3a summarizes the number of dung piles and footprints as well as the estimated ages of the dung piles found on each round at each fence. Since the dung piles were destroyed after being recorded, the number of old (>10 days) dung piles decreased in later rounds. Most dung piles and footprints could be found along the DWLC fence, which was also the longest. On the Pussellayaya fence only two dung piles and one footprint were found. Thirteen of the 17 new dung piles found on the last round at the DWLC were lying very close together, suggesting, that an elephant herd had been in that area the night before. Also, the nine new dung piles from 22 September at the Weheragala fence were found in close proximity, therefore likely to be from a herd.

**Table 2.6.3a.** Number and age of dung piles and number of footprints found along the fences

| Fence | Date | Dung | | | | | Footprints |
|---|---|---|---|---|---|---|---|
| | | Age | [days] | | | Total | |
| | | <1 | 1 – 3 | 4 – 10 | >10 | | |
| DWLC | 6 – 7.9.05 | 0 | 0 | 3 | 23 | 26 | 3 |
| | 10 – 14.9.05 | 0 | 3 | 10 | 4 | 17 | 3 |
| | 19 – 21.9.05 | 8 | 2 | 14 | 3 | 27 | 1 |
| | 25 – 28.9.05 | 17 | 7 | 4 | 0 | 28 | 4 |
| | **Total** | **25** | **12** | **31** | **30** | **98** | **11** |
| Pussellayaya | 9.9.05 | 0 | 0 | 0 | 1 | 1 | 1 |
| | 12.9.05 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 23.9.05 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 27.9.05 | 0 | 0 | 1 | 0 | 1 | 0 |
| | **Total** | **0** | **0** | **1** | **1** | **2** | **1** |
| Weheragala | 8.9.05 | 1 | 1 | 0 | 5 | 7 | 3 |
| | 11.9.05 | 0 | 3 | 3 | 2 | 8 | 3 |
| | 22.9.05 | 9 | 6 | 12 | 3 | 30 | 0 |
| | 24.9.05 | 5 | 8 | 1 | 0 | 14 | 2 |
| | **Total** | **15** | **18** | **16** | **10** | **59** | **8** |

Circumferences of 1 – 4 boli from 73 dung piles were measured. Based on their size, most dung piles (63%) could be assigned to either a subadult male or an adult female. A total of 22 dung piles seem to originate from a juvenile or an infant (Fig. 2.6.3f). Only five dung piles had the size of adult male dung.

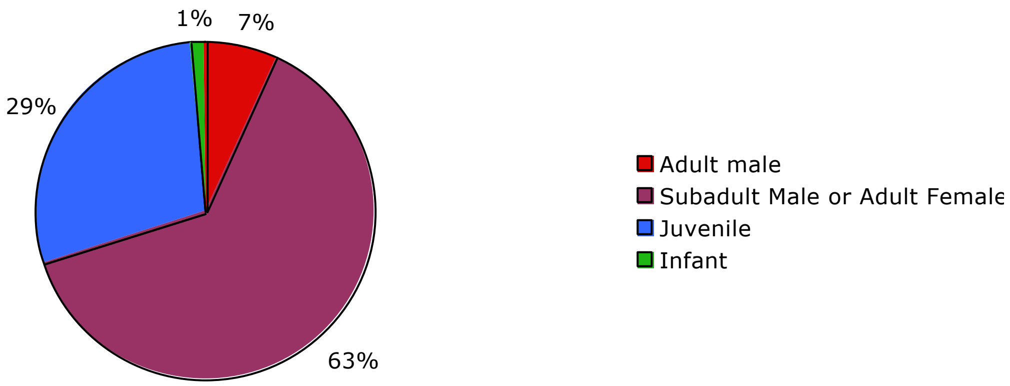



**Fig. 2.6.3f.** Age categories of elephants based on total dung piles found along the fences.

The proportions of age categories found along the DWLC fence and Weheragala fence were similar (Fig. 2.6.3g). The two dung piles found at the Pussellayaya fence could not be measured.

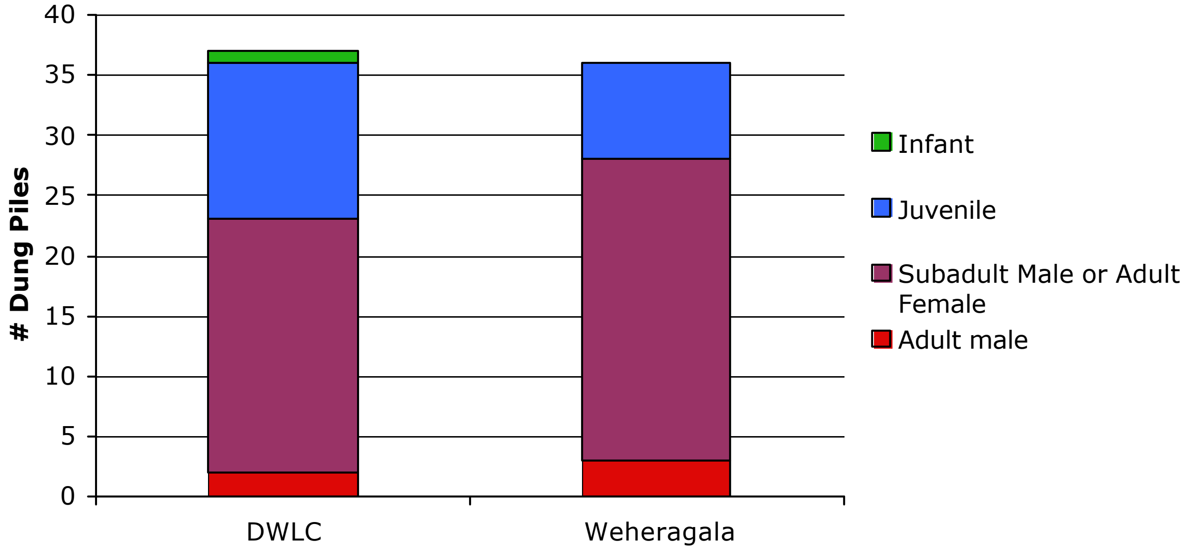



**Fig. 2.6.3g.** Age classes of elephants found along two fences. Age was estimated with dung circumference.

Based on footprint diameter we were able to estimate the age of the elephant. Eight of the 17 measured footprints had the size of a male elephant (Fig. 2.6.3h).

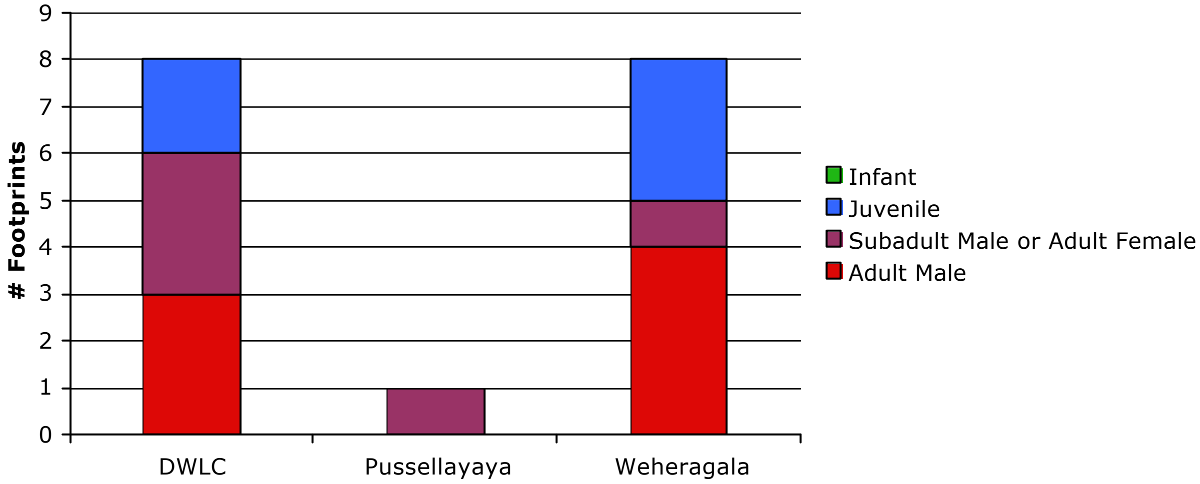



**Fig. 2.6.3h.** Age classes of elephants found along two fences. Age/sex class estimates based on foot diameter.

We recorded on which side of the fence the dung piles were found (Fig. 2.6.3i). Of the 157 dung piles found on all trips along all fences, 45% were found on the side of the fence where no elephants should be (outside the Park or in the village area).

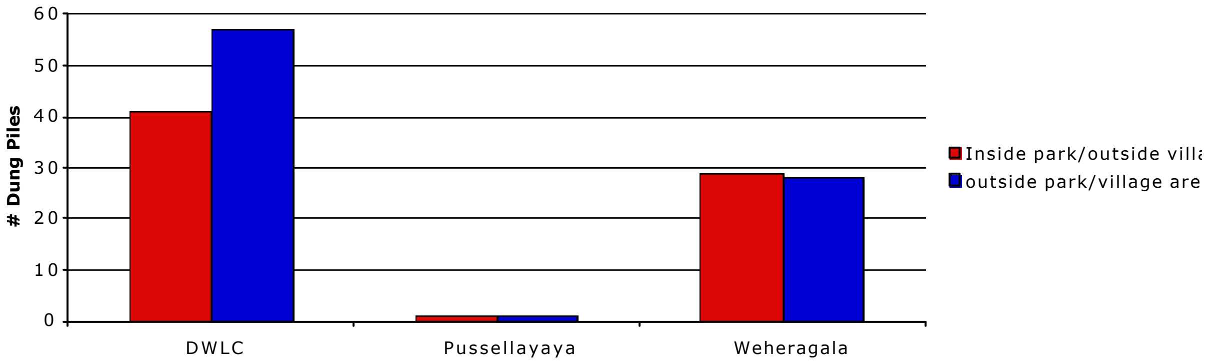



**Fig. 2.6.3i.** Number of dung piles found on each side of the three monitored fences.

We measured the footprints found along the fence and recorded on which side of the fence they were situated or if the elephant walked through the fence. In 10 out of 19 occasions the elephant was indeed passing the fence (Fig. 2.6.3j).

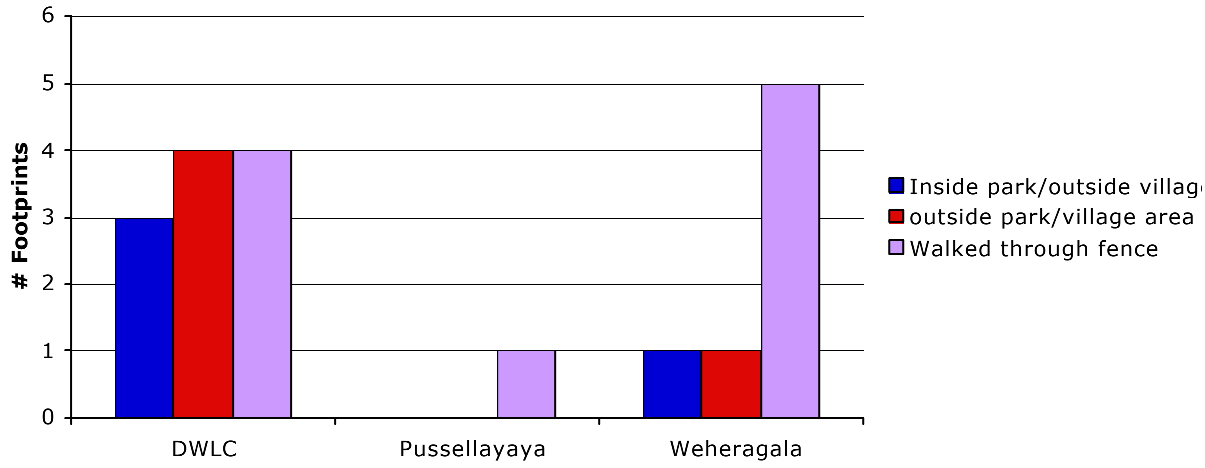



**Fig. 2.6.3j.** Location of the footprints found along the fences.

When breaking up the dung after measuring, we looked for seeds. We found paddy in 26 dung piles and seeds of the maila tree in 28 dung piles (Fig. 2.6.3k).

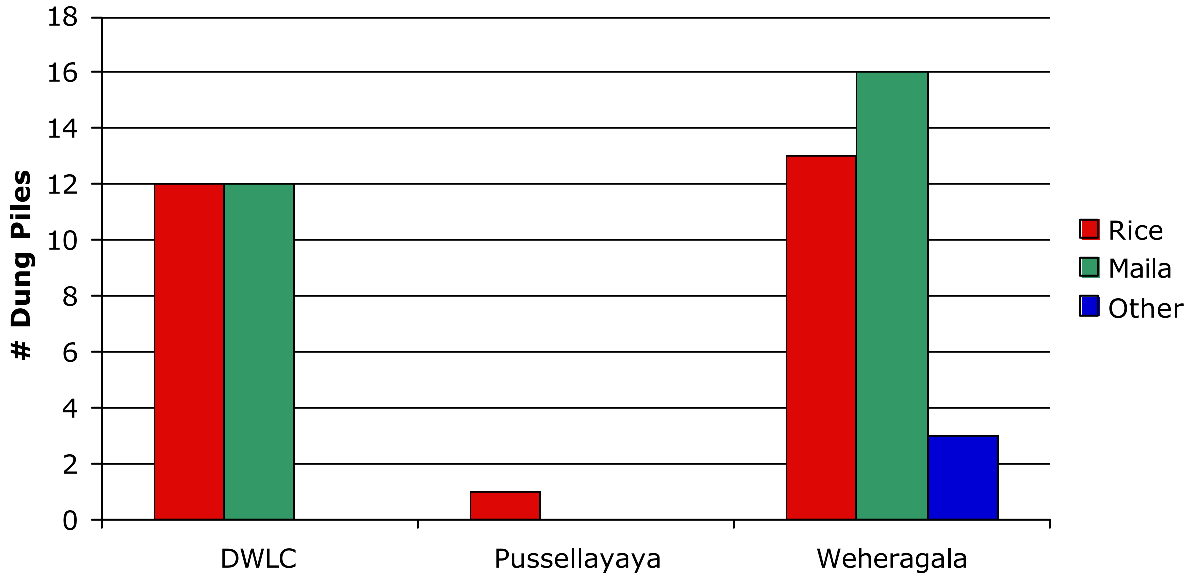



**Fig. 2.6.3k.** Type of seeds found in the dung piles along the three fences.

2.6.4. Discussion

The number of fallen posts, 4%, 5% and 13% in the Pusselyaya, DWLC and Weheragala fences respectively demonstrated that none of the fences were operating very successfully. Minor differences in the number of fallen posts recorded, especially decreases in number, were probably due to observer variation in recording. The very high number of fallen posts indicates that the fences have not been repaired for some time, rather than high numbers of elephants knocking them down every day. The number of fallen posts was not a good indicator of the number of times elephants crossed the fence, as elephants repeatedly crossed the fence in the same place once it was down.

Recording of whether a fence post had fallen 'in' or 'out' enabled us to determine if the elephants broke the fence to get inside it (into the village area or the Park) or to come out (to go out of the village area or to go out of the Park). In the two fences around the villages, similar quantities of posts were found to have fallen in and out, suggesting that elephants went into the village area and raided and came out. In the DWLC fence, distinctly more fence posts were fallen in than out, suggesting that more elephants moved into the Park than came out in the period preceding and during the survey.

Other fence deficiencies identified were loose or missing wires, branches falling/touching the fence from above and plants growing under the fence and touching it. All three fences suffered from all these deficiencies to some extent, further demonstrating that their maintenance was inadequate. In all three fences, areas with easy access or visible from the road were better maintained. However, elephants are more liable to challenge fences in more secluded areas, therefore increasing access to such areas may be of value.

The voltage on the fences demonstrated the result of the deficiencies above, with all three fences having areas where they were completely inoperative. While only a few individuals tended to challenge and break fences, most elephants, when confronted with fences, tended to travel along them till they either found a break or could go around them. Therefore, having even a few breaks or non-functional areas compromises the entire fence.

The data from both the dung piles and footprints suggested that both herds and adult males were found in the area. There appeared to be comparatively fewer elephants in the Pusselyaya area. The fact that similar numbers of elephant dung piles were observed on either side of the fence as well as the number of instances that footprints were observed crossing the fence indicates that there was little difference in elephant numbers on either side of the three fences. Macroscopic examination of dung found seeds of both cultivated (paddy) and wild plants (maila). This indicates either that elephants that raided crops as well as those that did not raid were found in the area, or that elephants raided crops only some of the time. Continued collection of this type of data and comparison with dung examination data from other situations will provide us with greater insight into feeding and crop-raiding behaviours of elephants.

## 2.7. Human Elephant Conflict (HEC) Survey

### 2.7.1. Introduction

The main problem confronting elephant conservation in Sri Lanka ? and much of Asia ? is the conflict between humans and elephants. HEC results in the death of approximately 60 people and 160 elephants annually. Understanding the patterns of HEC, its variations seasonally, annually and regionally, and the factors that contribute to it is of critical importance in attempting to mitigate it.

### 2.7.2. Methods

The survey was conducted by visiting village areas (Fig. 2.7.2a) on bicycles and enquiring if there had been any recent (within one year) elephant depredations in the neighbourhood. Once an instance of depredation was identified, we visited the scene and interviewed the persons involved. The survey was limited to outside the protected area as there are no human habitations within the protected area. It included the area within the Weheragala and Pusselyaya fences as well as areas outside. The following were recorded:

- Interviewer and date
- Complainant and address
- GPS of damage location
- Administrative division
- Whether inside or outside of the fence (Weheeragala or Pusselyaya)
- Date and time of damage
- Number of elephants involved
- Human casualties (number of persons and whether chased, injured or killed)
- Crop damage (type and extent of damage)
- House damage (extent of damage, rice stocks lost, property damage)
- Other damages and comments

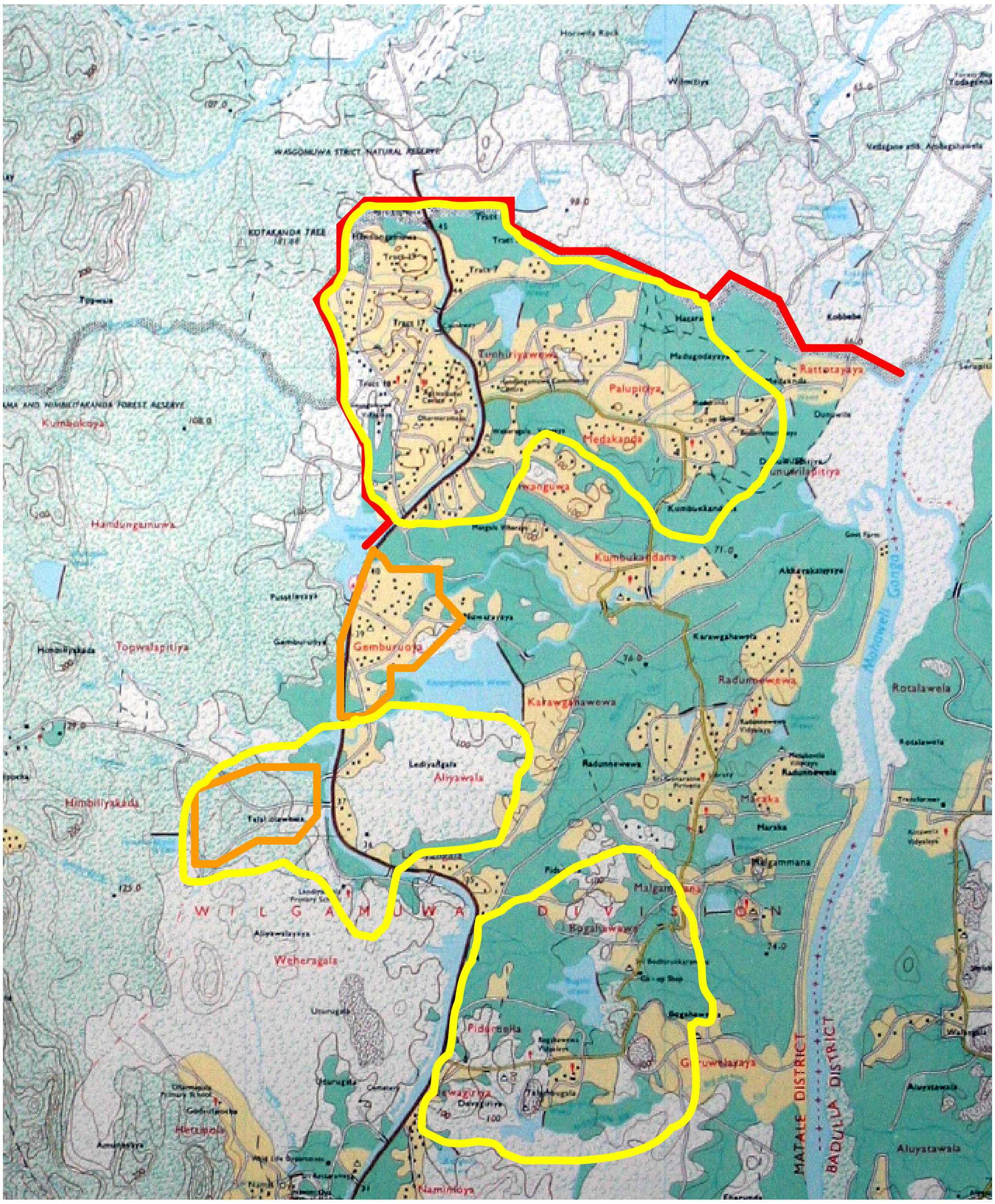


**Fig. 2.7.2a.** Map showing the areas visited for interviews on the human-elephant conflict (yellow outline). The electric fences are marked in red and orange.

## 2.7.3. Results

We recorded a total of 29 damages caused by elephants. Twenty-four had occurred within the past year and five during the survey period. Eleven occurred inside the Weheragala or Pusselyaya electric fences, the other 18 outside them.

Most damages were caused by single males (52%). Groups without young caused 41% of the damage (Fig. 2.7.3a). The number of elephants in such groups numbered two or three. In two instances the number of elephants that caused the damage was not known. In none of the instances did anyone observe any young animals or signs such as small footprints suggesting the presence of young.

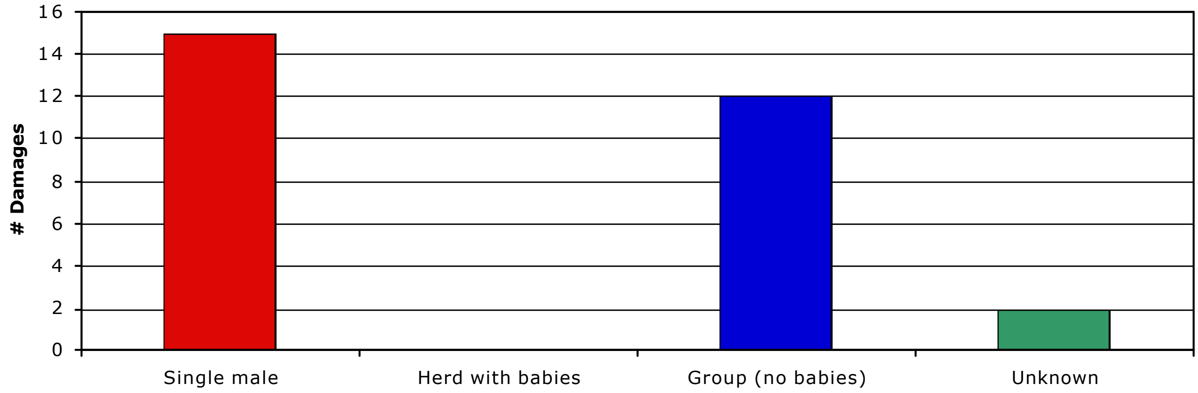



**Fig. 2.7.3a.** Details of elephants causing damage.

The majority of damage occurred in the night (86%). One damage was reported at dusk and three at dawn. No damages were reported during the day (Fig. 2.7.3b).

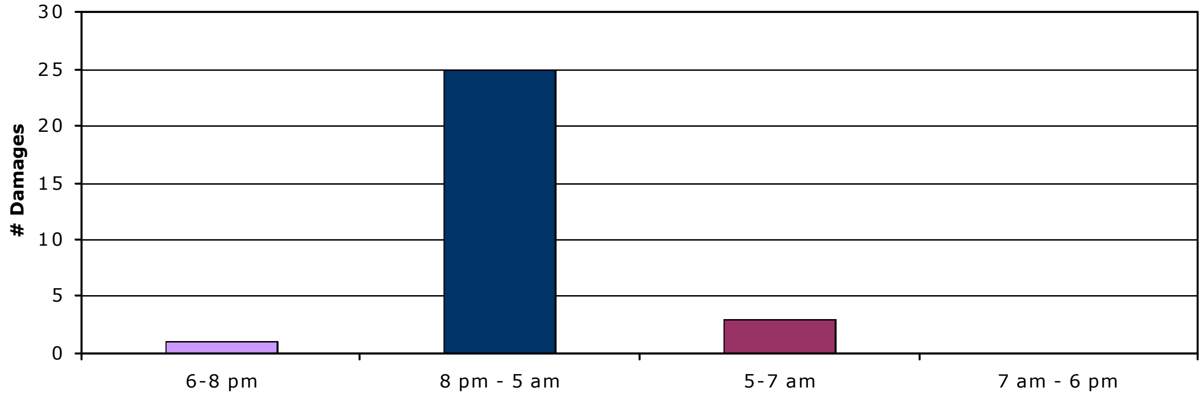



**Fig. 2.7.3b.** Time of elephant depredations.

There were three instances in which threat or harm to humans were reported. One person got chased by an elephant, one person suffered a minor injury (no hospitalisation needed) and one person was attacked by an elephant and had to be hospitalised for three months.

In 11 events, crop damage was reported. In all 11 cases the elephants damaged crops by consuming it and in five cases they caused additional damage by walking through the crop field.

Houses were damaged in 16 cases. In one case house damage was combined with crop damage. The amount of house damage ranged from 1% to 50% with an average of 17%. In 14 instances the elephants got at rice that was stored in the house. In 10 instances, parts of walls were damaged. In six houses, the roof was damaged.

In one instance an elephant damaged the rim of a well and in another instance an elephant damaged some building material.

2.7.4. Discussion

Most of the damage occurred from single elephants. The fact that the group size recorded was only two or three, and the absence of any evidence of young animals suggests that such 'groups' were male groups and not herds. Therefore, although the other activities conclusively proved the existence of herds in the area, all damages recorded can be attributed to males. All damages occurred between dusk and dawn.

Of the types of damage, the most prevalent was damage to crops or property, with only three instances of threat or harm to humans, of which only one was serious. Therefore, the greatest impact from the recorded damages was the economic loss. The number of damages did not appear to be extremely high or extensive. However, the psychological impact of the damages was much higher than the actual loss.

## 2.8. Dung Monitoring

2.8.1. Introduction

Asian elephants are forest animals and are very difficult to study through direct methods such as observation. Therefore, indirect techniques such as dung and sign monitoring, radiotelemetry, etc., are extremely useful in collecting data on elephants. Dung monitoring is exceptionally valuable as it is very low tech, but can provide a wealth of information. Therefore, understanding the decay rates of dung and the factors that influence it is an important exercise.

Elephants consume approximately 200 – 300 kg of food per day and most of it is deposited as dung. Therefore, elephant dung can be an important resource for a number of species. In addition, elephants may play an important ecological role in modifying their habitat through seed dispersal.

2.8.2. Methods

Piles of fresh (less then one day old) dung were collected once every other day for the dung monitoring experiment. Single boli were numbered and kept under different experimental conditions.

Sun or shade: The dung was kept in an open area without trees, which exposed it to the sun most of the day. The dung in the shade was kept under some high trees.

Dry or wet: Both dry and wet dung were kept in the open, but the dry dung was covered with a temporary roof in the form of a plastic sheet about 1 m above the dung if there was any precipitation. The wet dung was watered two or three times a day (morning, noon, evening).

Broken or complete: Boli were kept in one piece (complete) or were broken by hand into small pieces.

The different treatments added up to eight different combinations in which a dung bolus could be kept. A total of 102 dung piles were monitored in the experiment. The age of the dung piles at the end of the study varied from one to 23 days.

The day the dung was collected and placed in the experiment was considered day 0 and no data were collected on that day. The next day, the dung was considered one day old and data collection started. For every dung bolus, the following data were recorded:

- wetness (half wet, slightly wet or completely dry)
- bolus degradation (percentage intact and, into how many pieces if broken)
- insects (# of species and # of individuals, excluding termites)
- termites (if? present now, constructions present, % of bolus converted to earth)
- plants (# of species and # of individuals)
- mushrooms (# of species and # of individuals)

2.8.3. Results

Plants and mushrooms

Plants usually started to grow from day 5 onwards. Most dung piles had only one plant species growing on them. Figure 2.8.3a shows the proportion of dung piles that had plants growing on them. Once a dung pile was added to the experiment, it was monitored daily. If a plant started growing on day 2 but was dead on day 3, it was only recorded on day 2.

As dung piles were continuously added to the experiment, dung piles that were set up at the beginning of the study were recorded for up to 23 days, whilst dung piles added at the end of the study could only be recorded for one day. Therefore, the sample size declined over time.

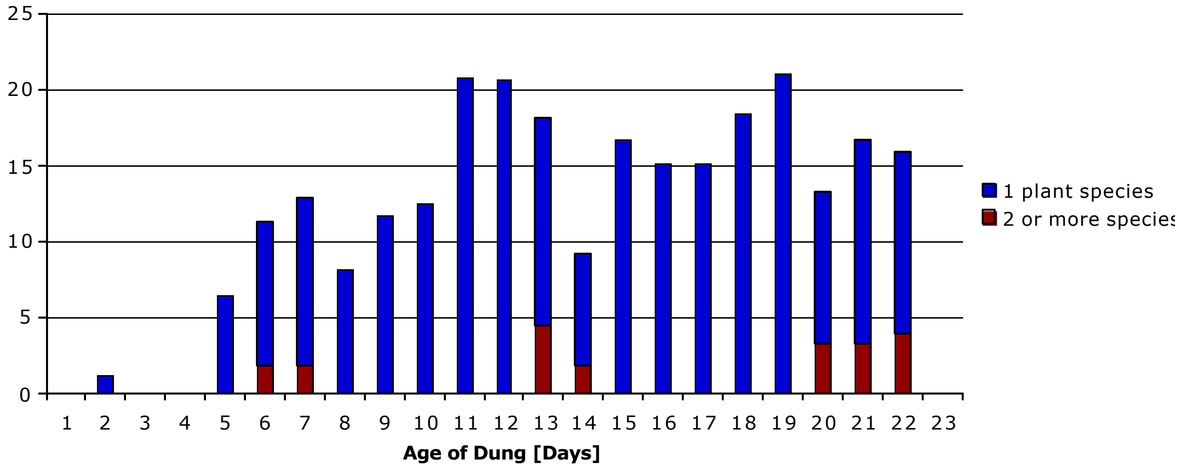



**Fig. 2.8.3a.** Percentage of dung piles having plants growing on them, in relation to age of dung.

We also recorded mushrooms growing on the dung piles. Growth of mushrooms started from day 12 (Fig. 2.8.3b). Early in the morning a very small type of mushroom could be seen growing on some dung piles. However, they disappeared by afternoon. Since we always collected data in the afternoon that particular mushroom was not recorded.

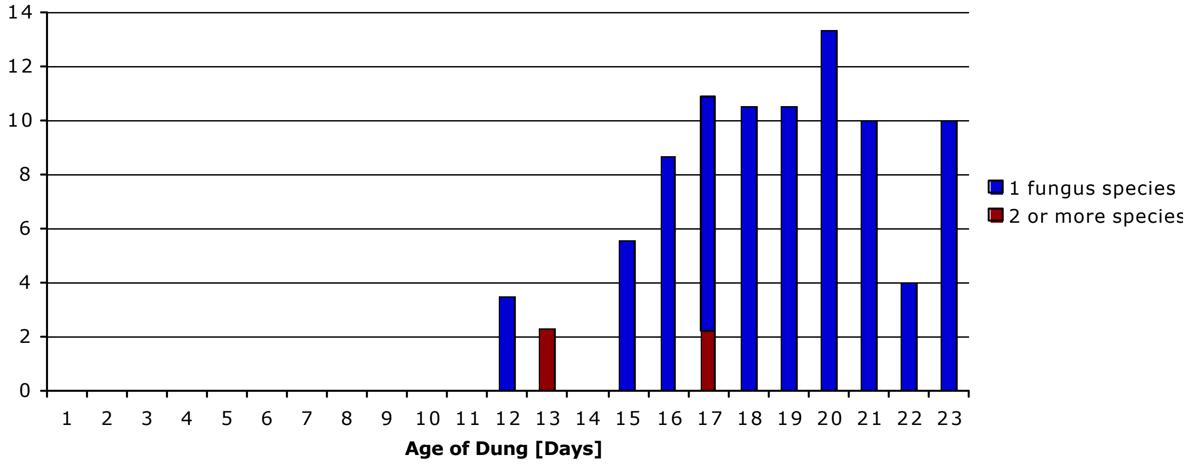



**Fig. 2.8.3b.** Percentage of dung piles having one or more mushroom species growing on them.

Only a small number of plants and mushrooms grew from the dung (Figs. 2.8.3c & d).

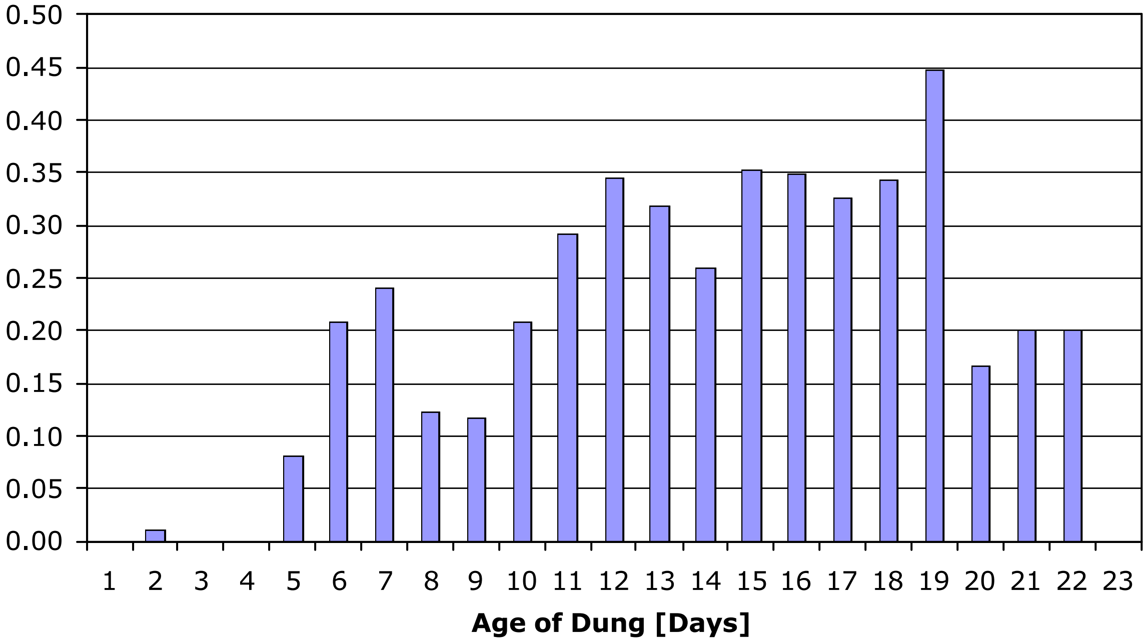



**Fig. 2.8.3c.** Number of plants per dung pile in relation to the age of dung.

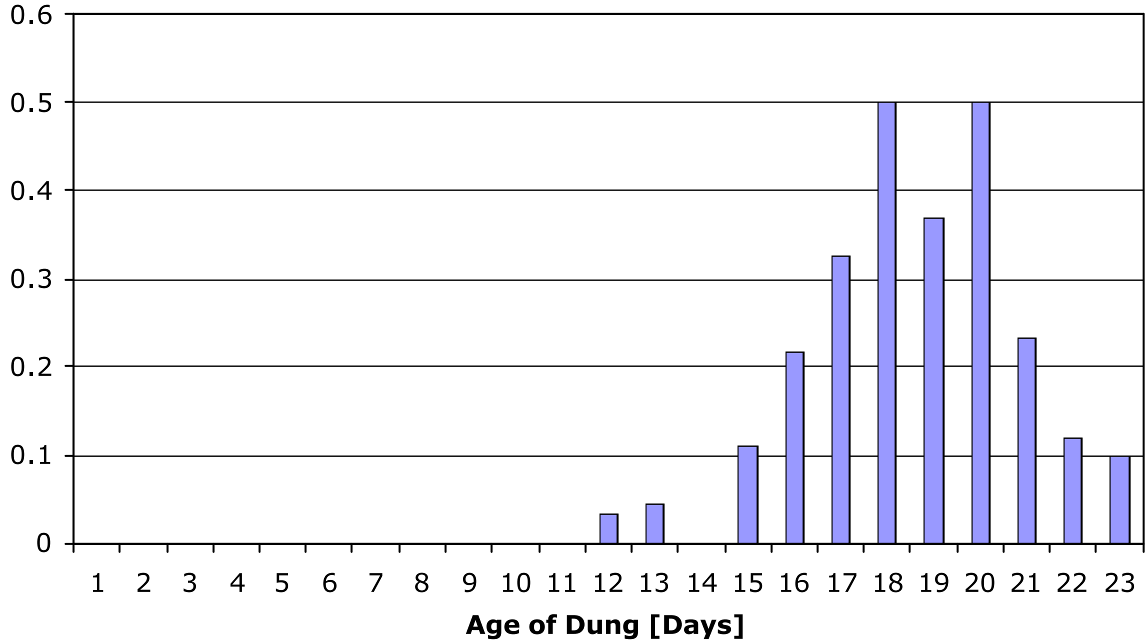



**Fig. 2.8.3d.** Number of mushrooms per dung pile in relation to the age of dung.

The number of mushrooms growing on a dung pile appeared to decrease after 20 days (Fig. 2.8.3d).

Plants grew better under wet conditions than under dry conditions (Fig. 2.8.3e). Surprisingly, more plants were observed under shade than in the sun.

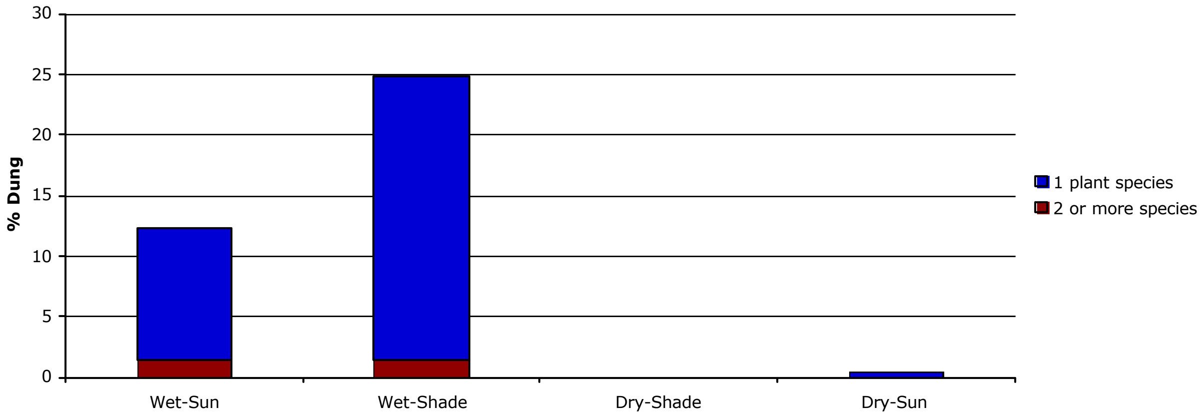



**Fig. 2.8.3e.** Percentage of dung piles with one or more plant species growing on them in four experimental conditions.

In contrast, mushrooms did better under wet and sunny conditions (Fig. 2.8.3f).

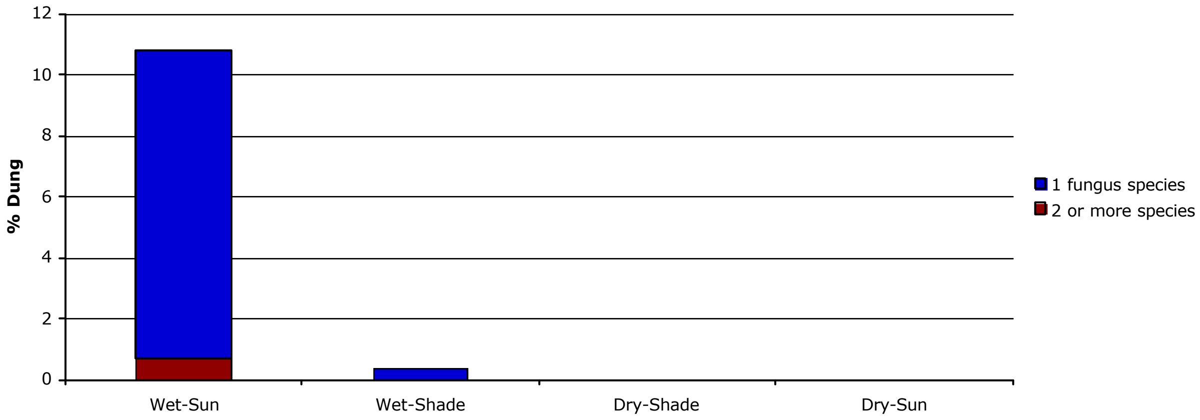



**Fig. 2.8.3f.** Percentage of dung piles with one or more mushroom species growing on them in four experimental conditions.

The results for the average number of plants or mushrooms growing on a dung pile confirm the results found above (Figs. 2.8.3g & h).

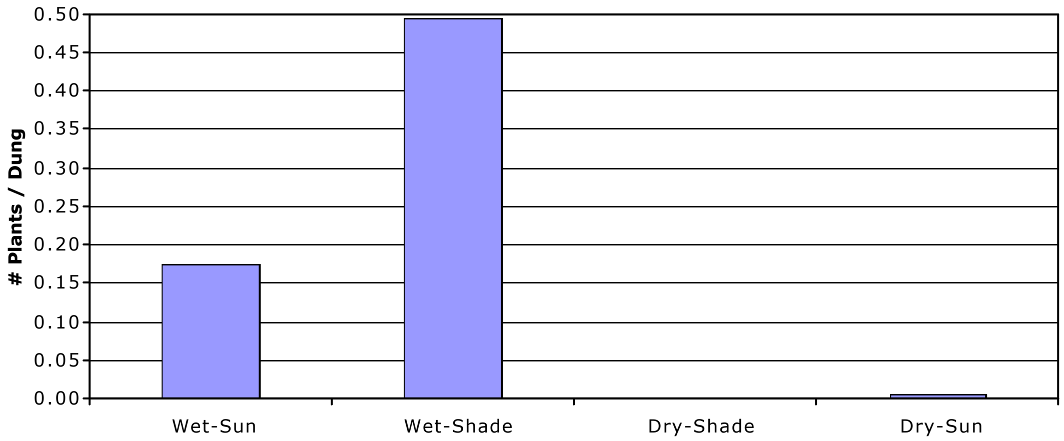



**Fig. 2.8.3g.** Number of plants per dung pile in four experimental conditions.

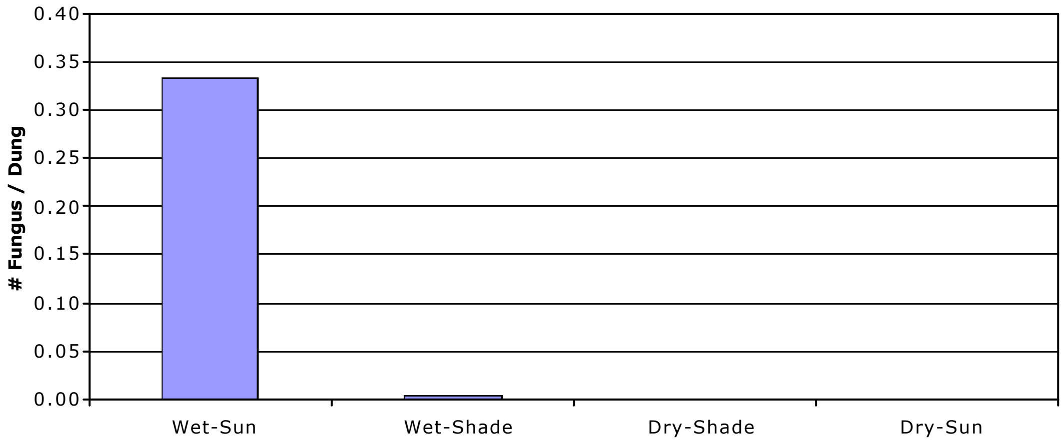



**Fig. 2.8.3h.** Number of mushrooms per dung pile in four experimental conditions.

When results from complete boli are compared with those of broken boli, plants seemed to grow better on broken boli (Figs. 2.8.3i & k), while mushrooms grew better on complete boli (Figs. 2.8.3j & l).

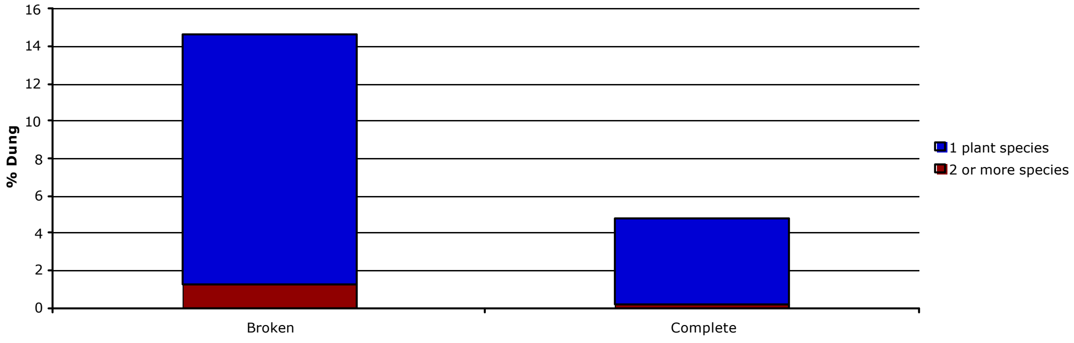



**Fig. 2.8.3i.** Percentage of broken or complete dung piles with one or more plant species growing on them.

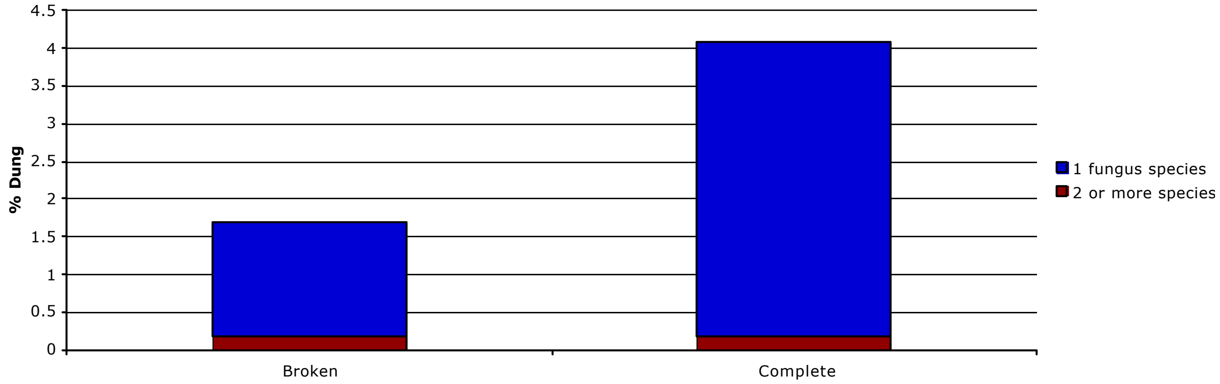



**Fig. 2.8.2j.** Percentage of broken or complete dung piles with one or more mushroom species growing on them.

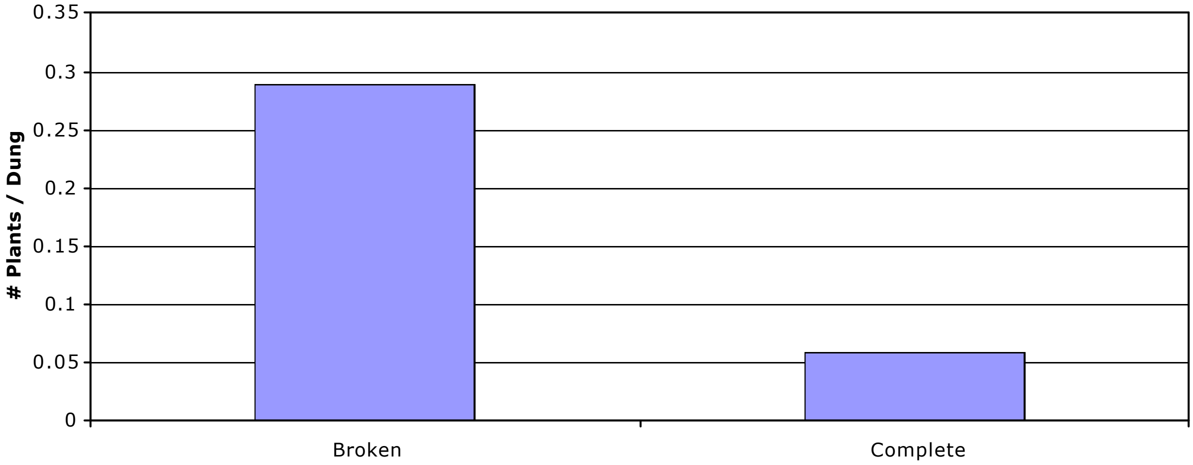



**Fig. 2.8.3k.** Number of plants found on broken or complete dung piles.

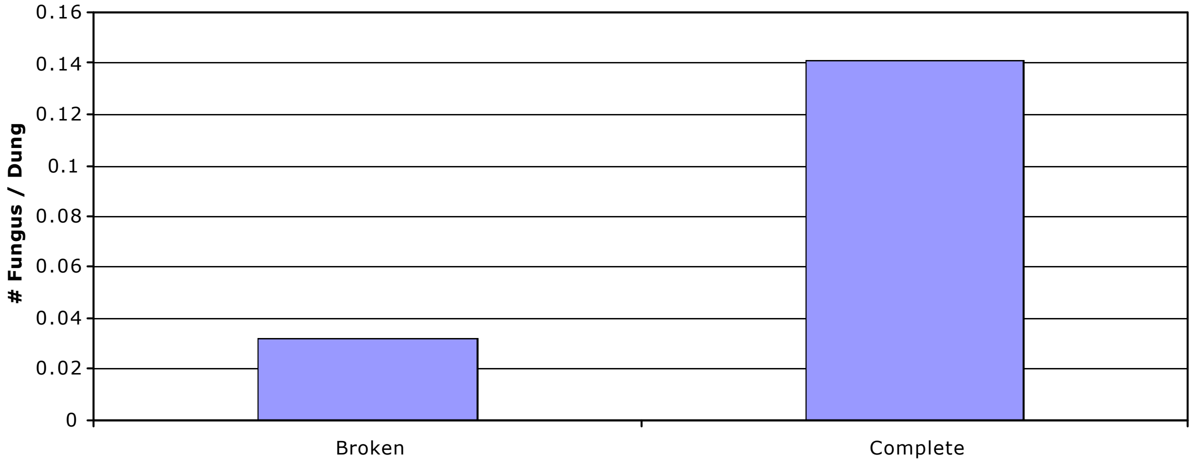



**Fig. 2.8.3l.** Number of mushrooms found on broken or complete dung piles.

Insects

Insects were found from the first day onwards with a slight decrease over time (Fig. 2.8.3m). Also the number of species found per dung pile decreased slightly over time.

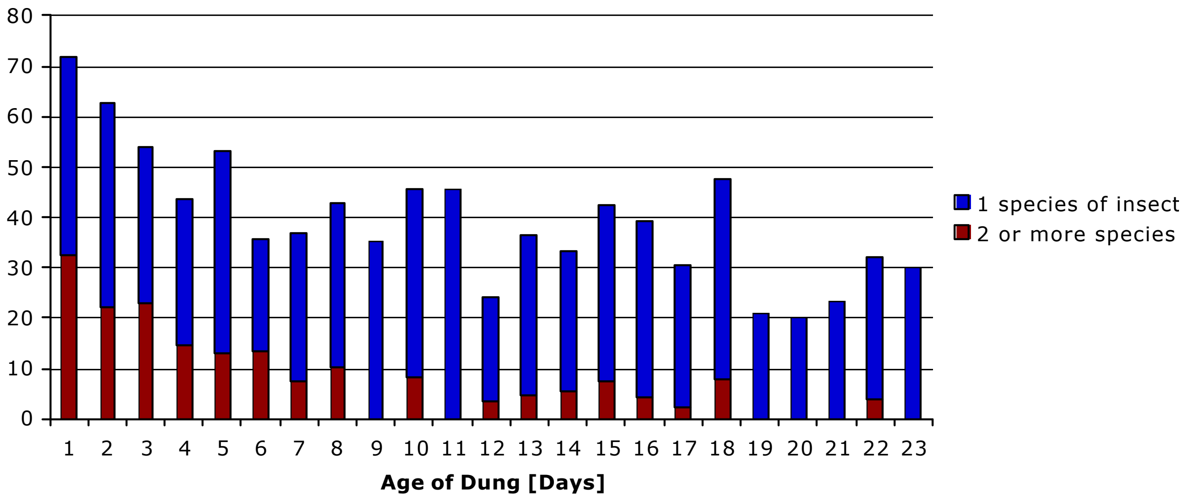



**Fig. 2.8.3m.** Number of insect species found on dung piles of different ages.

Figure 2.8.3n shows the average number of insects seen on a dung pile. If there were too many insects to count, it was recorded as “lots”. For the analysis, “lots” was taken as 20, which was in most cases an underestimate. In most cases, “lots” was recorded when there were ants. The number of insects seen on a bolus therefore is not as informative as the number of species.

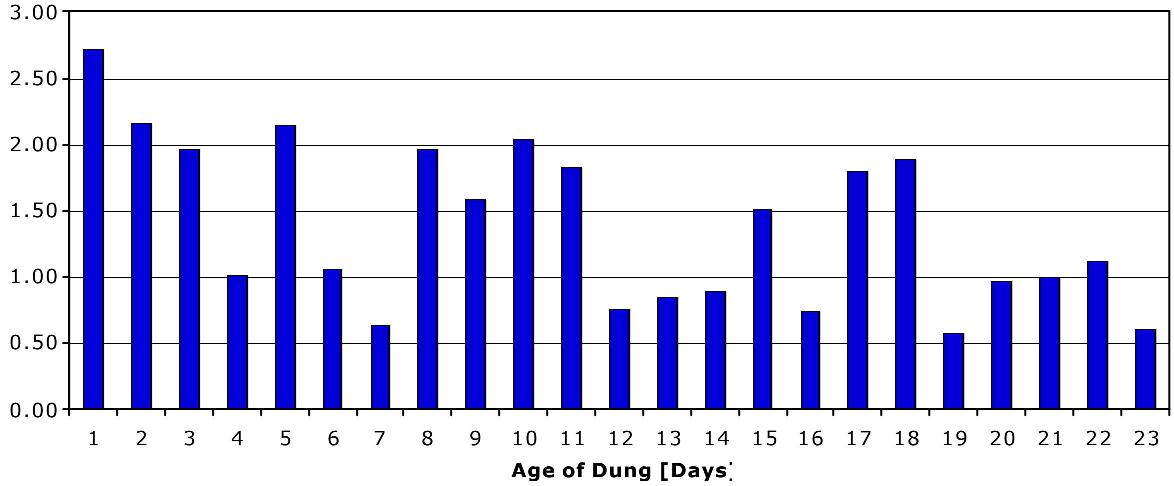



**Fig. 2.8.3n.** Number of insects found on average on dung piles of different ages.

On the last day of our study, after first recording through observation, we then broke the dung up into pieces, again recording the number of insects. As expected, we found more insects when braking up the dung (Fig. 2.8.3o).

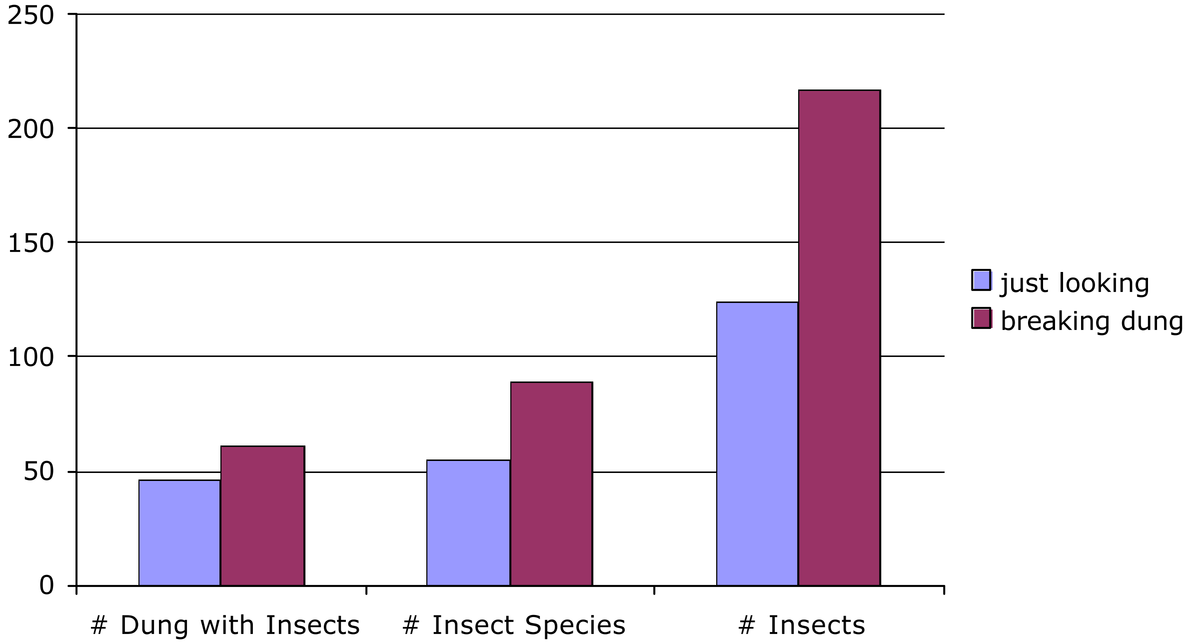



**Fig. 2.8.3o.** Comparing the number of insects found on the dung by just looking and after breaking it into pieces.

We also found more insects on the broken dung than on the complete dung (data not shown). This is mostly explained by the fact that on broken dung the visibility is much better and as such insects can be more easily counted.

Insects could be found on dung piles in all four experimental conditions (Fig. 2.8.3p). Dung piles in the sun and wet were more likely to have a greater number of insect species.

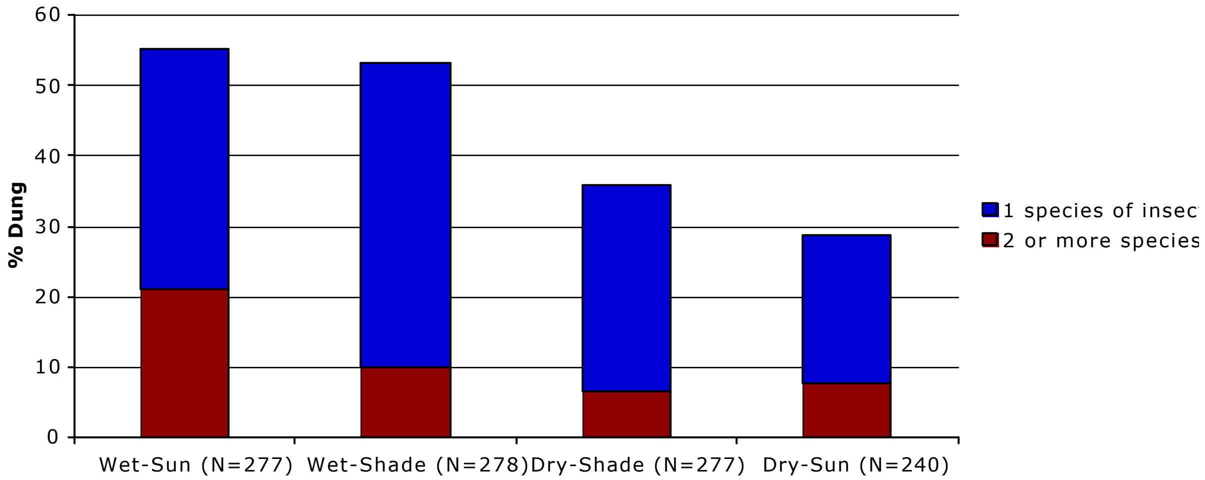



**Fig. 2.8.3p.** Number of insect species found on dung piles in four experimental conditions.

Dung piles kept wet and in the shade had the highest number of insects (Fig. 2.8.3q).

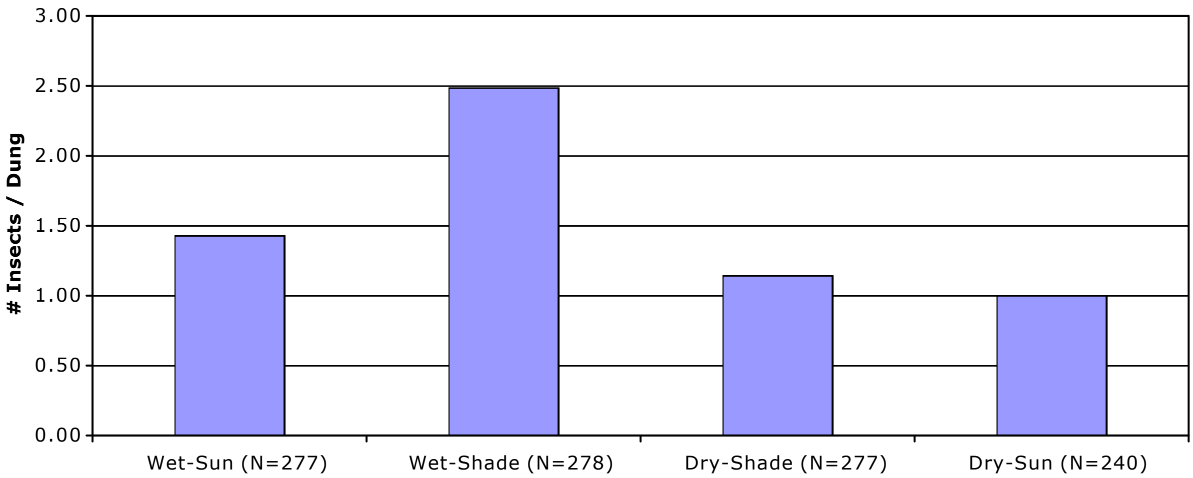



**Fig. 2.8.3q.** Number of insects found per dung pile under different experimental conditions.

Termites

Termites had the most impact on dung as they converted it into earth. Of the 102 dung piles monitored, 54 had termites (53%). On average termites were initially observed when the dung was four days old. If a dung pile was colonised by termites, on average 58% of it got turned into earth.

Colonisation of the dung piles by termites happened in most cases within the first four days (Fig. 2.8.3r).

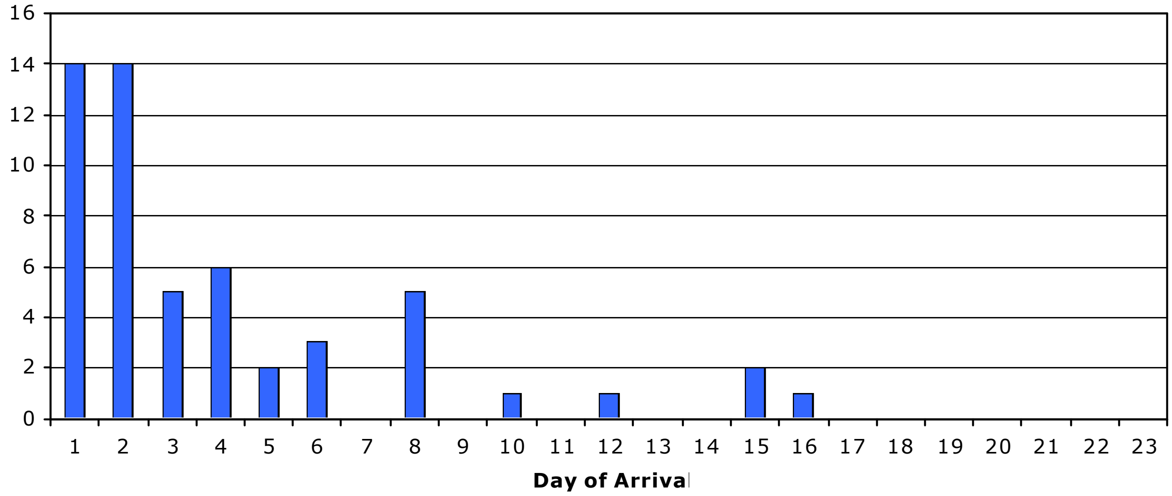



**Fig. 2.8.3r.** Day of arrival of termites at a dung pile.

Termites colonised dung piles under all four major experimental conditions (Fig. 2.8.3s). Under wet and shady conditions most dung piles were colonised by termites. Interestingly, the termites appeared to prefer dry dung piles in the sun over those in the shade. However, when the dung piles were kept wet, the ones in the shade seemed to be preferred.

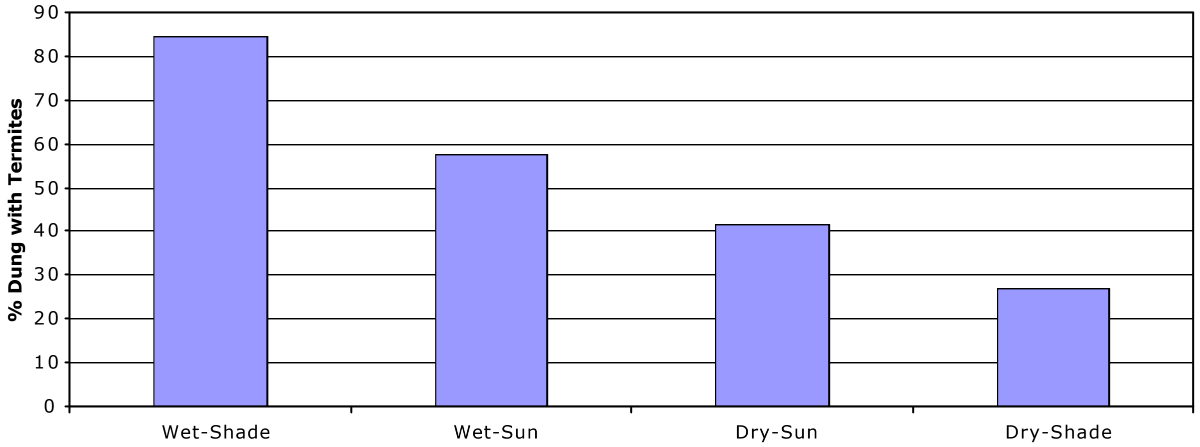



**Fig. 2.8.2s.** Percentage of dung piles colonized by termites under four experimental conditions.

Figure 2.8.3t shows the average day of arrival of the termites under the four experimental conditions. The dung under dry and shade conditions were colonised much later than under wet and sunny conditions.

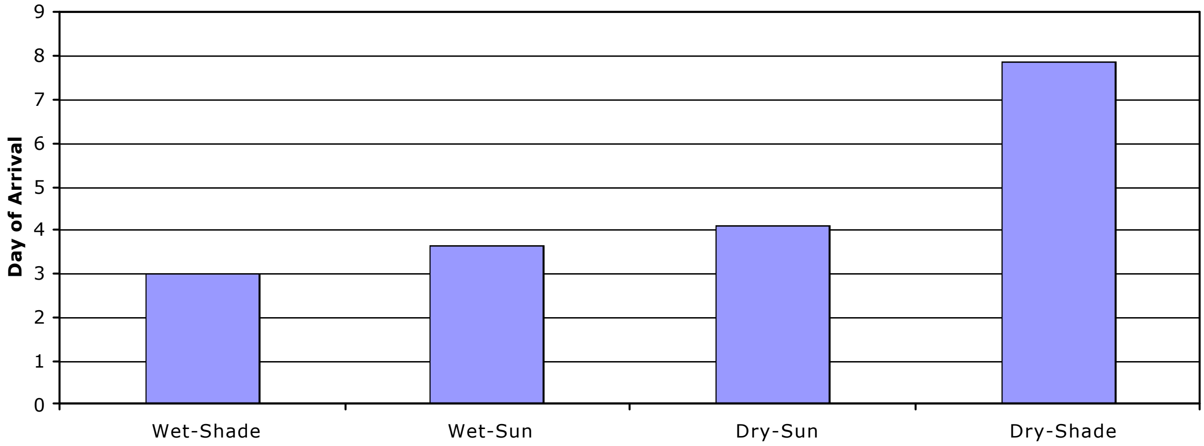



**Fig. 2.8.3t.** Day of arrival of the termites in four experimental conditions.

A bigger portion of the dung was turned into earth when the dung was kept wet than when it was kept dry (Fig. 2.8.3u). The dung piles in the dry and shady area had on average 26% of the pile turned into earth, which was less than half of what was turned into earth in the wet section (67% and 70%).

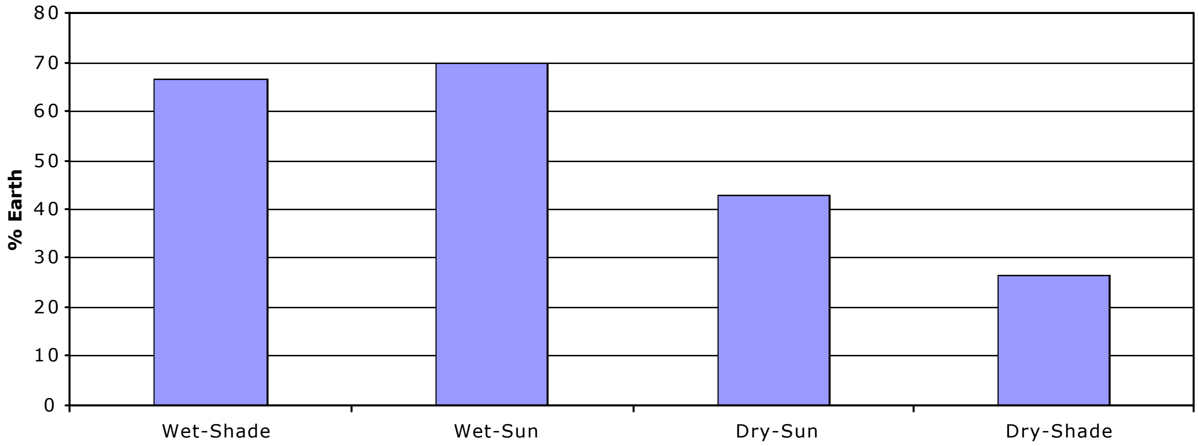



**Fig. 2.8.3u.** Percentage of dung turned into earth by termites under different experimental conditions.

When analysing the data for the broken and complete dung boli, no major differences were observed regarding the number colonised by termites, the average day of arrival or the average amount of dung turned into earth (data not shown).

Test for estimating the age of dung

On the last day, nine people with experience in the field for estimating the age of dung were asked to estimate the age of each of the 102 dung piles in our experiment.

The test persons had not helped set up the experiment, hence were not aware of the age of the dung. Additionally, the numbers on the dung piles were changed because in the experiment increasing numbers corresponded to decreasing age. Each dung pile had to be assigned to one of five categories of dung age used in our surveys (<1 day, 1-2 days, 4-10 days, >10 days, too old).

If the estimate was one category off, an error point of "1" was given. If the estimated age was two categories off, the error was "2". All error points were added up to give the final result for each tested person.

The errors ranged from 43 to 74 with an average error of 58. This is a very high error rate. The estimates would probably have been better if the test person had been allowed to break up the dung to check for its moistness. However, this was not possible in this test. Also, during road transects dung age is estimated without the possibility of breaking it up to test for moistness.

### 2.8.4. Discussion

The dung experiment demonstrated that environmental conditions such as sun, shade, dry and wet had a significant effects on the degradation of dung and the fauna and flora associated with it. It also demonstrated that estimating the age of dung by observation alone is subject to a fair degree of error. While the percentage of dung that had plants growing from them was fairly small, it is difficult to come to any conclusion regarding the role of seed dispersal by elephants.

## 2.9. Discussion and Conclusions

The different activities conducted during the expedition provided conclusive proof that a considerable number of elephants consisting of both adult males and herds, ranged outside the protected area. It also suggested that densities of elephants may in fact be higher outside the protected area than within. The data also demonstrated that none of the electric fences functioned properly. In the case of the two fences around the villages, there was elephant depredation within the fenced areas; therefore, proper maintenance would help decrease the conflict by keeping elephants out of the villages. However, with regard to the DWLC fence, a large number of elephants ranged inside and outside the fence. There is no possibility of keeping all the elephants that currently range outside the Park within. Therefore, paradoxically, proper maintenance and enforcement of the fence would in fact be detrimental to elephant conservation. It was also observed that considerable numbers of elephants cross the DWLC fence. If the fence is enforced, such elephants will either be marooned within the Park or outside of it. In the former case, they would then come into greater competition with elephants that range only within the Park. Those that get marooned outside would have to find their food from outside areas throughout the year and this likely would cause increase in HEC.

Continued collection of data through these activities will provide a better understanding of elephant movements, their seasonal changes and how they respond to environmental changes on a longer time scale of years. As elephants can become quite old, understanding their ecology and behaviour is critical to developing management plans for their conservation and for mitigation of HEC. In conclusion, this project run by Biosphere Expedition and SLWCS has provided some excellent data as a basis for continued research on elephants that can improve their conservation in Sri Lanka as well as in the rest of Asia.

## 2.10. References


Fernando P (1997) Keeping jumbo afloat: is translocation an answer to the human elephant conflict? *Sri Lanka Nature* 1:4-12.

Fernando P (2000) Elephants in Sri Lanka: past, present, and future. *Loris* 22:38-44.

Fernando P & Lande R (2000) Molecular genetic and behavioral analyses of social organization in the Asian elephant. *Behavioral Ecology and Sociobiology* 48:84-91.

Fernando P, Wickramanayake E, Weerakoon D, Jayasinghe LKA, Gunawardene M & Janaka HK (2005) Perceptions and patterns in human-elephant conflict in old and new settlements in Sri Lanka: insights for mitigation and management. *Biodiversity and Conservation* 14:2465-2481.

Fernando P (2006) Elephant conservation in Sri Lanka: Integrating scientific information to guide policy. In: *Principles of Conservation Biology* (Eds. Groom MJ, Meffe GK & Carroll CR) Sinauer Associates, Inc. Sunderland MA USA, pp 649-652.

Gunawardene MD, Jayasinghe LKA, Janaka HK, Weerakoon DK, Wikramanayake E & Fernando P (2004) Social organisation of elephants in Southern Sri Lanka. In: *Endangered Elephants. Past Present and Future. Proceedings of the Symposium for Human-Elephant Relationships and Conflicts* (Ed. Jayewardene J) Biodiversity & Elephant Conservation Trust, Colombo, pp 65-67.

IUCN (2002) IUCN Red List of Threatened Species. IUCN, Gland, Switzerland.

Olivier R (1978) Distribution and status of the Asian elephant. *Oryx* 14:379-424.

Sukumar R (1989) *The Asian Elephant: Ecology and Management*. Cambridge University Press, Cambridge.

Weerakoon DK, Gunawardene MD, Janaka HK, Jayasinghe LKA, Perera RAR, Fernando P & Wickramanayake E (2004). Ranging behaviour and habitat use of elephants in Sri Lanka. In: *Endangered Elephants. Past Present and Future. Proceedings of the Symposium for Human-Elephant Relationships and Conflicts* (Ed. Jayewardene J) Biodiversity & Elephant Conservation Trust, Colombo, pp 68-70.

**3. Expedition leaders' diary: Sri Lanka 2005 (kept by Marian Sutton)**

27 August

Tomorrow Dr. Matthias (Hammer, the boss) and I fly out to Sri Lanka, so today we are both in Germany (this expedition originates from the German office), checking equipment and packing expedition kit into aluminium trunks.

When we arrive in Sri Lanka we will travel from Colombo to base camp, where I will spend the next five days making final preparations for the expedition. Matthias and Pruthu will spend some of this time at base camp, and some time at Yala National Park in the south of the island, another site in Pruthu's Sri Lankan elephant research project.

Now we are ready to leave, I just want to be there, so looking forward to seeing you all. Remember it's 20:00 on 3 September at the Ranweli reception for those who want to come for an informal dinner with official assembly in the same place at 07:00 on 4 September (same procedure for the second slot).

See you there!

2 September

Over the last two days much has been accomplished at base camp. In a frenzy of building, wiring and plumbing and the scaling of a large tree to put up the aerial for the satellite phone (much crashing about and final success).

There is a hill behind base camp, craggy and covered in lush forest. It is a spot favoured by Buddhist monks as a meditation retreat as it is so wild and quiet. Though in reality it is never quiet here. There is always a cacophony of frogs, insects, and birds, sometimes deer and other noises I can't identify yet. We're nearly ready to welcome the first team.

6 September

The first expedition team arrived on 4 September. As we drove to base camp along the main road from Colombo we saw domesticated elephants returning from an elephant festival, probably in Kandy. One was being driven in a flat bed truck, just standing looking very relaxed on the back of the truck with two men sitting on the tailgate.

As we approached base camp on the dirt track, we stopped to try and make a phone call as we got a signal for the phone (rare in these parts). Suddenly a wild elephant turned the corner on the track behind us and started to approach us. Lionel, our driver, bundled us back into the van shouting 'elephant coming, elephant coming!' and raced off, pedal to the metal; his van is his livelihood and I don't think he wanted any personal experience of 'elephant damage' or 'human elephant conflict'.

Base camp is running smoothly now and as I write this the teams are out on their second day's work. We are blessed with overcast skies, so it is not as stiflingly hot as was when we were setting up. Roy (our cook) is making birdcalls in the kitchen, and a bird nearby is answering him. Outside tents are being secured after a gusty night, and I can hear the trundling of the coconut mill as lunch is being prepared ready for the team's return.

This afternoon I shall go out with one of the teams. Matthias and I are down on the schedule as 'Free Radicals' so I just need to choose which of the 10 activities I would most like to work on. I will get back to you later on how it went.

9 September

Matthias left yesterday afternoon and will be flying out to Namibia in a week's time to prepare the forthcoming expedition there.

The expedition teams are getting lots of work done; every day one team spends the day on elephant ID work in the National Park. They are seeing herds and lone males every day, and collecting lots of data, they photograph elephants to ID them later from distinguishing features such as ear shape and tail configuration. They are getting some great photographs of their own as well, whilst they are there working. Over the last couple of days we had herds surrounding the vehicle sniffing it out and apparently quite keen to be added to the first-ever elephant ID catalogue of the National Park!

There is also a night tree hut elephant ID activity that runs every other day. The night observation tree hut is close enough to a Buddhist temple to hear the mantras drifting across on the breezes that blow here at night. So they feel as though they have a little company as they wait for the elephants to arrive. Not much luck so far, but we are hopeful!

The human/elephant conflict interviews are also yielding good results with everyone enjoying the interaction with local people, if not the bike-riding into their villages! In fact the first expedition blood was spilled when one of the team members came off her bike on a gravel track yesterday and sustained some cuts and grazes, which were taken with good humour and a suitably stiff upper lip!

All else is well, though, with camp running smoothly – amazingly smoothly for Sri Lanka really and the “in” tray of datasheets filling up slowly and steadily.

10 September

Yesterday the National Park elephant ID research team were rather closely inspected by a herd of elephants in what was described by team members as a 'Jurassic park moment' where one of the elephants approached the vehicle and looked inside. The rear door was opened and slammed shut again by Harsha in an effort to encourage the elephant to keep a little more distance from the Land Rover. Unfortunately, however, a lunch box full of rice and biscuits fell out of the back door (we still have the lunch box as a memento, bravely retrieved later by Harsha). The curious elephant then turned its attentions to the rice and biscuits within, before booting the box into some grass at the side of the track. We have the pictures to prove it, though unfortunately I can't include them with this email.

My shopping list now includes one new lunchbox.

12 September

Elephants are being sighted during the tree hut elephant ID from the hut hide next to a nearby tank (tanks are actually reservoirs built hundreds or even thousand of years ago to irrigate the lands of the dry zone, many have been restored in recent decades and attract lots of wildlife, especially in the dry season). There are two 3-4 meter crocodiles in the nearest tank where we have our tree hut hide, and whilst waiting for elephants you can see a wide variety of birds, including three types of kingfisher, egrets and painted storks.

Team members seem to be thriving on the electric fence survey (of elephant fences), which regularly involves wading through chest high water and picking your way through areas of 'chena' slash and burn land adjacent to the national park fence. This chena land is hard and dirty going, full of toppled thorn scrub, sharp stumps, holes in the ground and grubby charcoal.

A snake or two have also been seen, one rat snake and one described as a viper by the field scouts seen on the road after the rain, trying to warm itself up. Monitor lizards and tortoises are common here and we encountered a four foot long monitor lizard sauntering down the road holding up traffic. A few blasts on the horn quickened its exit into the undergrowth.

The last two days have been cloudy with some rain as the wet season finally starts here. For the expedition team members this is a relief from the heat, and for the land, farmers and wildlife it is badly needed rain for vegetation growth and water supply. But for the solar power supply system at base camp it means shutdown, so I have arranged the use of a generator for times when the solar powered system grinds to a halt. Data input needs to be done in the afternoon, and the Landcruiser which is the vehicle fitted with an inverter to power equipment such as laptops is out all day everyday in the National Park.

17 September

On Wednesday I joined Karin's team (whose birthday it was) in the National Park for elephant ID in the afternoon. We were approached by a curious elephant who peered short-sighted into the vehicle as I frantically searched the floor for the window winding handle, which drops off when you go over bumpy ground! The window is normally difficult to close, but it went up very fast on that occasion!

Thursday was a hive of activity at base camp, as it was the final day and all data entry and preliminary analyses had to be completed so that the expedition teams could prepare their presentations. So no computer time then for me to send you a diary update. In the early evening the teams presented their findings, and Pruthu gave a talk on the wider context of the research into human/elephant conflict and elephant conservation in Sri Lanka. The field scouts also joined us for our final night BBQ and bonfire

Today several expedition team members old and new are at Ranweli as we are in transition between slot 1 and slot 2. With sole use of the laptop I can catch up on admin and diary updates after a gruelling 3 am start and 8 hour drive to Colombo yesterday.

Thank you to the first team for all your efforts and I look forward to working with team 2.

20 September

We are all settling back into camp life now on the second day back in Wasgamuwa base camp with the second expedition team. The familiar old favourites of fence monitoring (electric anti-elephant fence) and tank monitoring (irrigation reservoirs) including wading duties where there are small bodies of water to be crossed are being introduced to the new team.

Yesterday I joined the tree hut elephant ID team at out at the tank tree hut. This has a long, high 2 section ladder with a dog leg in it near the top. It is lovely up in the tree, and the whole platform creaks and sways slightly like a ship at sea. This hut stands at the forest margin overlooking our nearest reservoir tank, the one with two 3 - 4 meter crocodiles in it. After about an hour we heard lots of loud trumpeting from very close by in the forest, and later on we saw that a herd of eight elephants come out of the forest and having a dust bath across the tank from us with the local people doing laundry and bathing in the waters of the reservoir.

22 September

The weather has turned extremely hot; even the local staff working at base camp are feeling the heat. The night shift in the tree hut saw a herd of elephants pass by the tank, and early in the morning around dawn, a solitary bull elephant walked past the tree hut.

Teams were late back this evening as there was a herd of 23 elephants at the tank, Pruthu and Marlene were in the midst of them at one point as they surrounded the vehicle and then passed on their way.

A journalist from the south of England spent a couple of days with us quizzing us about whether we were actually working on a research project, he mentioned the 'H' word, so we planned to send him on a fence monitoring mission. He may have got the picture as he left early the following morning, neatly circumnavigating his appointment with fence monitoring!

27 September

I have been out on trail transect with Pruthu twice in the last three days, both times on new routes.

On Saturday the trail went up onto a ridge with views across to the Knuckles Range. Neil and Carole were working on the trail transect that day, and Neil was delighted when Mahesh, one of the two field scouts with us, spotted a frogmouth, a nightjar apparently. I don't know a lot about birds, but it caused a lot of excitement.

A little further along Pruthu found a recently deceased purple-faced leaf monkey. Grisly but interesting!

At the end of the ridge the trail petered out, and we navigated our way over scrubby terrain, through some woods and 'chena' slash and burn land to get down off the ridge into the valley bottom. By the time we got there we were all coated with red dust and covered in charcoal streaks from the slash and burn lands.

We had to cross another smaller ridge to reach the road and the old Series III Land Rover with Sampath at the helm, and just as we climbed up to the final ridge a tropical storm began, soaking us and blending our charcoal streaks to an overall grubby grey colour.

Probably my most enjoyable day of the expedition though. Neil and Carole also agreed (after initial reservations about the angle of the descent slope off the ridge).

28 September

We have had several snakes in camp over the last couple of weeks, first there was the harmless rat snake, where Marlene found all of Ecoteam (Roy, Jayasakara, Janika and Prabat) who run the camp, looking under her tent using a long stick; flushing it out.

Next there was a speedy seba's bronzeback also harmless, which shot across camp with people shouting "snake, snake". Pruthu IDed it as harmless so we let it slope off under a bridge.

Then I saw a small dark snake sliding past the shower block,. again "snake, snake" and it was ID'e by Pruthu as a banded racer, also harmless.

Today though as I was working on the accounts and everyone else was out working, there was the shout of "snake, snake" from Ecoteam in the kitchen. I didn't pay too much attention after the other three, but a minute later Roy came out to consult the reptiles book and said it's a pit viper, poisonous!! Prabat the youngest cook in the kitchen had found it in the bag of coconuts, then they moved it out with a stick and put the first bottle they could find in front of it, it slid in, the bottle was capped, the cap pierced to make an air hole and the snake released safely far away from camp.

29 September

The last week has passed so fast, and today is the final day of the expedition. The expedition team are analysing the data, and preparing their presentations for this evening. The field scouts are involved in this too and will stay on for the final night barbecue that Roy and Jayaskara are preparing.

I am busy paying people, making arrangements for transport and packing the expedition equipment, so this will be the last Sri Lanka Diary.

Thank you to everyone for making this happen. We have achieved much. In Pruthu's words: "The findings of the expedition were very interesting. We surveyed about a 100 square km area outside the park and found elephants in all that area with some indication that the densities outside may be even higher than inside. Both single adult males and herds were found outside the park. Both the electric fencing models - containment (on boundary of park) and exclusion (around villages) had issues about maintenance. Dung decay rates may be very rapid.... and so on. The information collected also points to the importance of looking at additional factors such as the effect of slash and burn cultivation and its restriction in the area."

All of this will be written up in the report and I am looking forward to reading it in about six months time, as I am sure you are.

All the best

Marian Sutton
Expedition Leader