ELEPHANT IMPACT OF LARGE-SCALE PLANTATION;

A CASE STUDY - PELWATTA SUGAR PLANTATION.

by

G.W.K.G. NANDASIRI.

(00/AS/032)

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Department of Natural Resources
Faculty of Applied Sciences
Sabaragamuwa University of Sri Lanka
Buttala-91100

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DECLARATION

The work described in this thesis was carried out by me at the department of Zoology, Faculty of Science, University of Colombo under the supervision of Dr. Devaka K. Weerakoon and Miss. Enoka P. Kudavidanage. A report on this has not been submitted to another university for degree.

Kaushal
.....
G. W. Kaushal G. Nandasiri

13/5/2004
.....
Date

Certified by

External Supervisor,
Dr. Devaka K. Weerakoon,
Department of Zoology,
University of Colombo,
Sri Lanka.

.....
Signature

9/5/2004
.....
Date

Internal Supervisor,
Miss Enoka P. Kudavidanage,
Lecturer
Department of Natural resources
Faculty of Applied Sciences
Sabaragamuwa University of Sri Lanka
Buttala

.....
Signature

13/05/2004
.....
Date

Professor Mahinda Rupasinghe
Head of the Department
Department of Natural resources
Faculty of Applied Sciences
Sabaragamuwa University of Sri Lanka
Buttala

MSRupasinghe
.....
Signature

13.05.2004
.....
Date

FONDLY DEDICATED TO MY PARENTS

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Abstract

Human elephant conflict is a result of increasing human population, unplanned development and extensive agricultural practices in most Asian and African countries. Elephant is a large terrestrial animal and it needs comparatively large habitat areas and food resources. The study area, which is close to Yala national park, Lunugamwhera national park and Handapanagala area, was a good elephant habitat before the establishment of Pelwatta sugar plantation. The clearance of habitat and sugarcane cultivation result in scattering of the resident elephant population and their resources becoming scarce. To over come this the elephants began to attack sugar cane field since it can supply their food need spatially in dry seasons. This created human elephant conflict in the area.

PSI faces a great economic loss to elephant attack. Elephant enter the plantation by breaking the fence during the nights and through the gaps in the fence. The consuming of sugar cane and the elephant movement damages sugar plantation.

There are some control measures adopted by PSI management. Initially an electric fence was constructed together with trenches to keep the elephants away. But there is no efficiency in both methods and elephant still damage the cane fields. Currently elephant drives are used to chase the elephants to Yala But the elephant return almost immediately and there fore the drives had to be conducted often. The drives also have a negatives impact on the elephants. Large amount of money is used to control damage to sugar adding up to an amount of Rupee 4,562,500s,Per annum.

There are different perceptions of the peoples regarding this problem. Some agree that a permanent elephant drive together with a strict monitoring of the fence can be successfully in solving this problem. This has been proposed in a management plan offered by PSI management. DWLC has proposed an elephant corridor from Yala to Handapanagala Sanctuary. Farmers and laborers perceptions vary with the level of understanding. A contradiction free agreement among all the involved parties is essential in finding a long-term solution for the problem. More attention should be paid to keeping the elephants out rather than driving them.

There is a relation ship between rainfall and elephant entrance. In highly rainfall season elephant damage is lower than in dry season and increased levels of damage is observed in dry season.

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Abbreviations

PSP	Pelwatta Sugar Plantation
PSIP	elwatta Sugar Industry
EPS	Estate Protection Section
SPE	Solar Power Energizer
EAE	Elephant Areas Erosion
EF	Electric Fence
E/D	Elephant Drives
E/E	Elephant Entered
DWLC	Department of Wildlife Conservation

CHAPTER 1

Introduction and Objectives

1.1 Introduction

Elephants are threatened due to poaching for their ivory as well as due to the destruction and fragmentation of their habitat. Asian Elephants however, are mostly threatened by habitat loss. This is due to the fact that unlike their African counterparts, only a small percentage of Asian elephants possess tusks (Weerakoon, 2001).

In Sri Lanka, particularly in the dry zone, elephants are increasingly threatened by the loss and fragmentation of their habitat, which is mainly caused by the clearing of forests to make way for human settlements. This has led to the human-elephant conflict, which has resulted in the death of elephants as well as the destruction of property and the loss of human life. This conflict is also fuelled by the fact that many of the crops such as sugar cane, bananas and other fruits grown by these communities are favored by elephants as a source of food (de Silva, 1998; Fernando, 1999; Weerakoon, 2001).

Conflict normally occurs between farmers and elephant living in the same area. This affects both humans and elephants. In the entire dry zone the crop raiding by the elephants increased in last few decades. The elephant raid not only home garden but also sugar cane and perennial crops. Furthermore, the elephant raid paddy before and after the harvesting and also damage forest plantations in the dry zone (Munaweera & Kuruwita, 1995; de Silva, 1998; Santiapillai, 1998; Fernando, 1999; Weerakoon, 1999).

Pelwatte sugar plantation (PSP) is one of the largest plantations in Sri Lanka. It was established in 1981 and before that the area was used for chena cultivation (Pelawatte Sugar Industries Limited, 1993). Before the PSI was established, there were enough space for both animals and the settlers, with the elephants migrating from area to area from jungle routes. Today, due to loss of their normal routes and available habitats, elephants use route through the adjacent villages and have created severe conflict situations, especially during dry seasons, when the animals used to migrate to Handapanagala reservoir area. Socio Economic indicators suggest that the farmers in this area find it difficult to meet their daily needs because of the prevailing elephant problem. The plantation itself encounters many impacts by

because of the prevailing elephant problem. The plantation itself encounters many impacts by wild animals, especially elephants (Munaweera & Kuruwita, 1995; Munaweera, 1998).

The Handapanagala tank is close to PSP on the western boundary of Yala National Park. Jungle clearing for development of the sugar plantation in the mid 1980's was done without due consideration for the impact on resident elephant herds. At present during the dry season (July to September) there about 120-150 elephants all using the water available in the Handapanagala Tank and taking refuge in the teak forest. Experience during the last few years indicates that these animals' comprise several clans and families forming one large heard during the dry season, which together share the common resources of water in the tank. The absence of the large number of the elephants during the rainy season suggest that, since water is not a problem, this large heard breaks up into its original clans and families which move to other areas in search of food. (Munaweera & Kuruwita, 1995; Munaweera, 1998). As a result, probably displaced herds' began to feed on the sugar plantation. The elephants that are migrating from Yala to Handapanagala sanctuary uses the teak plantation area that is found near Handapanagala tank and are attracted to sweet and easily available sugar cane causing a significant impact to Sugar Cane harvest. During dry seasons over the past years, due to over grazing by large herds, the caring capacity of the teak forest is also under threat since there is severe de-barking and even up-rooting of trees by elephants. The incidence of crop raiding is highest during the dry season and includes whatever crops cultivated by the villagers (Munaweera, 1998). Acute scarcity of food sometimes forces the matriarchs to bring young calves into human settlement areas knowing the risks that they might face.

To minimize the damage, in addition to the conventional protective measures adopted by the farmers to discourage the elephants, trenches and electric fences were used by the PSI, with a large number of staff to patrol the fence. But the elephants learned to break the fence and despite modifications, number of bull elephants managed to get through every night (Thouless, 1994; Munaweera, 1998).

After the elephant drive in 1996, the electric fence along the Menik Ganga was removed, whilst the balance was not effectively patrolled by the PSI. Many farmers who tried to cultivate crops, which are disliked by elephants, reverted to the cultivation of sugar thinking they were rid of elephants. However, the animals returned and the conflict became worse than before the drive (Munaweera, 1998).

Even at present PSI still relies on drives, trenches and the fence to keep the elephants away. The management conduct frequent drives to get rid of elephants that enter the sugar plantation from time to time. This activity takes substantial amount of money, time and labor, raising doubts about the economic viability of this management strategy as the elephants keep on returning drive after drive. The farmers use traditional methods such as making noise, lighting crackers and fires and using hurricane lamps to discourage the elephants from the raiding their sugar cane. It was noted that animals become conditioned to these practices with time and are sometimes even become bold enough to attack the farmers who use them (Munaweera & Kuruwita, 1995).

Economic losses to the PSI due to elephant damage as well as expenses associated with elephant drives despite continued returning of elephant after each drive indicates that a detailed analysis of the elephant management strategy of PSI is needed to evaluate future management options of this conflict situation. However, a preliminary discussions with the elephant management unit of PSI indicated that there is no systematic record keeping of environmental, social and economic impacts of elephants on the PSI. This is a major hindrance to develop a long-term management strategy to solve the human-elephant conflict that exists at PSI. Therefore the aim of this study is to establish a baseline for systemtic analysis of the human-elephant conflict at PSI.

1.2 Objectives

The specific objectives of this study are,

i. Assessing the perceptions on the human-elephant conflict at PSI, based on the previous studies carried out on this aspect within the PSI or surrounding areas.
ii. Identifying patterns of elephant damage to PSI based on data collected by the elephant management unit of PSI.
iii. To systematically document the methods adopted by PSI to control elephant damage.
iv. Carry out a preliminary assessment of the economic loss caused by elephants to PSI.

CHAPTER 2

Literature Review

2.1 The Elephant

Elephas maximus, the Asiatic elephant is presently the largest living terrestrial mammal of Asia. It is a purely herbivorous animal that consumes about 150 kg of plant material per day. They inhabit forests, grasslands and savanna lands and are gregarious and highly social animals. There are three species of the elephants living in the world today, the African elephant, *Loxodonata africanus*, and *Loxodonata cyclotis* that inhabits the African continent and the Asian elephant *Elephas maximus* that inhabits the Asian Region (Weerakoon, 2001).

2.2 Human Elephant Relation in Sri Lanka – The Past

In Sri Lanka, the elephant has been closely associated with man and has played a central role in the country's' economy, conflicts, religion and culture for many millennia. Domestication of Asian elephants probably began over 5000 years ago. Ancient Sri Lankan kings used them at war (Weerakoon, 2001). Subsequently, elephants dressed in ceremonial outfits were a major part of traditional cultural pageants like the Kandy Esala perahera. The domesticated animals were also used as work animals in logging operations and building projects, Hence throughout the years, the elephant has remained a viable part of the cultural heritage and is a priceless possession treasured by the Sri Lankan's.

2.3 History of the Human Elephant Conflict

In ancient day the elephant population in Sri Lanka remained in harmony with man. However the increase in the human population and also foreign domination of the country changed this picture (Fernando, 1999).

Elephas maximus was once present in all the forest tracts, both in the central hill region as well as in the lowland parts of Sri Lanka. During the British occupation of the country, elephants got progressively eliminated from the wet and fertile regions mainly due to large-scale forest clearance, at first for cultivation of coffee and later for tea, and uncontrolled shooting. Since gaining independence in1948, despite the authorities taking some meaningful

steps to give special protection to the elephant, the situation has not improved to any appreciable degree (de Silva, 1998; Fernando, 1999). The current total elephant population in Sri Lanka is estimated to be about 4000 elephants by most researchers (Weerakoon, 2001). They are found Scattered in disjointed ranges in the north, north-central, north-western, eastern and south-eastern parts of the country. This drastic decline in the elephant ranges is basically due to habitat loss through:

a) Major irrigation schemes – settlement schemes embracing river valley basins
b) Cultivation – both legal and illegal encroachment
c) Change in forest composition by silvicultural practices, and
d) Loss of habitat through man made interventions

In unfamiliar surroundings, the movement and behavior of elephants change drastically. Such elephants are compelled either to wander aimlessly for a few years until they find a new route back to their old haunts, or to remain confined to the new areas. Man made barriers, habitat discontinuity and deterioration can lead to a group becoming isolated from the original population and finally ending up in an unexpected area. In either situation, the result is increased frequency of human elephant interaction. (Santiapillai, 1996; de Silva, 1998; Santiapillai, 1998; Fernando, 1993)

2.4 Elephant Conflict with Human

Elephant-human conflict poses a grave threat to the continued existence of elephants in Sri Lanka. Studies on conflict between elephants and humans in Asia have identified crop raiding as the main form of conflict. (Williams, 2003)

Elephant feeds on a wide range of vegetation from grasses, small shrubs, palms, vines trees, herbaceous broad-leaved plants and woody plants. They also consume leaves, twigs, bark, fruits and some times even flowers. Elephants need large quantity of food daily. An elephant consumers around 150 kg of green matter each day (Weerakoon, 2001). They are wasteful feeders and break off more branches than they actually eat. They also have a very inefficient digestive system and therefore all the food they take in is not assimilated. With the clearing of the forests, elephant habitats have been steadily reduced over the time. With this reduction the elephants have found it difficult to contain themselves in within the remaining forest

areas. As such they have started invading into human use areas in search of food leading to conflict with man.

With habitat reduction elephant populations have been broken up and some herds are pocketed in small jungle patches. With their movements restricted, especially when food and water resources are depleted, the elephant wander into the newly cultivated areas, which were within their former home ranges, in search of food. Here the elephants find a ready source of food, which is tasty, nutritious and easily harvestable on the other hand the farmers are not prepared to allow the elephants to destroy the crops that they had taken a great deal of trouble to cultivate and on which their income livelihood depends. In one night elephants can destroy six months, earnings of a farmer. The conflicts between man and elephant start with these elephant incursions. With reducing habitats the conflicts keep increasing (Santiapillai, 1996; de Silva, 1998; Santiapillai, 1998; Fernando, 1999).

At first the conflicts that developed, between man elephant, were not of a serious nature. The farmers got together and drove the offending elephants away. However, with time, the conflict escalated causing an increased incidence of injuries and deaths to both human and elephants.

The then warden of the department of wildlife Mr. C. W Nicholas states in his Administration Reports, that on an average 100 elephant were shot as well as captured annually between 1943 and 1951. He says that another 50 per annum were shot in the defense of crops (Noris, 1959)

. This meant that around 150 wild elephants were killed each year. Subsequent records show that between 1951 and 1969 a total of 1163 elephants were lost in the wild of which 639 animals were killed in the defense of crops (Santiapillai, 1994). This means that on an average, between 1951 and 1969, 61 elephants that tried to raid crops were killed each year (Jayewardene, 1999).

2.5 Nature of Human Elephant Conflict

2.5.1 Killing or Injuring of People

Elephants are large and powerful animals that can easily kill an unarmed man. A number of people are killed each year by elephants in Sri Lanka, but considering how widespread human elephant conflict is in the country, it is surprising how few are killed. This is because elephants are not normally aggressive animals, and will generally avoid confrontation with humans.

D.W.L.C has not routinely collected information on human deaths. However, since the establishment of the insurance scheme most cases have been reported to D.W.L.C in pursuit of insurance claims, and additional information has been provided in regional monthly reports. These indicate that elephant killed at least 54 people in 1993. The majority of these were from Mahaweli Region (18 cases) and North-eastern Region (25 cases). According to a study done by Thouless (1994), in 7 villages in North-western, Eastern and Mahaweli region, there was deaths rate of about 0.13 per thousand people per year in the year 1990. Out of all the cases reported 1990 71 were men and 14 were women. Table 2.1 shows the stated circumstances.

Table2.1 Circumstances of human deaths caused by elephants.

Circumstances	No. Cases
Walking at night	9
Walking (time unspecified)	8
Outside house	6
Protecting crops	3
Fishing	3
Sleep in house	2
Taking cattle through in daytime	2
Bathing in tank	1
Bicycling	1
Working in field	1

Source; Preliminary Technical report for GEF Project. Conflict between Human and Elephant in Sri Lanka (Thouless, 1994)

2.5.2 Crop raiding

The most important crop in Sri Lanka is paddy, which is grown on about 8% of the land area of the country. Elephants raid paddy fields even when they have just started growing, but the main problem is damage just before harvest time. Elephant also eat paddy after harvesting, when it is stored in field or houses.

Elephants also raid crops grown in the chena system. These include cow-pea, kurukam, ground nut, mung bean, maize, vegetables, golden melon, millet, manioc roots, gingerly, pumpkins and chili.

In addition to paddy fields and chena areas, which may be situated at some distance from farmers' houses, there are also crops grown on the plots surrounding their houses, which are also eaten by elephants. Bananas coconut trees are particularly affected and they also eat the roots of cashew trees, plantations and vegetables.

In two areas of sugar plantation, elephants have been responsible for causing much damage to the canes. These are Pelwattae and Sevanagala sugar plantations located in the southern region of Sri Lanka (Thouless, 1994).

Table2.2 Damage to different crops in the Handapanagla area.

Crop	Total grown (ha)	Damage (ha)	% Damage
Maize	668	195	29
Manioc	110	16	15
Vegetables	378	44	12
Bananas	1315	140	11
Cowpea	575	57	10
Coconut	447	43	10
Sugarcane	4695	445	9
Green gram	818	69	8
Kurakkan	30	2	7
Paddy (rice)	2296	39	2
Ground nuts	3021	53	2
Chillies	331	5	2
Onions	298	0	0
Tobacco	1047	0	0

Source; Preliminary Technical report for GEF Project. Conflict between Human and Elephant in Sri Lanka (Thouless, 1994)

2.5.3 Damage to Forest Plantations

Elephant damage is a major problem in the establishment of forest plantations in the dry zone, with teak plantations particularly badly affected. Bark is striped from mature trees, in some cases leading to the death of the tree, while damage to young trees may result in coppicing. A survey of the forestry plantations was carried out in 1984-6. Results indicate that hurricanes, poor management, insect pests and elephants were the main causes of damage and failure of these forest plantations. In some forestry divisions, elephants damaged a high percentage of plantations (Table 2.3). The vast majority of these were teak; only 2.2 ha of *Tamarix* sp. And 3 ha of Eucalyptus were recoded as damaged. There has been a reduction in further establishment of dry zone forest plantations in the last ten years, so it is likely that the total percentage damaged has increased since this survey (Thouless, 1994).

Table2.3 Area of the forest plantation destroyed by elephant, from 1984-6 forestry planning unit survey.

Forestry division	Ha. Destroyed	Total Ha	% Destruction
Anuradapura	383	3,556	10.8
Puttalam	239	7,732	3.1
Ampara	1,170	21,449	5.5
Monaragala	312	1,756	17.8
Kurunegala	216	6,334	3.4
Polonnaruwa	410	2,614	15.7
Matale	100	2,249	4.4
Northern	90	2,343	3.8

Source; Preliminary Technical report for GEF Project. Conflict Between Human and Elephant in Sri Lanka (Thouless, 1994)

2.5.4 House Breaking

Elephants attack houses, mostly to get access to stored rice, or other foodstuff inside (Weerakoon, 1999). In one case an elephant appeared to break into a house to get access to salt, and in another an elephant was reported as having died after eating a sack of flour, which swelled up inside its stomach. Elephants will break into even quite substantial brick build

houses using their heads to batter down the walls, and in some cases, where houses are on regular movements route, will attack the same house several times. All cases of house breaking appear to be caused by single bulls (Weerakoon, 1999).

The main factor affecting house damage appears to be whether or not houses lie on a regular movement route. Elephants have broken into some houses repeatedly. This is particularly noticeable in the area near Elahera (Thouless, 1994).

2.5.5 Indirect Effects

While the total amount of damage done by elephants may be relatively small, seldom exceeding 10% of the total crops, even in severely affected areas, the damage would be higher if people did not defend their crops. This means that during the harvest season, men have to stay awake at night, and expose themselves to danger if the elephants come (Thouless, 1994). This has a great impact on the psychology of these farmers.

2.5.6 Effects on Elephants

Publicity about human elephant conflict tends to be one sided, concentrating on damage suffered by humans. However, elephant suffer more in the long term. Clearing of jungle in areas once used by elephants usually causes the conflict. This disrupts their movement patterns and reduces the amount of natural food available to them. Farmers often defend their crops using shotguns or home made guns, both of which are more likely to injure elephants severely, than to kill them immediately, condemning them to considerable period of suffering (Thouless, 1994).

2.5.6.1 Number of elephants killed

The DWLC has not systematically collected information on numbers of elephant deaths and cause of deaths in Sri Lanka for many years. However, information is reported in the Regional Assistant Directors' monthly reports, and is available from other source. Table2.4 compiled from the recently established database summaries information on elephant mortality in 1993-4 (Thouless, 1994).

Table2.4 Recoded elephant mortality in Sri Lanka during 1993 and 1994.

	1993						1994					
	M	S	N	C	E	Total	M	S	N	C	E	Total
Jan	5	0	5	1	0	11	4	2	3	1	0	10
Feb	1	1	3	0	0	5	1	1	8	0	0	9
March	7	3	5	0	1	16	2	2	4	0	0	8
April	3	1	3	0	1	8	5	0	7	0	0	12
May	5	2	2	0	0	9	1	3	3	0	0	7
June	6	1	7	0	0	14	3	4	3	0	0	10
July	2	2	2	1	0	7						
Aug	3	2	7	0	0	12						
Sep	5	1	6	1	0	13						
Oct	6	1	3	0	1	11						
Nov	3	2	4	0	0	9						
Dec	4	0	2	0	0	6						
Total	50	16	49	3	3	121	18	12	28	1	0	56

Source; Preliminary Technical report for GEF Project. Conflict between Human and Elephant in Sri Lanka (Thouless, 1994)

There are also unconfirmed records of large numbers of elephants that have been killed due to the ongoing civil war in the north and east of the country. For instance 50 elephants were said to have been killed by the Tamil separatists between January and august 1990, and other elephants are believed to have been killed by land mines (Wanigasundara, et al 1990 cited as by Santiapillai, 1996).

2.5.6.2 Causes of death

The vast majority of the elephants reported dead had died as a result of human activities with gunshot injuries being the most common cause of death (Table2.5). Many of the accidents resulted from human interventions. These included poisoning (1 case). The large numbers of electrocution were partly due to farmers' attempts to protect their crops using exposed mains cables, and the lack of tension in the electric fences. It is possible that large proportion of the unknown category included animals that had been shot, were found too late for the cause of death to be determined (Thouless, 1994).

Table2.5 Recorded causes of elephant deaths.

Cause	N	%
Gunshots	246	57
Unknown	81	19
Natural	55	13
Accident	50	11

Source; Preliminary Technical report for GEF Project. Conflict between Human and Elephant in Sri Lanka (Thouless, 1994)

2.6 Methods Use To Minimize Human Elephant Conflict

2.6.1 Use of firecrackers

This is one of the commonly used methods to chase wild elephant off cultivated areas by farmers. But elephant soon learn to recognize such psychological bluffs. Rockets that end with a bang appear to be more effective, particularly with family groups. Bamboo gun rockets have been successfully used to chase wild elephant out of cultivation in Sri Lanka (Norris, 1959). In the past, wildlife Department officials in the filed used to provide farmers with thunder flashes. (Puchihewa, 1989 cited as by Santiapillai, 1996). But these devices could not eradicate the elephant raids but were able only in mitigating the problem (Santiapillai, 1996).

2.6.2 Use of Fire arms

Shooting with firearms and guns over elephants may be effective in driving the animals back in to the forest. But some belligerent bulls may ignore such noises and move in to cultivated areas (Santiapillai, 1996).

2.6.3 Trenches

To be effective, the trench has to be at least 2 m deep, 2 m across at the top and 1.8 m across at the base. However, under wet conditions, some erosion can occur, often resulting in a reduction of the effective depths of the trench (Blair & Noor, 1981 cited as by Santiapillai, 1996). The effectivenes of the trench can be improved by either strengthening the walls with concrete or by growing thorny vegetation along the inner- trench edge. Erecting an electric

fence along the inner trench edge can make a further improvement in the effectiveness of the trench. But these efforts will be expensive. Alternately, hollow trenches (1.2 m deep and 1.2 wide) can be used provided they are covered with a layer of bamboo matting which presents a psychological rather than a physical barrier. The traditional elephant-proof trenches, if well constructed and maintained, can be useful in minimizing elephant depredations. But its usefulness must be weighed against the cost of its construction and maintenance. In Malaysia, trenches did reduce the extent of elephant damage to oil palm plantations, but usually not significantly enough to warrant their high cost (Santiapillai, 1996).

2.6.4 Electric Fence

Many people, although an expensive option, see physical barriers, as potentially a permanent solution to an elephant problem. Several types of barriers have been tried against elephants, most commonly electrified wire fences (Hoare, 2003). In penisular Malaysia, the use of non-fatal electric fence has been found to be most effective in containing elephant depredations in oil palm plantations (Blairr & Noor, 1981 cited as by Santiapillai, 1996). The fence essentially consists of 2 strands of high tensile high carbon galvanized steel wires through which an energizer (operated either by a battery or solar panel) passes every second an electric pulse of 5,000 volts, which is non lethal because of its very short duration (3/10,000 th of a second). It appears to be the cheapest and most effective from of all physical barriers (Lahiri-Choudhury, 1991 cited as by Santiapillai, 1996). In one instance in peninsular Malaysia, the fence was parallel by elephants' foot prints and dung that the electric shock had one occasions literally "knocked the shit" out of the elephants (Blair & Noor, 1981 cited as by Santiapillai, 1996). But it is difficult to fool elephants. The tuskers have an advantage in that the ivory does not conduct electricity and so the tusks can be used to dislodge the fence or insulators. Constant maintenance is the key to the success of the fences (Santiapillai, 1996).

CHAPTER 3

Methodology

3.1 Study area

Pelwatte sugar plantation is located in between Wallawaya & Buttala. It belongs to Monaragala District of Uva Province and covers about 6933 ha of land area. Plantation mainly consists of two major parts, the nucleus state or the plantation area on the eastern part and the settlements and the industrial area on the western side. The whole plantation area is subdivided into sixteen blocks and it is interspersed by a number of forest patches and small tanks. Two flowing water bodies, the Menik Gaga & Kudaoya transect the estate from north to south. Its southern & eastern boundaries adjoin Yala National parks, and western boundary by Lunugamwhera National Park, Handapanagala sanctuary & Tank (Pelawatte Sugar Industries Limited, 1993). This estate lies on the boundary of the intermediate and dry rainfall zones of Sri Lanka, and ranges between 1957 mm to 1313 mm a year. The temperature varies only from $26C^0$ January to $29C^0$ in June. The two rainy seasons extend from early October to late January and from late March to late May respectively. The soil type of this area is Reddish Brown Earth(CEA, 1992).

Where the plantation is now located once was the natural habitat for elephant, wild boar and deer. Other than the elephants that are considered a problem, boars, deer and a number of wild fauna still occur on the plantation area. Chena cultivations, which took place after the forest clearance, were in constant conflict with the elephants. With the opening up of lands for cane cultivation at Pelwatta, the usual habitats of the elephant were destroyed and since then elephant have tried to return to these areas, damaging the sugar cane cultivation. Elephant have acquired a taste for sugar cane and try to migrate into the cane fields in the dry seasons.

A separate estate protection unit was established to control the elephant movements and remove elephants from the cane fields. Cane fire control was also a task allotted to the estate protection team. Several techniques were adopted from inception to keep away the elephants from the plantation like cutting trenches. The plantation boundaries are fully protected by an electric fence. The company also extended support to surrounding villages by erecting 23 km

from Ayakepolla to Gonaganara on the Buttala-Kataragama road protecting the villages in the immediate periphery of the plantation.

3.1.1 **Map of the study area** (Pelwatte Sugar Plantation)

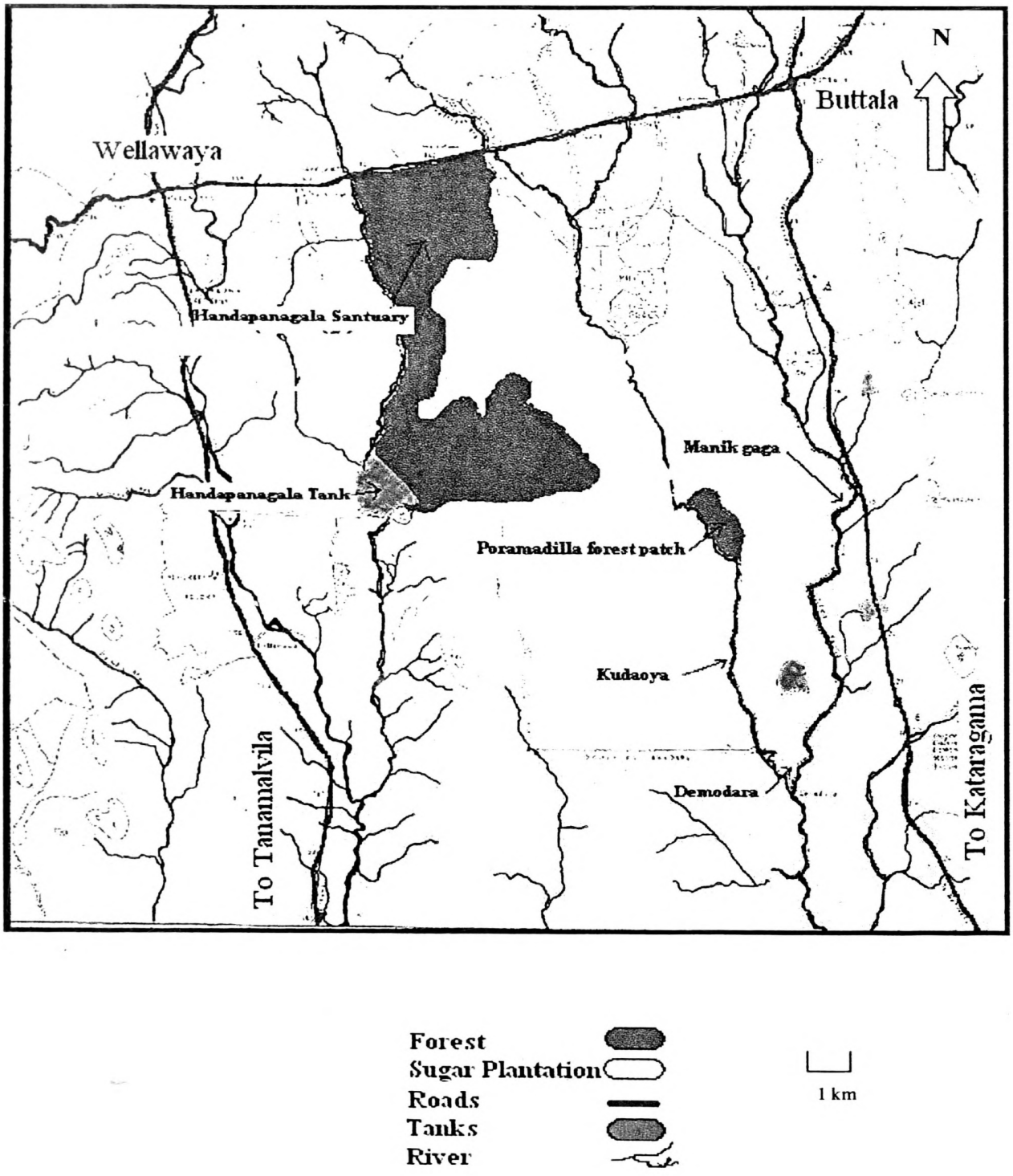


Figure 3.1 Modified map of PSI

3.2 Field Study

The study period was from 1st November 2003 to February 2004. During this period all the elephant drives conducted by estate protection section in PSI were followed up and all information of elephant drives were collected. These included the information on methodology adopted for the drive, the number of vehicles and laborers used, number of elephants in each drive and the path of the drive.

Information was collected on the electric fence by observations made in the field and a full trace of the fence along the boundaries of the PSI. The current status of the fence, weak points that are susceptible for damage, points that are often broken and the efficiency of the staff that guard the fence were some of the information accumulated.

All existing records of elephant problem of PSP were collected using PSI s monthly reports and annual reports of elephant drives. In addition, discussions and personal communication made with the staff provided additional information.

Elephant damage to sugar cane field was also a part of the field observations and is discussed in 3.3.2. In addition, rainfall patterns were noted to identify possible correlations with the pattern of elephant attacks.

3.3 Elephant Damage Assessment

The damage assessment was carried out using three methods.

1) Identification of the location and the nature of damage
2) Interviewing the workers and the farmers in the field
3) Quantification of the damage using pre determined values

3.3.1 Information gathering from crop damage sites

The damage site was visited and visual observations were made to collect information pertaining to damage caused such as the type of crop(s) damaged, the total area of the crop(s) damaged, number of elephant foot prints present, and diameter of the foot prints.

3.3.2 Interview with the workers, farmers and Field Officers

Farmers that experience crop damage were interviewed to identify how the elephant damage the sugar cane, how much sugarcane an elephant consumes over night and how much damage occurred in one night due to elephant movements.

3.3.3 Quantification of the damage using predetermined values

The damage caused was calculated according to the following basis.

1) If the damage site was mature sugar cane, it was assumed that a bull elephant damaged 1/4 acre overnight.

2) If the damage site was immature sugar cane, it was assume that a bull elephant damaged one-acre overnight.

CHAPTER 4

Results and Discussion

4.1 Map of the Electric fence

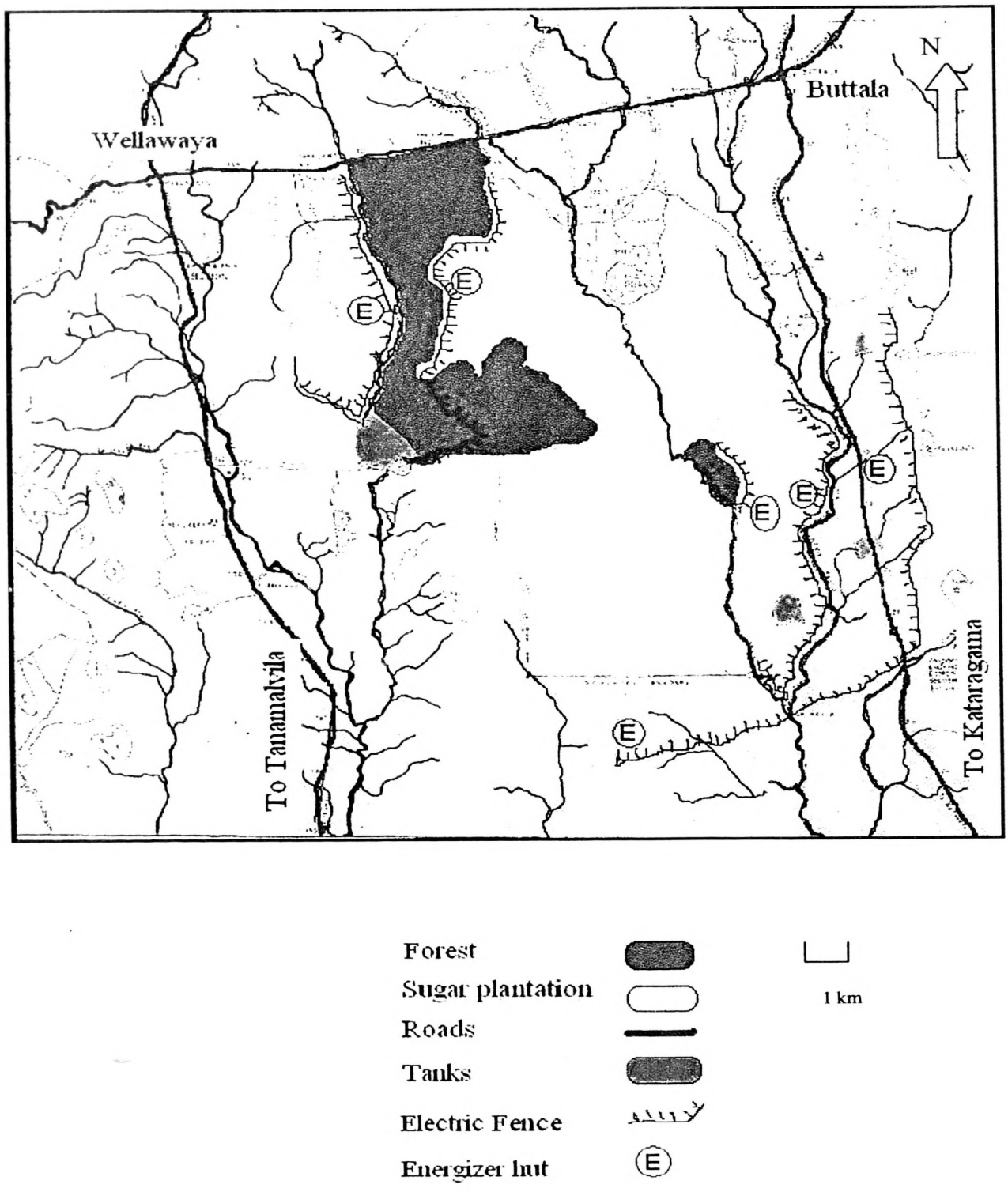


Figure 4.1 Map of The Electric fence

4.1.1 Location of Electric Fence

- 1st EF is located parallel to the Buttala-Kataragama road
- 2nd EF is located along the left bank of Menik Gaga
- 3rd EF is located in and around Poramadilla forest patch
- 4th and 5th EF's are located beside the Handapanagala sanctuary

For G.P.S locations of EF's see appendix II.

4.1.2 Design of the Electric Fence

In Pelwatta Sugar Plantation there is an Electric Fence (EF) system. Its main function is prevention of damage by elephants. It was established, maintained and repaired by Pelwatta Sugar Industry (PSI). Its total length is about 45 km and there are 5 EF. Its main (1st EF) fence is located in the eastern boundary of the PSP. It extends over 18 km parallel to Buttala-Kataragama road. The rest of the fence covers the southern boundary PSP. Electricity is supplied using a Solar Power Energizer (SPE) and a 12 kv generator. The other EF (2nd EF) is located along the left bank of Menik Ganga. The 3rd EF is located around Poramadilla Forest patch and 4th and 5th EF's are located along the Handapanagala sanctuary. All these EF's are powered by five separate SPE's.

The fences are not successfully and continuously maintained and therefore it does not function efficiently. EF is constructed using aluminum and wooden posts and at certain points wires are clipped to trees. This cause frequent short circuits and create weak points. There are problems regarding the night monitoring which is not efficient. The minimum attention of workers sometimes results in elephants breaking of the fence during night.

The point of the fence that is often subjected to break is at "Aya kapolla". This is a gap of the mountain range and falls across the easiest access path used by the elephants. They also use a location in "Kithul kote" where there is a discontinuity of the fence. During almost all the drives, the elephants cross the river at "Demodara" to get out the plantation, thus breaking the fence there in the process.

4.2 Peoples Perception

People's perception of the human elephant problem at Palwatte is highly varied and controversial. Although they all generally agree to the fact that elephants are problematic and the problem needs immediate solution, there are arguments over the quantification and the nature of damage and the solving of the problem.

4.2.1 Management

PSI management is highly concerned, especially economic viability of the present management strategy of this problem. They are expecting complete control of elephant damage as soon as possible. But the problem has been prevailing for a long time and does not seem to come to an end in the near future. Management has developed an action plan to control elephant damage. This plan suggests driving elephants of Handapanagala into Yala National Park permanently and strict monitoring of the electric fence.

They are trying to initiate this through the on going elephant drives. The elephant drives that are conducted frequently cost large amount of money labor and time. However drives are inefficient and elephants return with in a very short time.

Considering all the stakeholders, there is a clear conflict within and among the groups owing to their different perception of how to solve the problem. This can be one major cause to the delay of a permanent solution. Other major fact is the lack of understanding and awareness of the nature of the problem. There is willingness within the management for a long-term solution but a delay in action. There is an urgent need of co-operation among all these parties to find a solution for the problem.

4.2.2 Labourers

Laborers perception is not clear. Majority agrees to the fact that the present operation is not successful and only provides a temporary solution to the problem. They comment that EF and trenches are not well maintained. Although elephants cause damage majority of the laborers agree that elephants come to the plantations because once the area was their habitat. Although the laborers comment on the safety issues and threats to their lives by the presence of

elephants, it was observed that they are well used to the co-existence with the elephants within the plantation, even while they are working.

4.2.3 Farmers

Farmers' perception is almost the same as that of laborers, although they agree that the EF provides some protection for their cultivation. Apart from the plantation management, the farmers use their own methods to drive off the elephants. There were some past recordes of using guns to drive the elephants away but no evidence was recoded of this during this study. Farmers complain of the elephant damage but there is no "hatred" strong enough to kill elephants among majority of the farmers.

4.2.4 Wildlife Officers

The drives are done under the supervision of the wild life range officer from Monaragala .The wild life officer does not agree with PSI management strategy. Their perception is that not only the drive is inefficient; it is highly destructive to the elephant. DWLC propose an elephant corridor from Handapanagala to Yala as a long-term solution to this problem. The drive path is suggested to be reserved for this corridor.

4.3 Nature of the Elephant Drives

PSI protects their sugar cultivation by driving elephants to Yala National park. The duty of operations belongs to Estate Protection Section of PSI. It is lead by EPS Manager. In this section about 200 workers serve including field Assistants, Drivers and Labourers

A drive is planned accordingly with the number of elephants in the plantation. It may take place once in two weeks or few times a week. The elephants scattered all over the plantation are gathered to "Poramadilla" and kept their till and drive is conducted.

An elephant drive is conducted using about 13 workers, 3 or 5 Tractors, 1 Bowser, 1 Lorry and a Cab. Some times ED's are conducted during daytime for only few hours. It is dependent on climate, number of elephants and number of vehicles and workers available for the drive. Some times it extends throughout the night, which is extremely difficult. A truck with a watchtower attached to it locates the elephants and leads the drive. Animals are

directed to the path of the drive using tractors and firecrackers. The water bowser is kept alert for fire resulting form crackers.

Elephant are driven from Poramadilla to the nucleus estate and from there through "Demodara" across the Menik Ganga. Elephants go through the fence breaking it each time a drive is conducted. There are times when the drive becomes unsuccessful and elephants make there way back to the plantation. Almost always a number of elephants driven out of the plantation is less than the number that was gathered during the roundup of elephants as few animals invariably escape during the drive. Furthermore, during the drive extensive damage is done to sugar cane by tractors, workers and running elephants. This damage too is accounted as elephant damage.

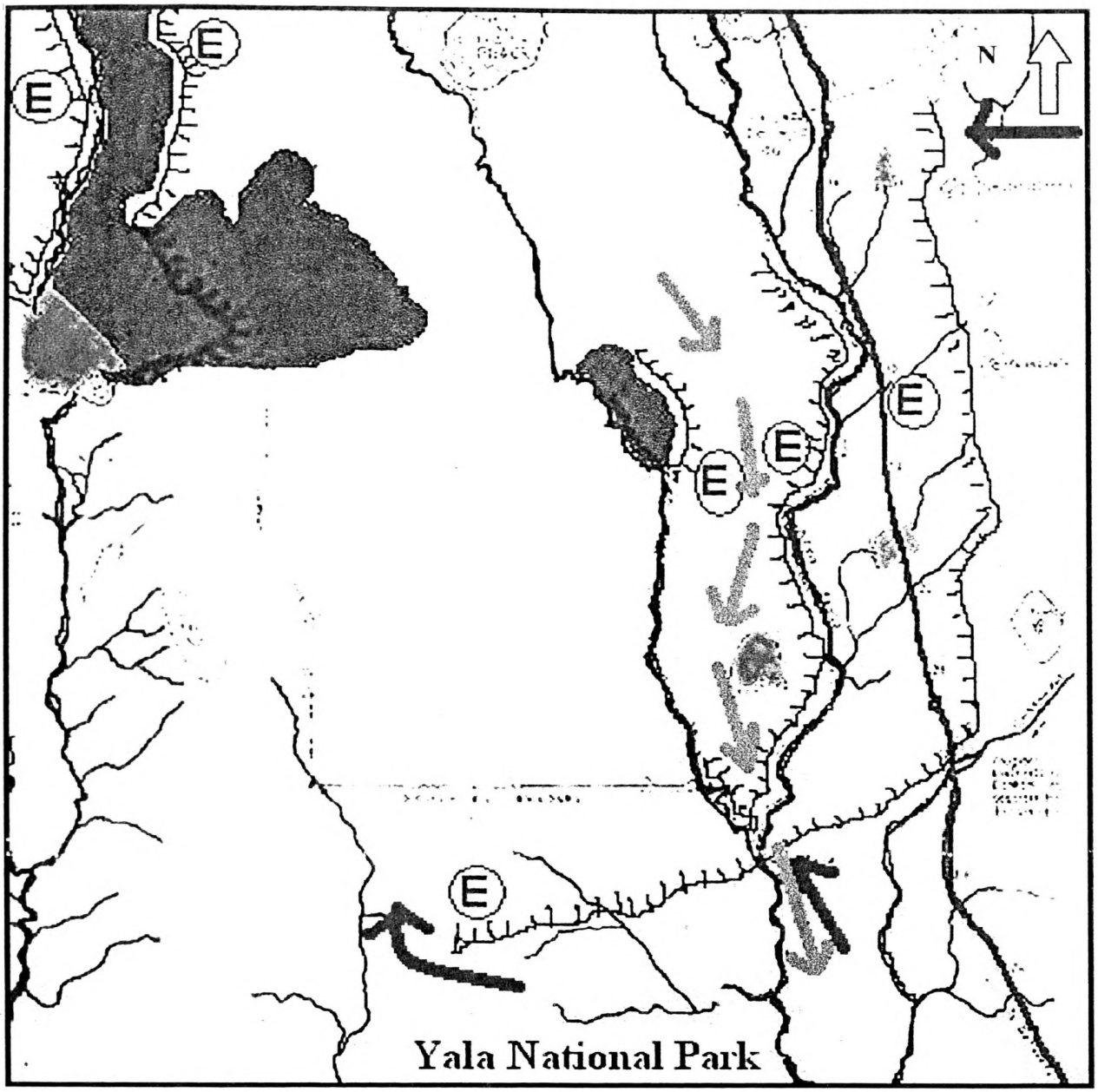


Figure 4.2 Elephant drive path in PSP to Yala

4.3.1 Existing Records of Elephant Drive

The recorded information by PSP of elephant drives conducted were extracted using EPS monthly reports and are given in table 4.2.

Table 4.1 Numbers of Elephant entering PSP 1994-2002.

	1994	1995	1996	1997	1998	1999	2000	2001	2002
	N/E	N/E	N/E	N/E	N/E	N/E	N/E	N/E	N/E
January	-	218	183	78		183	331	240	126
February	-	240	174	96	185	222	149	194	131
March	-	384	292	240	568	285	236	210	316
April	31	516	55	179	329	190	247	199	254
May	122	309	402	288	325	451	313	223	258
June	273	326	476	242	374	507	365	427	242
July	219	449	438	263	369	906	319	509	350
August	174	749	311	399	294	1363	380	692	649
September	577	869	149	310	422	795	492	911	646
October	349	906	360	274	473	564	614	959	382
November	645	388	219	156	388	336	335	513	298
December	540	288	116	-	209	339	281	376	103

Number of Elephant Entered (N/E)
Source: PSI Monthly reports

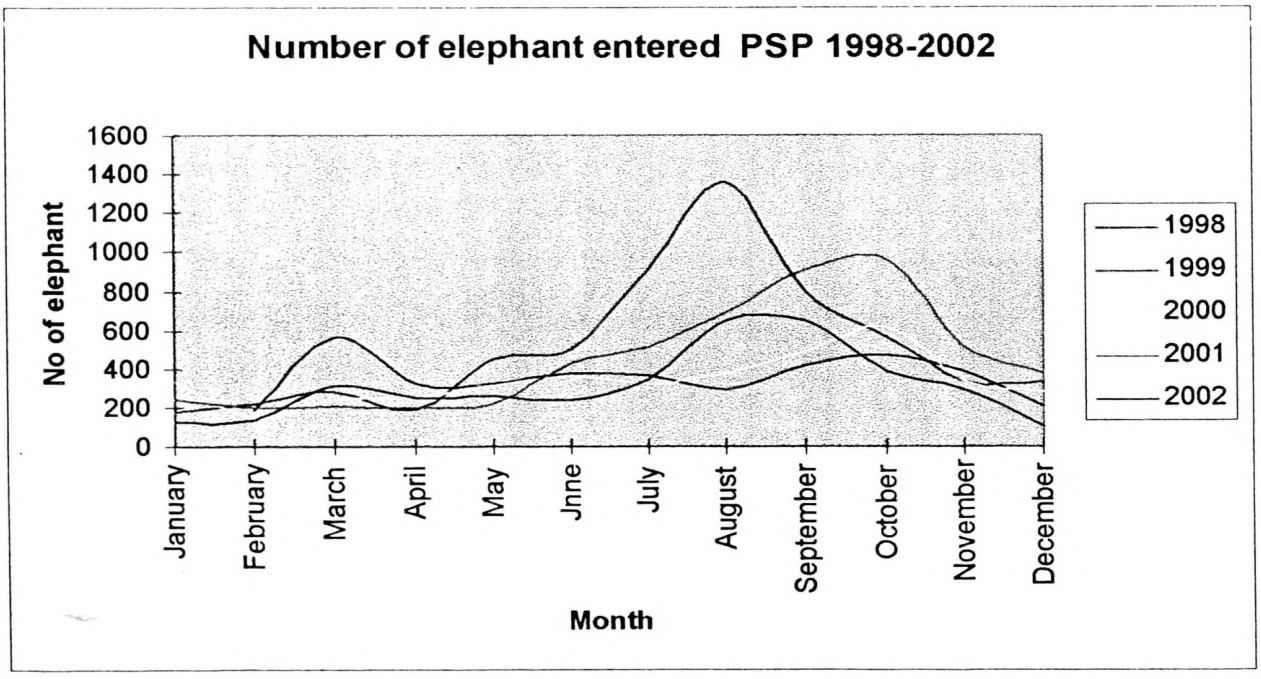


Figure 4.3 Number of elephant entered into PSP 1998-2002

Numbers of elephants entering the plantation annually are given in the table 4.1. This is not an indicator of the population but a cumulative count of the number of elephants encountered at each drive. Therefore the same elephant is repeatedly counted at each drive. The reliability and accuracy of these records cannot be assured and proper record keeping is essential for a long term management of this problem.

Table 4.2 Numbers of Elephants Driven out from PSP- 1994-2002.

	1994	1995	1996	1997	1998	1999	2000	2001	2002
	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
January		182	178	78		183	331	240	126
February		217	171	94	185	222	149	175	131
March	33	372	290	210	549	281	236	210	316
April	26	575	55	173	328	190	247	199	254
May	13	275	402	281	324	451	312	206	258
June	164	305	476	242	374	504	365	427	242
July	80	398	438	247	351	906	319	509	223
August	101	666	311	345	203	1363	380	692	486
September	477	735	149	263	403	795	492	911	473
October	345	872	360	273	470	564	614	959	380
November	594	382	219	155	388	336	335	513	280
December	508	218	116		209	339	281	376	94

Source: PSI Monthly reports

4.4 Rain fall seasonal patterns

Annual rainfall measured by the Agronomy section of PSI. is shown in Table 4.3.

Year / Month	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
January	130.9	305.3	166.7	17	129.3	120.5	121.2	128.8	32.7	84.4
February	113	96.8	76.1	32.3	30.5	239.8	305.5	63.9	85.8	78.5
March	41	148.2	87.1	2.7	42.5	84.4	126.7	111	58.4	342
April	228.5	197.7	264.6	511.7	90.8	82.6	45.2	294.2	129.6	234.8
May	11.7	169.9	2.7	236	76.6	9.2	42.5	4.9	103	116
June	1.1	42.6	10.7	5.4	1.5	45.6	45	54.4	4.9	4.5
July	50.4	1	6.9	16	186.2	8.2	10.5	27.8	0	73.1
August	22.4	0.7	250.7	11	107.5	0	89.3	31.6	17.4	23.9
September	164.2	86.7	105.7	142.9	97	61.1	108	31.4	59.5	53.1
October	301.1	282.3	170.4	292.4	89.7	249	58	222.2	161.7	76.3
November	264	328.3	211.3	478.9	434.5	262.3	229.7	318	408.8	462.6
December	153.6	50.1	195.7	293.1	287.2	60.4	48.9	217.4	139.2	31.9

Table 4.3 Rainfall in PSP (mm) 1994-2003. Source: Agronomy section of PSI

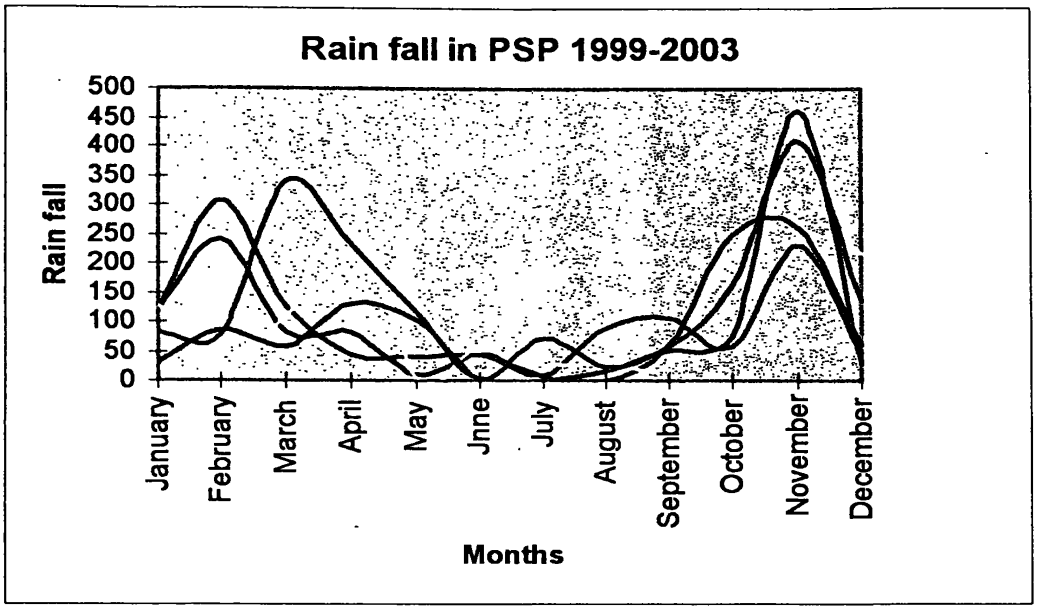


Figure 4.4 Rain Fall in PSP

Weather and climate is very important for the behavior of animals. Therefore the relationship between number of elephant entering into PSP and the rainfall was studied. According to existing data of rainfall (See figure 4.4) rainfall becomes decreased from February and March and from May to September. According to Fig. 4.5 each time when the rain fall goes down there is an increase of elephants entering into PSP. Therefore there is a strong relationship between rainfall pattern and elephant entering into PS. With the beginning of dry season, food and water become scarce. Therefore large elephant herds fulfill their food and water needs form easily available sugar cane and easily available water source in Handapanagala. This can be the reason for increased damage and high number of elephants entering PS plantation during the mentioned periods. It is also evident that the number of elephant damage decrease with the increasing rainfall.

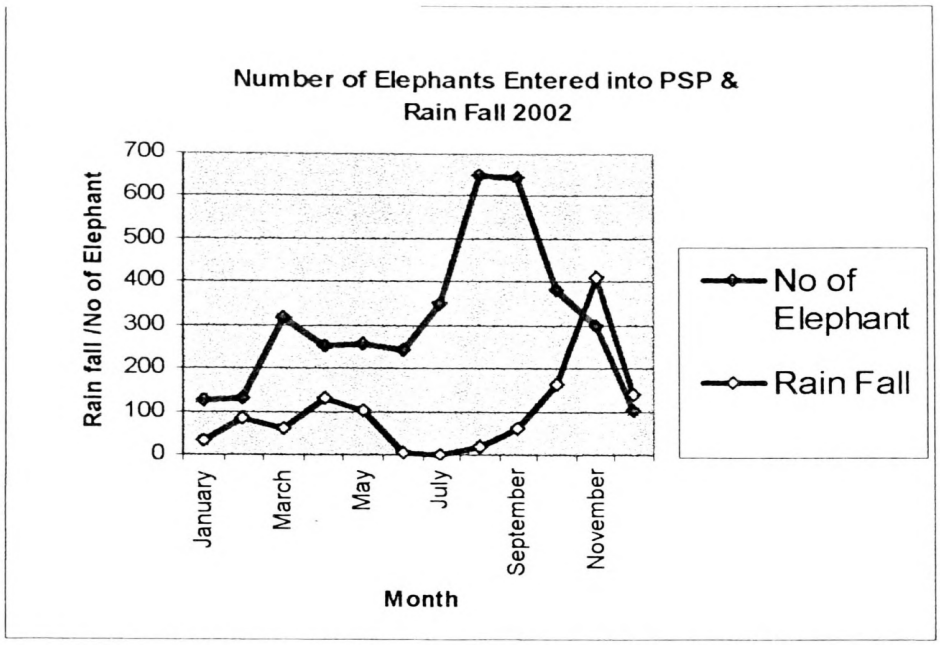


Figure 4.5 Number of elephant Entered into PSP &Rain Fall in 2002

4.5 Elephant Drive Records during study Period

Data in (Table 4.4) was obtained by the monitoring of elephant drives. The frequency of drives, number of vehicles, drive path and people participations in drives were recorded. This data shows a strong contradiction to the data from PSI reports. The numbers obtained are lower than what is given in the reports.

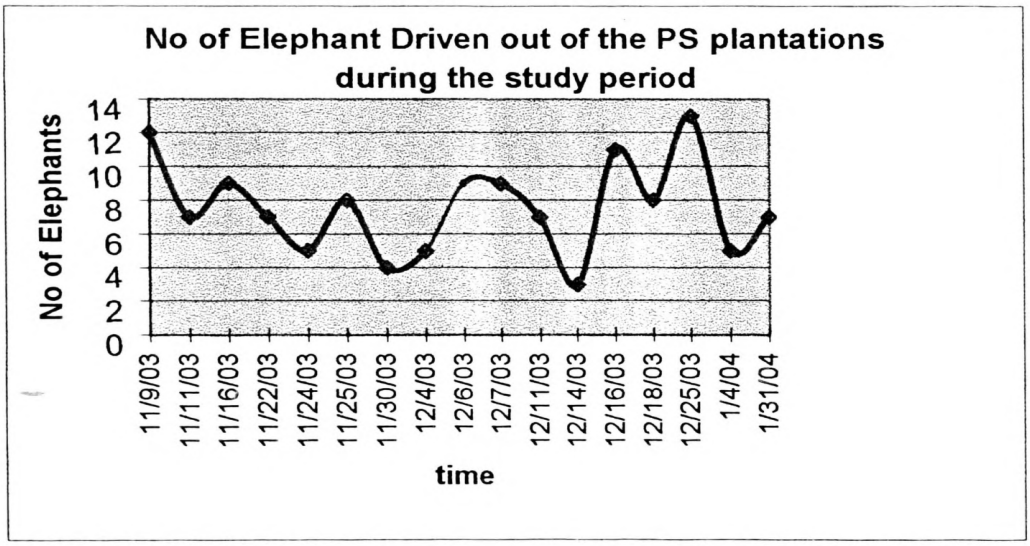


Figure 4.6 Number of elephants driven out of PS plantations from 2003 November to 2004 February.

Table 4.4 Elephant Drive Records in 2003 November to 2004 February.

Date	Number of elephant Drive	No of Vehicles	No of workers
2003/11/09	12	6	18
2003/11/11	07	6	18
2003/11/16	9	6	13
2003/11/22	07	6	15
2003/11/24	05	6	18
200311/25	08	6	14
2003/11/30	04	6	13
2003/12/04	05	8	22
2003/12/06	09	8	21
2003112/07	09	8	21
2003/12/11	07	6	17
2003/12/14	03	6	13
2003/12/16	11	6	14
2003/12/18	08	6	14
2003/12/25	13	6	15
2004/01/04	5	6	13
200401/31	7	6	13

Source: Collect in My Field study

4.6 Economic Damage to PSP by elephants

There are two major economic considerations. First, the economic loss due to the damaging of sugar cane and secondly, the cost of elephant drives.

4.6.1 Average Cost for One Elephant Drive

Average number people participation for one drive = 13 workers

Average salary for one workers = Rs 155/=

Average vehicles in used one drive = 6 vehicles

Amount of charges for one vehicle for one hour = Rs 800/=

Average time taken for one elephant drive = 6 hours

Average payment for workers in one elephant drive = Rs 2015/=

Average cost for vehicles in one elephant drive = Rs 4800

Total amount of spend in one elephant drive = Rs 6815/=

expenses together with the time spend by the management makes the true cost of the drive above the given value

4.6.2 Average Cost Damage Due to Elephant in PSP

Due to the wild elephant entering to PSP a considerable damage is done. Therefore to evaluate the damages in addition, the cost for the bowser, damage to vehicles which is often, food and other, a scientific method is required. After entering into Sugar cane field the elephant feed and move continuously. Due to this behavior sugar cane is damaged, not only as a food but also due to elephants moving. Therefore in damage assessment should be done carefully considering damage occurring due to both feeding and moving.

The damage assessment was based on the information derived from the field observations on the elephant damage and the discussions held with the farmers and laborers.

- There are minimum two elephant remaining all night in PSP
- Majority of the elephants entering the plantation are bull elephants.

According to basis used in the methodology, if the damaged site was mature sugar cane, it was assumed that a bull elephant damage1/4 acres overnight.

Average damage acres of due to min. two elephant in one night= ½ acres

Average damage acres of due to elephant in one year =365*1/2= 182 1/2

No of sugar cane production in one acres = 20 tons

Quantity of sugar cane damaged by two elephants per annum= 3650 tons

Economic value 1 Ton of sugar cane =Rs 1250/=

Average Economic lost of due to elephant damage =Rs 4,562,500/=

Caused by two elephants

This estimation made on an assumption. The value may vary on the actual number of elephants present in the plantation throughout the year. More accurate calculation can be done by doing a census of elephants in the plantation during a fixed time period and recalculating or recording the daily damage caused over that period of time.

CHAPTER 5

Conclusion and Recommendations

Resident and migratory elephants affect Pelwatta sugar plantation. Due to the elephant moving through sugarcane field and consuming of cane there is considerable a economical loss to PSI. Although the economical damage is further enhanced by the cost of elephant drives, the drives and the fence together manage to reduce the damage caused by the elephants to a considerable amount.

Efforts had been made to mitigate this problem in past, but none of them have successfully solved the problem.

Few publications are available on the Human Elephant conflict of the surrounding areas, but the awareness of the true nature of the problem in Palwatta is minimum, thus leading to a controversy and contradictory suggestion delaying the implementation of a solution. Complete documentation of the nature of the problem in Ecological, Economical and social aspects is required before any permanent mitigatory measure.

There are some elephant damage control measures adopted by PSI management and farmers. The most prominent are the electric fence and the elephant drives conducted by EPS of PSI. Watchman watches EF in during over night and in addition there is a trench parallel to EF. The efficiency of the fence and its maintenances not satisfactory and is continuously subjected to breaking by the elephants. The drives although are effective temporally is not a solution for the problem, the frequent occurrence of drives are highly damaging economically. The drives damage sugar cane and this too is accounted as elephant damage. The way the drives are conducted may have adverse effects on elephants.

Other than the short tem solutions, no permanent solution is available to mitigate this conflict at present. The PSI through a management plan has suggested driving elephants to Yala and securing the fence whereas DWLC suggests an elephant corridor along the drive path. Compensation through eco tourism is also being suggested as a novel solution to this problem.

An immediate solution is required to address the problem in agreement of all interested parties and a proper understanding of the problem. This requires active participation of all

affected parties including the elephant management personnel of PSP, officers of the DWLC, farmers, laborers and villagers to seek a suitable management strategy to overcome this problem. The efficiency of the fence should be increased to prevent or delay the return of the elephants after a drive. And present condition and trench should be maintains continuously the trench being filled by soil. Trench should be deep at least 2.5 m. A biological barrier together with the fence will be more effective in keeping the elephants out. More attention should be paid to keeping elephants from entering than driving them out.

A detailed study of the human elephant conflict of PSI should be conducted in future using this study and other supportive work as baseline. This is an essential step towards developing a proper understanding of the nature of the problem which is necessary in seeking a long term solution for the conflict that exist in the Handapanagala area.

Plate 1: Driving elephants to Yala

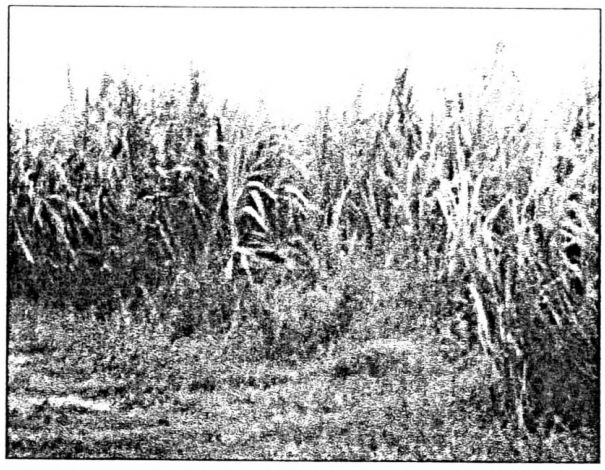


Plate 2: Damaged sugar cane field

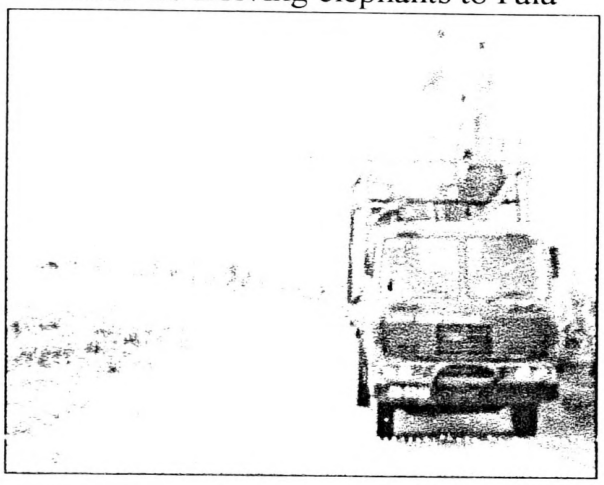


Plate 3: Searching for elephant

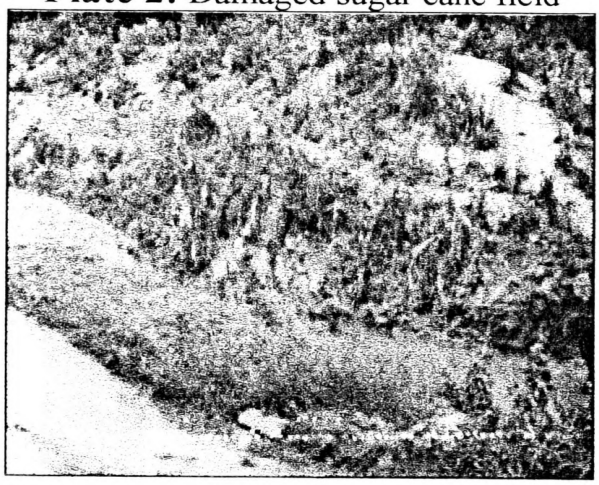


Plate 4: Trench field with soil

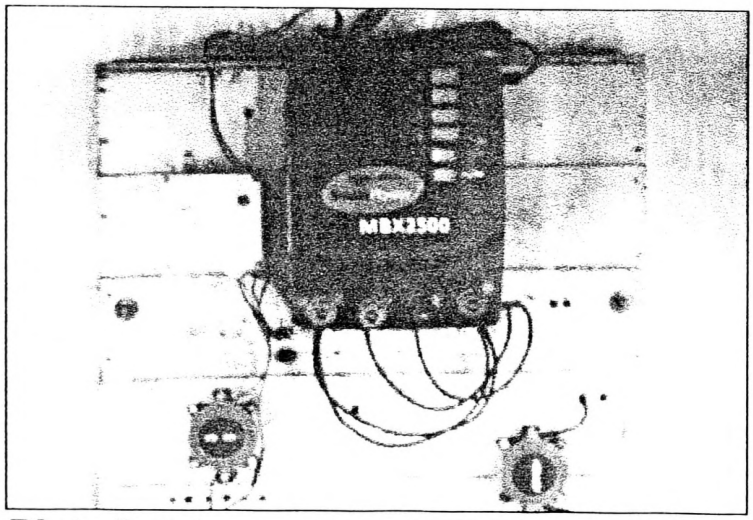


Plate 5: Solar power supply unit of electric fence

References

CEA. (1992). An Environmental profile of the Monaragala District,Central Environmental Authority with NORAD. pp; 41

De Silva, M. (1998). Status are Conservation of the Elephant (Elephus maximus) and the allevatiion of the man-elephant Conflict in Sri Lanka. Gajaha 19.

Fernando, A.B. (1993). Recent elephant conservation efforts in Sri Lanka A tragic Story. Gajah 10.

Fernando, P. (1999). Elephant in Sri Lanka Past Present And Future. Loris 22

Hoare, R. (2003). Http://www.iucn.org.

Jayewardene, J. (1999).Elephant Conservation in Sri Lanka. The Island 27-4-99

Munaweera, D.P. And Kuruwita, V.Y. (1995). Rapid assessment of human elephant conflict at Handapanagala area and recommendations for minimizing them. Department of forestry and Environmental Science, University of Sri Jayayardanapura, Sri Lanka (1996)

Munaweera, D. P. (1998). Handapanagala: a study in human-elephant conflict Management. Nature. V (1) pp. 66-68

Norris, C.E (1959). Preliminary report on the Ceylon elephant field survey by Te Times of Ceylon Ltd ., 24p

Pelwatte Sugar Industries Limited, (1993) Pelwatte Sugar Industries Limited: Company profile.

Santiapillai, C. (1998). Human-elephant conflict management in Sri Lanka. Sri Lanka Nature. V (1). pp; 34-36

Santiapillai, C. (1996). Mitigation of Human Elephant Conflict. Gajah 15.

Santiapillai,C. (1994). Elephant Mortality in Sri Lanka. Gajah 12: pp; 48-59

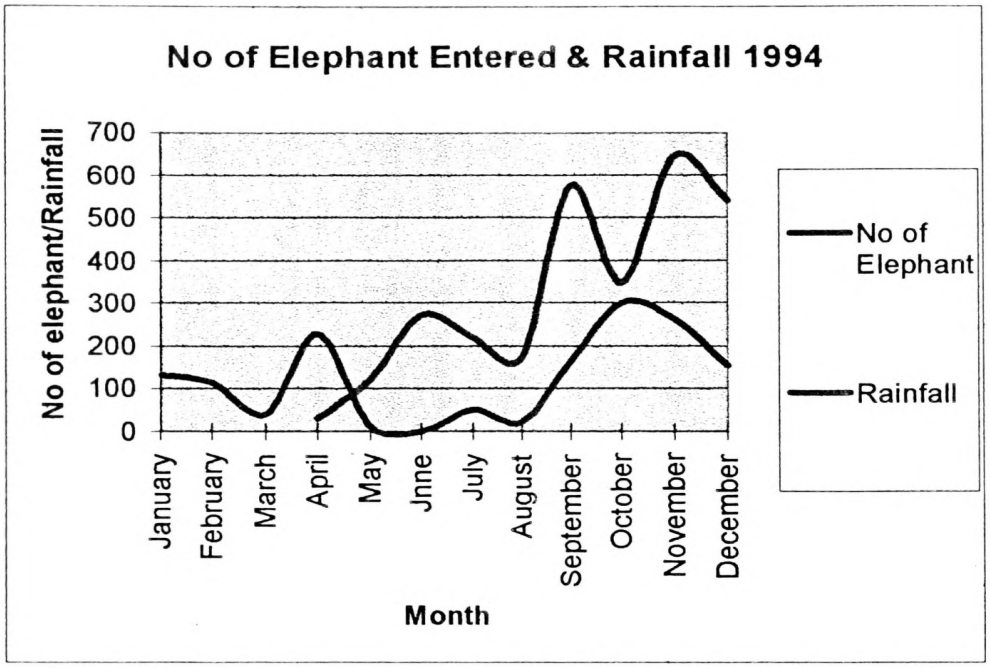
Thouless, D. C. (1994). Conflict Between Human and Elephant in Sri Lanka. Preliminary Technical Report for GEF project. Development of wild life Conservation and Projected Areas in Sri Lanka. Environmental Development Group. Pp. 41

Williams, A.C. (2003). Habitat Key to Human Elephant Conflict. Http:\\www.elephants.com.

Weerakoon, D.K. (1999). Ecology and Ranging Behaviour of Wild elephants and human elephant Conflict in Northwestern Region. A report submitted to Department of Wildlife Conservation.

Weerakoon, D K. (2001). Ecology and Biology of the Asian Elephant. Science in Sri Lanka 2.

Appendix I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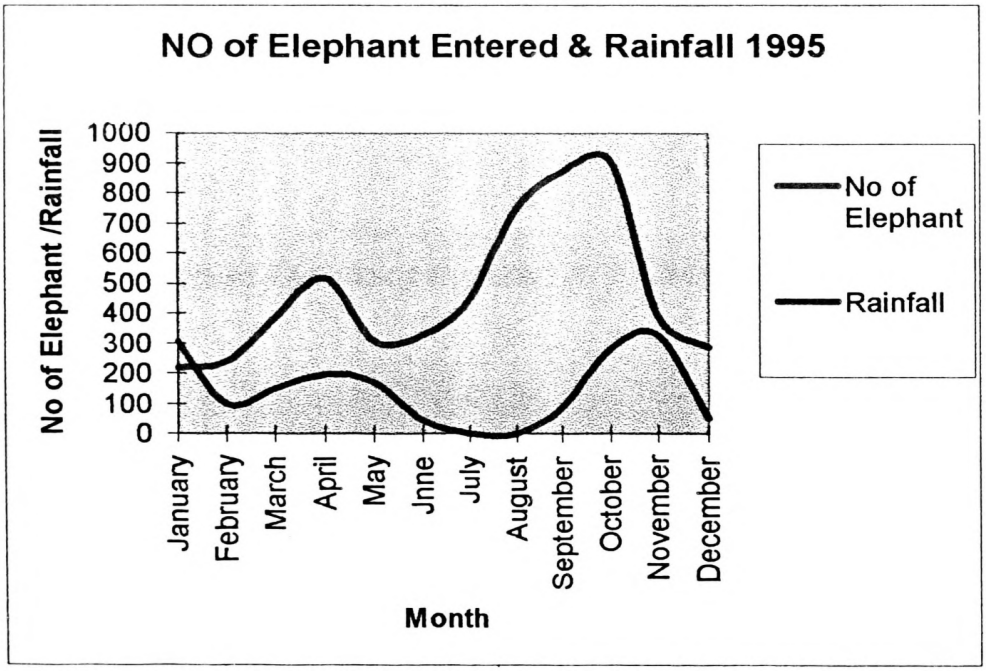
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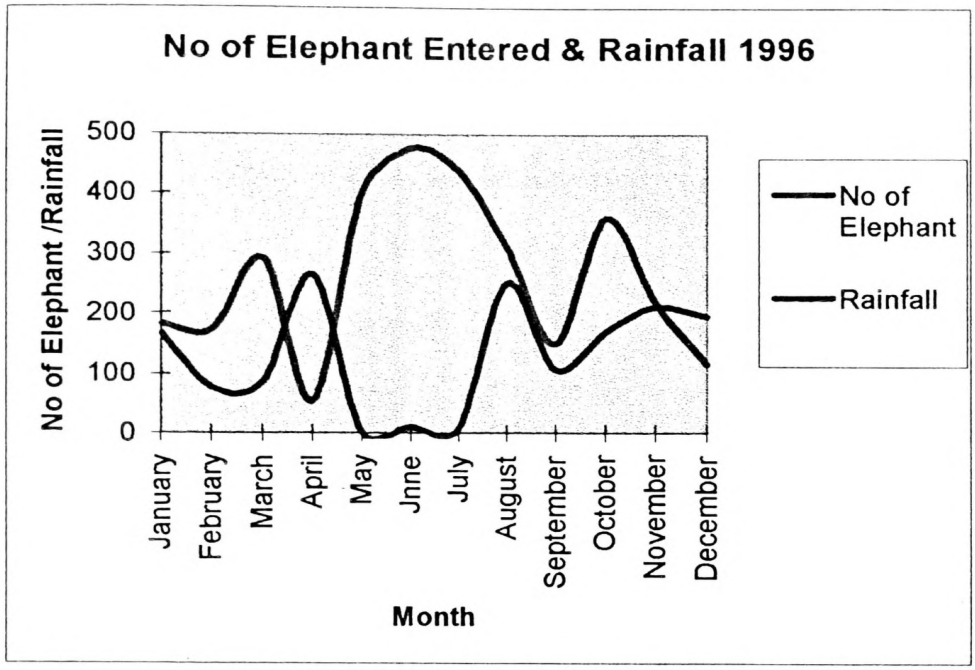
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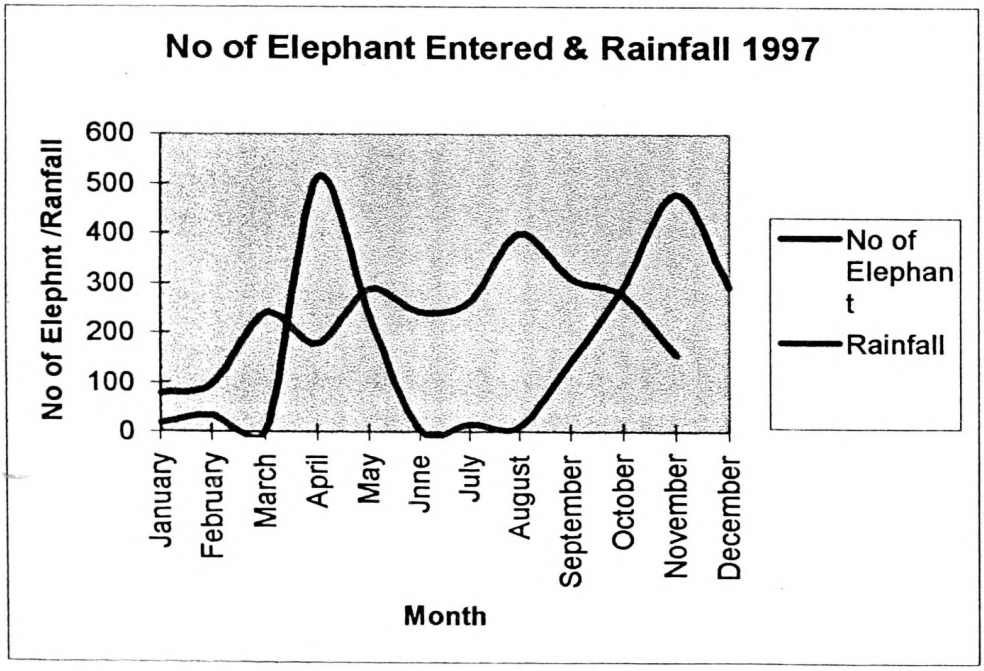
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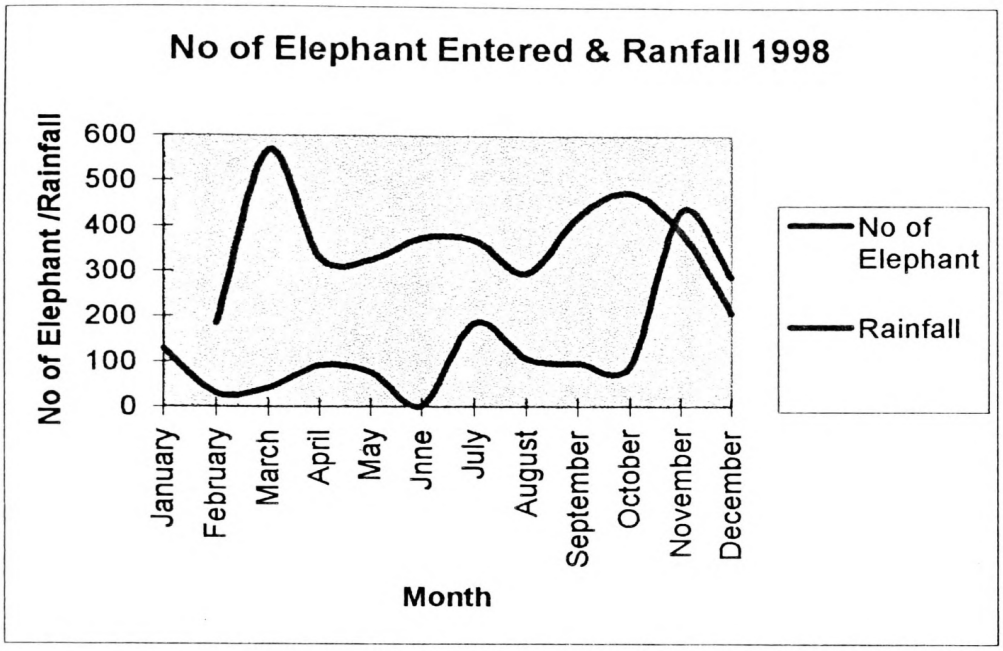
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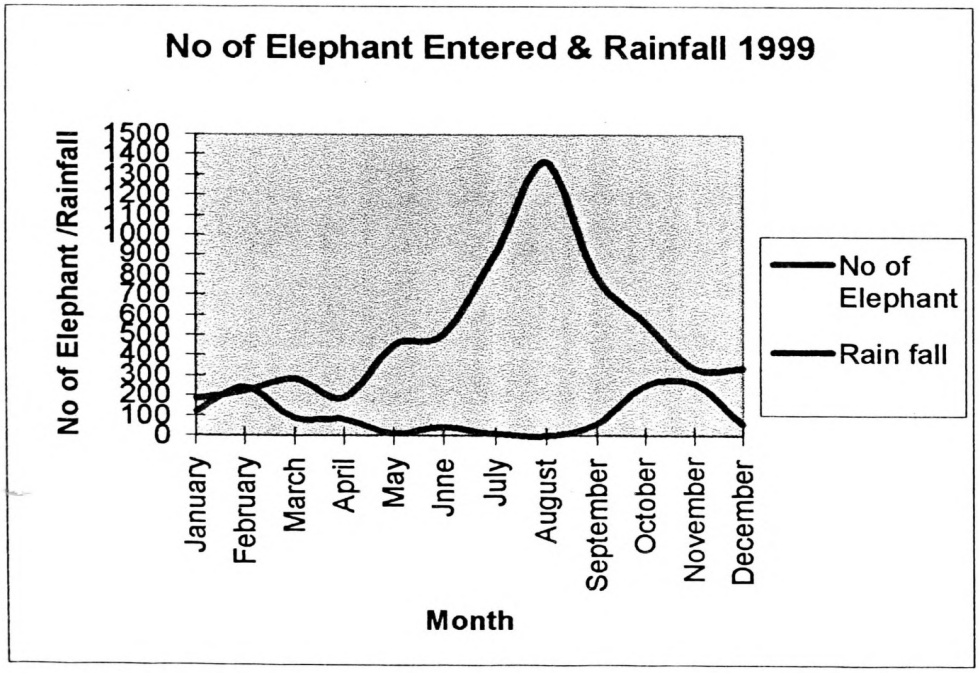
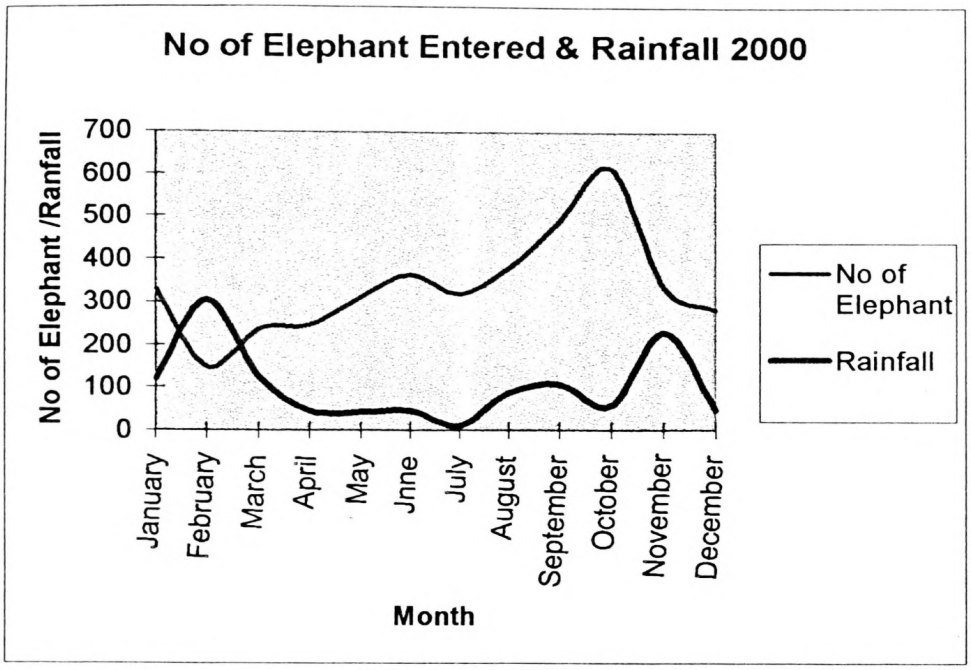
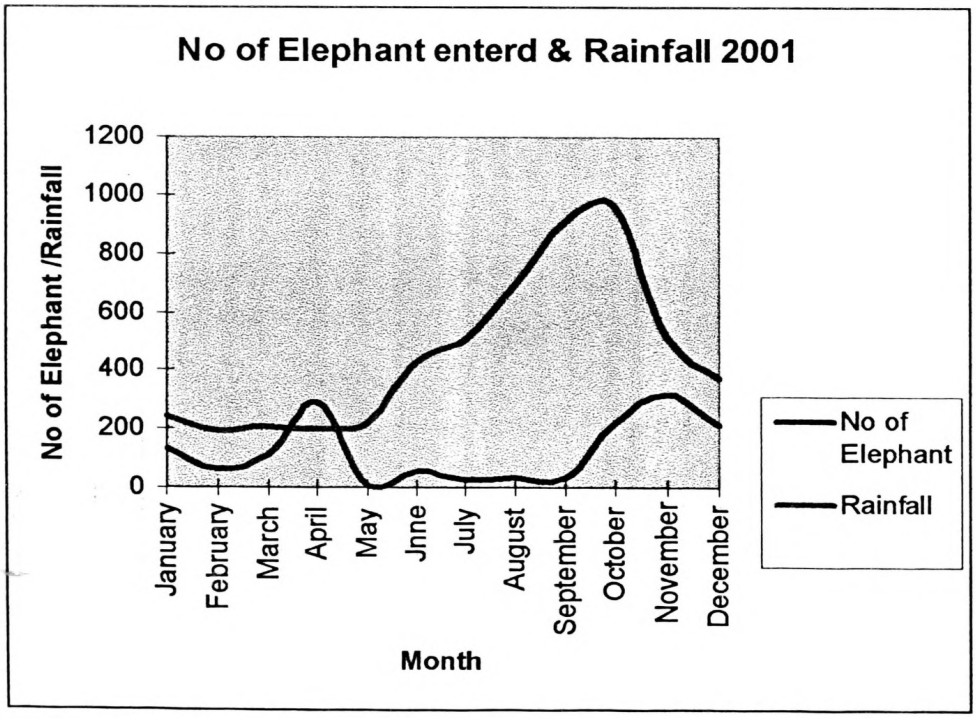
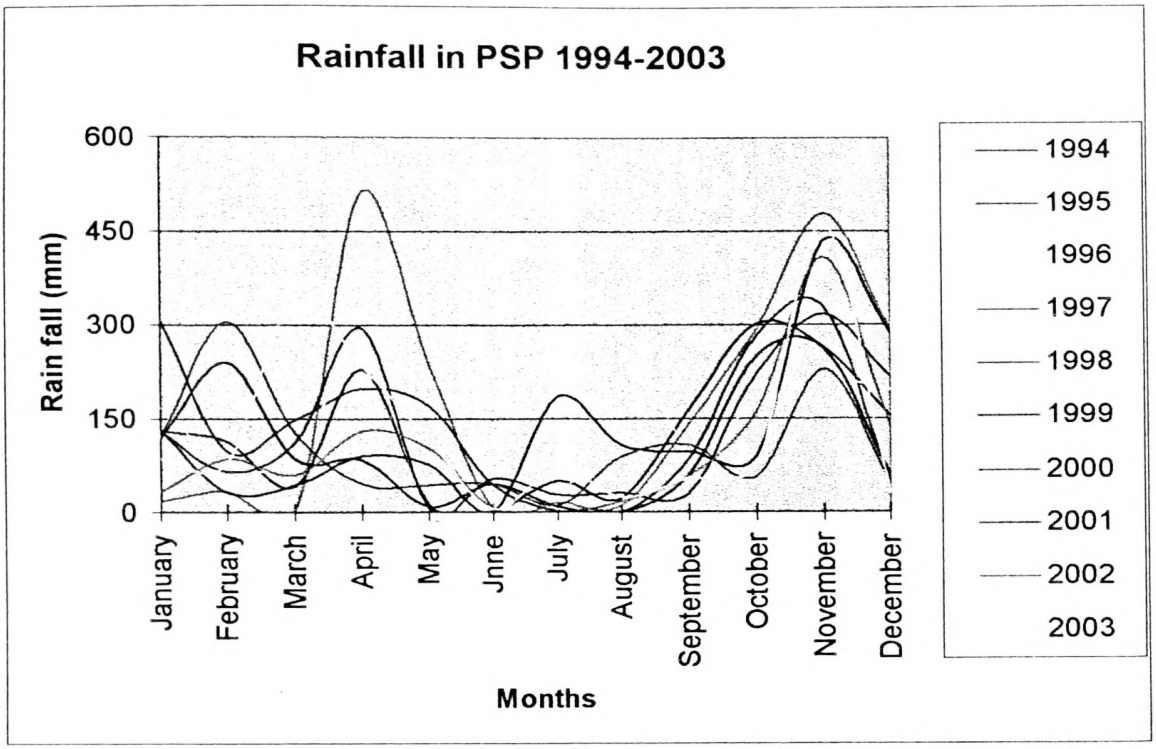
No of Elephant
Rainfall


No of Elephant Entered & Rainfall 1999
No of Elephant /Rainfall
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
January
February
March
April
May
Jnne
July
August
September
October
November
December
Month
No of Elephant
Rain fall


No of Elephant Entered & Rainfall 2000
No of Elephant /Ranfall
700
600
500
400
300
200
100
0
January
February
March
April
May
Jnne
July
August
September
October
November
December
Month
No of Elephant
Rainfall


No of Elephant enterd & Rainfall 2001
No of Elephant /Rainfall
1200
1000
800
600
400
200
0
January
February
March
April
May
Jnne
July
August
September
October
November
December
Month
No of Elephant
Rainfall


Rainfall in PSP 1994-2003
600
450
300
150
0
Rain fall (mm)
January
February
March
April
May
Jnne
July
August
September
October
November
December
Months
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003

Appendix II

GPS Location of Electric Fence

GPS Location of 1st Fence		GPS Location of 2nd Fence	
6' 41.605"N	81' 16.338"E	6 41.707"N	81 14.666"E
6 41.495"N	81 16.372"E	6 410.46"N	81 14.735"E
6 41.428"N	81 16.378"E	6 40.861"N	81 14.931"E
6 41.384"N	81 16.274"E	6 40.472"N	81 15.099"E
6 41.291"N	81 16.223"E	6 39.626"N	81 15.666"E
6 41.174"N	81 16.938"E	6 39.306"N	81 15.418"E
6 40.938"N	81 16.166"E	6 38.318"N	81 15.083"E
6 41.513"N	81 16.375"E	6 38.031"N	81 15.093"E
6 39.775"N	81 16.659"E	6 37.753"N	81 15.200"E
6 39.454"N	81 16.426"E	6 37.080"N	81 15.470"E
6 38.979"N	81 16.426"E	6 36.881"N	81 15.532"E
6 38.059"N	81 16.219"E	6 36.089"N	81 15.029"E
6 37.312"N	81 16.202"E	6 35.660"N	81 14.873"E
6 36.316"N	81 16.281"E	6 35.616"N	81 14.782"E
6 35.778"N	81 15.894"E	6 53.839"N	81 14.629"E
6 35.482"N	81 14.961"E	6 36.183"N	81 14.366"E
6 35.426"N	81 14.864"E	6 36.338"N	81 14.332"E

GPS Location of 4th Fence		GPS Location of 5th Fence	
6 41.189"N	81 10.715"E	6 41.152"N	81 08.422"E
6 43.912"N	81 10.618"E	6 41.117"N	81 09.250"E
6 43.609"N	81 10.653"E	6 41.765"N	81 09.294"E
6 43.067"N	81 10.684"E	6 42.561"N	81 09.174"E
6 43.038"N	81 10.173"E	6 42.906"N	81 08.998"E
6 42.530"N	81 10.015"E		
6 41.906"N	81 09.933"E		
6 41.346"N	81 09.991"E		
6 40.812"N	81 09.882"E		
6 404.63"N	81 10.205"E		
6 401.93"N	81 10.587"E		
6 39.866"N	81 10.370"E		
6 39.813"N	81 09.843"E		

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Mrs.T.N.NEIGHSOOREI
(MSSc.PGD.ASLA,BA)
Librarian
Sabaragamuwa University of Sri Lanka
P.O.Box 02 Belihuloya,Sri Lanka
Tele:+94 45 2280045
Fax:0094 45 2280045

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