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GAJAH

JOURNAL OF THE ASIAN ELEPHANT SPECIALIST GROUP

Number 12 JUNE 1994



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1. To highlight the plight of the Asian Elephant.
2. To promote the conservation of the Asian Elephant, and
3. To provide a forum for communication amongst the members of the Asian Elephant Specialist Group.

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Subscription price for two issues per year: Sri Lanka: Rs. 200.00 Overseas delivery: US$ 20.00
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THE SURVEY OF ELEPHANTS IN SRI LANKA

A report prepared for the Department of Wildlife Conservation by

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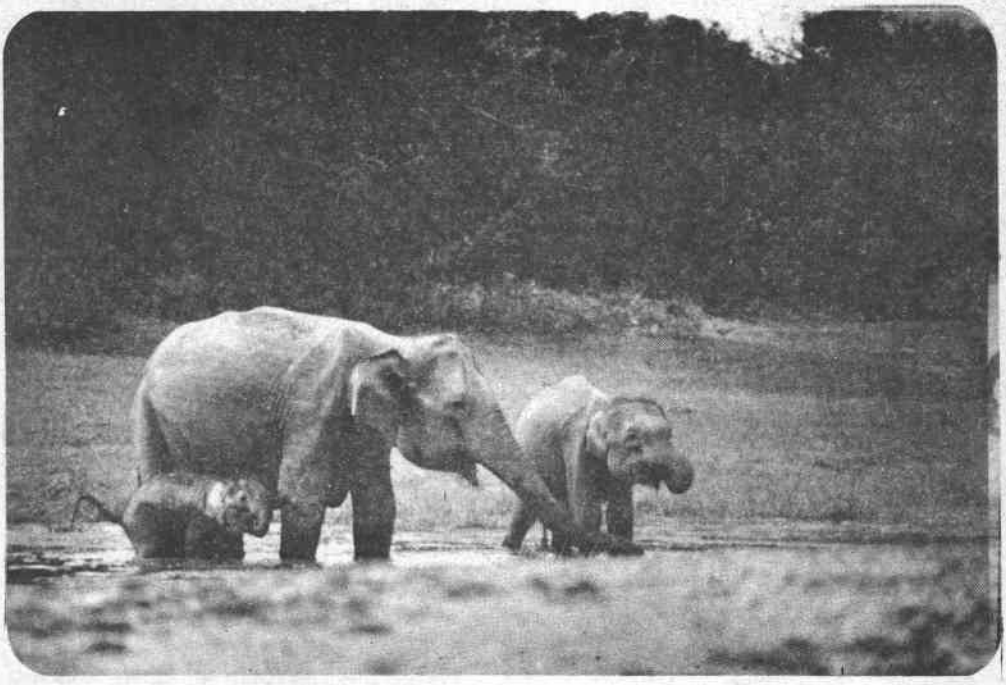
ABSTRACT

A survey of the elephants in parts of the Southern, Eastern, North Western, Central and Mahaweli regions of Sri Lanka was carried out for six days from 23 to 28 June 1993 in order to assess the structure and composition of the elephant populations. It was also designed to train the field staff in monitoring elephants in the wild. Some 800 personnel, including volunteers from NGOs spent more than 57,000 man hours recording the elephants in the five regions.

The population structure of the elephants appears to be biased in favour of the adult animals. The proportions of the adults, subadults, juveniles and calves on an average were 51.9%, 21.8%, 15.7% and 10.6% respectively. The highest proportion of the calves (21.1%) was seen in the Southern population. The adult sex-ratio varied from 1:1 in the small population of elephants in the Central region (n=30) to 1:2.9 in the Southern population. In the four large populations, the number of bulls per 100 cows ranged from 73 in the North Western to 34.8 in the Southern regions. No tuskers were seen among the adult bulls in the Central population but the proportion of the adult bulls with tusks in the rest varied from 15.3% in the North Western to 2.8% in the Mahaweli regions. It is significant to note that although the elephant population in the Mahaweli region makes up 34.2% of the estimated population size (minimum estimate) in the five regions, yet it accounts for the lowest percentage of tuskers (0.9%). The national average for the percentage of tuskers among the adult bulls, appears to be 7.3. In Sri Lanka, even though only a small proportion of the males have tusks, yet more bulls are being killed in conflicts with man.

The most frequent grouping consisted of 3-6 animals. In addition, larger groupings consisting of 10-20 animals were also observed. The largest grouping consisted of 124 animals. The most permanent social grouping appears to be related to cows and their offspring. Both solitary bulls and groups showed a bimodal pattern of activity, with activity reaching a peak during the late evenings.

While it is impossible to be certain about the actual population size of elephants in the five regions, it is clear that there are at least a minimum of 1,967 animals. Recommendations for logn-term conservation of elephants in Sri Lanka need not depend on precise quantification of its populations across the island. It is usually sufficient to know if they exist in significant numbers and thereafter, it is necessary to establish whether the populations are declining, increasing or remaining stable. The elephant is a "flagship species" whose conservation will result in the maintenance of biological diversity and ecological integrity across a large area of Sri Lanka.



Elephants in Ruhuna National Park, Sri Lanka
(Photo: Charles Santiapillai)

Introduction

The Asian elephant *(Elephas maximus)* is one of the most seriously endangered species of large mammals in the world. Given its enormous size and body mass, it is also one of the few species of terrestrial megaherbivores still extant. Its present geographic distribution extends from the Indian subcontinent in the west to Indo-China in the east across 13 countries including islands such as Sri Lanka, Sumatra and Borneo. The entire population in the wild is estimated to be between 35,000 and 55,000 (Santiapillai & Jackson, 1990). Even optimistic figures indicate that there are only about one tenth as many Asian as African elephants.

Throughout its rage, the Asian elephant is in decline. Increasing human populations and increasing agricultural land use have considerably reduced the area available to the elephants since the turn of the century. The obvious corollary to a decrease in a species' range, is a decrease in its resource base, and for such a wide-ranging species as the elephant, this means that the animal's flexibility to buffer the effects of local resource depletion by moving out is lost (Croze, *et al.*, 1981).

In Sri Lanka, changes in land use patterns are resulting in continuous contraction of the habitat available to the elephant, and over large areas of its range, there is no longer room for the animals to roam about and adjust their densities. The situation, as pointed out by Laws (1981) in the case of the African elephant, has reversed in Sri Lanka too from one in which "human islands existed in a sea of elephants, to a sea of people with elephant islands". The problem is further compounded by development programmes that have squeezed the elephants out of their former ranges and pushed them into a few refugia. The concentration of elephants into protected areas has led to a build up in their densities within these areas, even though absolute population size might be decreasing throughout the Island.

Erosion of habitats also forces the elephants into agricultural areas, where they destroy crops and at times kill people and in turn are themselves killed by irate farmers who have borne the brunt of elephant depredations. The elephants have lost so much of their former habitat, that they are now forced to invade the communities that have displaced them. This is the crux of the elephant-human conflicts in Sri Lanka (de Alwis & Santiapillai, 1993). Depredation by elephants has become a way of life!

It is now becoming increasingly clear that if the long-term survival of the elephant in Sri Lanka is to be enhanced, then some sort of a accommodation must be reached between man and elephant. Both have to live together by mutual adjustment. Furthermore, for elephant conservation to succeed, it should have the support of the local people. The local communities that bear the brunt of elephant depredations must be properly compensated for their losses. They must also be given the opportunity to participate fully in decisions affecting their land and resources.



Elephants In Ruhuna National Park
(Photo: Charles Santiapillai)

Rationale for the Survey

A sound scientific understanding of a natural resource is fundamental to any well planned management of that resource (Sale, 1985). In accepting the need for systematic research as the basis for improved management of elephants in Sri Lanka, the Director of Wildlife Conservation, Mr W. A. Jayasinghe embarked on implementing the plan to make an assessment of the current status of the elephants in the wild and in captivity, as recommended in the country's Five Year Development Plan.

An update on the status of the wild elephants in Sri Lanka was long overdue. The last comprehensive survey of the elephants in Sri Lanka was carried out more than 20 years ago, between 1967 and 1969 jointly by the Smithsonian Institution (USA) and the Department of Wildlife Conservation (Sri Lanka). On the basis of this survey, McKay (1973) estimated the *minimum* size of the total population of wild elephants in Sri Lanka at that time to be between 1,600 and 2,200. This estimate agrees closely with that of Norris (1959) who was very familiar with Sri Lankan wildlife. McKay (1973) based his estimate on the numbers known to be present in certain areas, and later extrapolated them to cover the entire island.

A more recent estimate by A. B. Fernando, who is very knowledgeable about wild elephants in Sri Lanka puts the figure as anything between 2,800 and 3,250 (Santiapillai & Jackson, 1990). These two estimates of abundance underline the difficulty involved in estimating the size of the population in the wild of even the largest terrestrial herbivore.

A considerable part of any study of wildlife populations relates to determining the number of individuals in population. But as Caughley (1977) points out, "estimates of abundance have no intrinsic value and they should never be considered ends in themselves. Many biological problems require no estimate of abundance. The majority of ecological problems can be tackled with the help of indices of density, absolute estimates of densities being unnecessary luxuries".

Objectives of the Survey

The main objective of the survey was to initiate a programme to monitor seasonally the changes in the structure of the local elephant populations across as large an area as is feasible. Obtaining information on the population size was incidental to the main study which was designed to understand the factors that mould population structure by affecting the survival of individuals.

The survey was also initiated with the view to providing the necessary training to the field staff of the Department of Wildlife Conservation so that they could regularly observe and monitor the changes in the structure (such as group size, composition, sex ratio, proportion of calves and tuskers) of the local elephants.

It was hoped that such a study would ultimately lead to an understanding of how elephants utilize their habitats, what times of day are favoured for feeding, how much time is spent in foraging, and how this activity varies seasonally.

In particular, much emphasis was placed on the need to monitor the proportion of calves and tuskers - two of the most vulnerable categories - in the local populations. The proportion of calves in any population is a good indicator of the habitat quality. The work of Corfield (1973) and Laws (1969) in Africa point to the selective mortality of calves, mature females with calves, and old animals among elephants.

It was not intended to carry out a census of the elephant population across the island. The entire island cannot be surveyed at present given the volatile ethnic situation currently prevailing in the country and hence an island-wide census of elephants is well nigh impossible. Estimation of elephant numbers was therefore incidental to the main objective of study of population structure of the elephants and it refers to the *minimum* number of elephants living in five regions.

Methods and Materials

While it may be possible at times, to record all the elephants in a small area such as Lahugala or Handapanagala, it is a much more daunting task to record all the elephants in such an enormous area in Sri Lanka as that incorporating the Southern, Eastern, North Western, Central and Mahaweli regions! In general, the larger the area to be searched, the more difficult it is to search the area effectively (Rodgers, 1991). A large area requires a greater amount of time or large number of people. This is the reason why, the survey was carried out for six days from 23 to 28 June 1993 and involved some 800 personnel, including volunteers from NGOs and villagers who spent a total of 57,600 man hours looking for elephants.

Such an exercise raises the problems of over counting due to movement of elephants (and observers too) during the survey period and to different observers recording the same animal. Attention to this bias was pointed out prior to the survey to the Senior Staff from the Department of Wildlife Conservation when they were given preliminary training at Pinnawala Elephant Orphanage and Ruhuna National Park.

The first training programme was held in Pinnawala under the auspices of the Director of Wildlife Conservation, on 13 and 14 March 1993. During this period, the domestic elephants provided the basis for the determination of the appropriate age and sex categories. This was followed by a more intensive field training given to the same staff from 26 to 31 March in Blocks I and II of Ruhuna National Park and at Handapanagala. On their return to their field stations, the Senior Rangers and the Regional Assistant Directors in turn trained their staff in the technique of monitoring and recording elephants in readiness to the proposed survey in June.

The problem with such an exercise is that it is often difficult to interpret the results. We have only the data sheets of the observers to rely on and there is thus no real way of telling how accurate or precise these results are. But the method, despite its inherent short comings, would be useful in that it is *repeatable*. It is particularly useful in studying the trends in the population, if it is repeated year after year in the same way, with the same bias occurring throughout. In successive total counts in an area, the highest total was taken to compute the minimum number of elephants in that area.

A total of 153 locations (listed in Tables 1-5) were surveyed during the six days and at every location, a group of five observers was given the task of monitoring elephants, Each group was led by a member of the Department of Wildlife Conservation. All observations were carried out from 0600 to 1900 hrs, from vehicles or on foot. Whenever elephants were encountered, the time, location, number of animals, size of groups, and activity were noted on maps and data sheets. Any special distinguishing marks (such as kinky tails, ear nicks, tusks, pigmentation, etc) were noted in order to help identify individuals and thereby reduce the possibility of double counting. All observations were made either with the naked eye or using a pair of binoculars. Each survey team covered as much of the study area as possible.

Population Structure
Southern Region

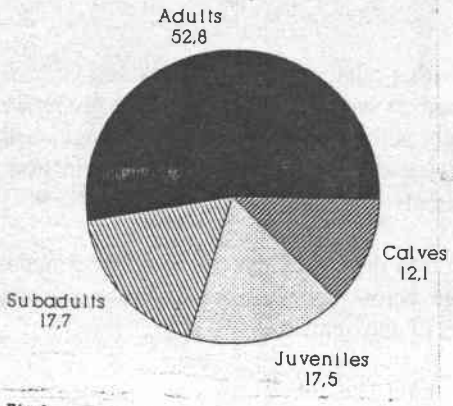


Fig 1

Population Structure
Eastern Region

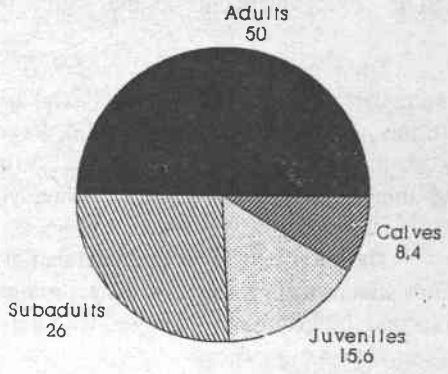


Fig. 2

Population Structure
North Western Region

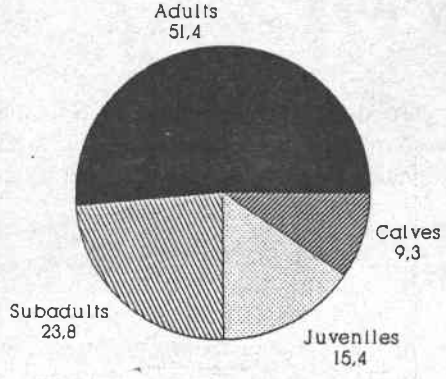


Fig. 3

Population Structure
Mahaweli Region

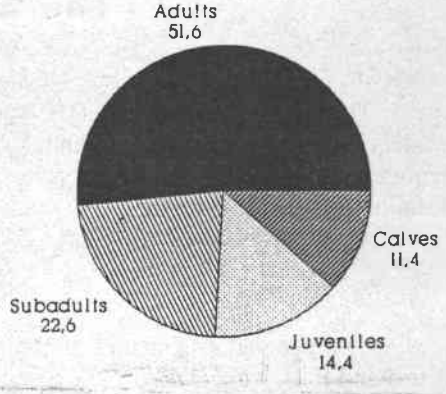


Fig. 4

Sex and Age Criteria

Sexing elephants in the field is not easy. It is particularly difficult in young animals. Tuskers present no problem but these are rare as only a small proportion of the males have tusks while the females are tuskless. The most reliable indicators of sex are the genitalia but these are not always easily observed in the wild. Often more indirect characters are used in sexing elephants in the wild.

The female in general is more box-shaped, with a relatively straight back and vertical hindquarters, whole the male tends to have a more convex back, which curves more gradually into the hindquarters (McKay, 1973). Reproductively active females could be distinguished by their tumescent mammary glands. Genitalia become become visible during urination, and this is about the only time when young animals may be sexed.

The relative size of the head can also be used to determine the sex of adult animals. Adult males usually have a very prominent bulge below and in front of the eyes, and a second bulge above the eyes which is lacking in the females.

For the purpose of censusing work, we distinguished four classes of animals based on age: adult, subadult, juvenile and calf. The calf can be easily distinguished by its long hair and its small size. It can easily walk under its mother. It is usually less than 1.2 m at shoulder height. The distinction between juveniles and subadults is not easy. Juveniles in general are between 1.2 and 1.5 m in height and tend to remain with the herd, forming play-groups (McKay, 1973). Subadult females tend to remain with the adults, while subadult males are often seen away from the herds (McKay, 1973). Males are considered to be in the subadult category from approximately four to nine years (Eisenberg & Lockhart, 1972).

The Study Area

The survey discussed in this report was carried out in five regions in Sri Lanka, namely the Southern, Eastern, Central, North Western and Mahaweli. The Padawiya tank represents the northern-most area surveyed. Observations were carried out in 153 separate locations in the five regions.

Results

The population structure of the elephants in the five regions are given in Tables 1 to 5 and Figs. 1 to 5, while Table 6 and Fig. 17 provide an overall picture of the population structure based on the total number of elephants (N=1,967). In addition, the population

Population Structure
Central Region

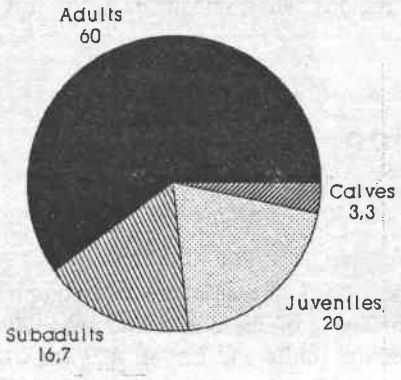


Fig. 5

Group Size
Southern Region

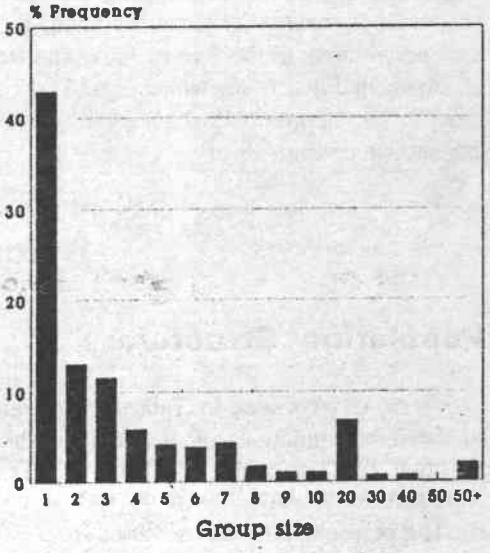


Fig. 6

Group Size
Eastern Region

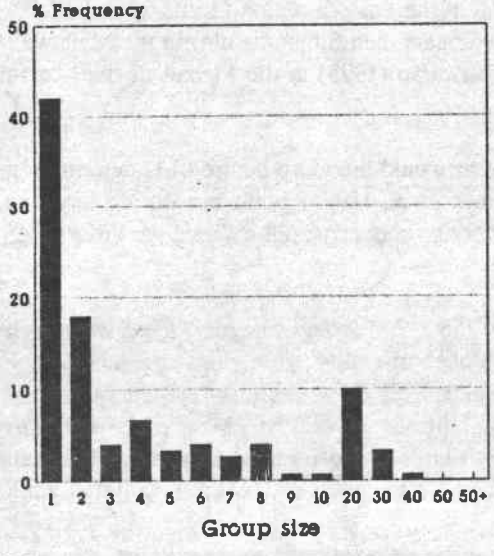


Fig. 7

Group Size
North Western Region

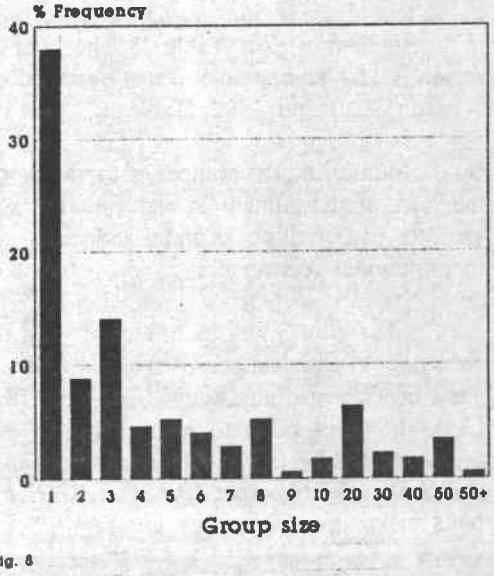


Fig. 8

structure of the classified animals is given in Table 7 and is based on a slightly lesser number of animals (N=1,611) as it refers only to those that were classified. The age and sex ratios of the elephants (Table 8) were based on the animals that were classified and not on the total number of animals counted. Table 9 refers to the proportion of tuskers in the five regions. The percentages of tuskers and the maknas (tuskless bulls) are based on the adult males. On the other hand, Fig. 16 refers to the proportion of tuskers in the total populations in the five regions. The frequency of groupings observed in the elephants is shown in Figs. 6-10, while Figs. 11-15 illustrate the activity patterns of the bulls and groups. The approximate boundaries of the five regions where elephants were surveyed are shown in Fig. 18.

Discussion

Population Structure:

As can be seen in Tables 1 to 5 and Figs. 1 to 5, the structure and composition of the five populations of elephants are biased in favour of the adults and subadults. Of the total 1,967 animals, 1,020 (or 51.9%) were adults (bulls and cows), 429 (or 21.8%) were subadults, while 309 (or 15.7%) were juveniles and 209 (or 10.6%) were calves (Table 6). The percentage of calves varies from 3.3 in the Central Region to 12.1 in the Southern Region (Figs. 1 & 5). This pattern is broadly similar to those of Eisenberg & Lockhart (1972) and Santiapillai *et al.*, (1984).

As far as the proportion of calves in each of the five regions is concerned, except in the case of the Central region where there was only 1 calf scored in a total of 30 animals, in the rest of the regions, it varies between 8.4% in the Eastern region (Table 2) and 12.1% in the Southern region (Table 1). The % of calves (less than 6 months old) in the Mahaweli region is 11.4 comparable to that observed by Ishwaran (1993) in the Mahaweli river basin between 1980 and 1982 (Table 3).

Monitoring the number of calves every year would therefore be useful in determining the rates of recruitment in elephants for as Laws *et al.* (1975) point out during any one year, the pattern of peaks and troughs in the lower age classes would indicate the differences in the annual recruitment.

Studies in South India indicate that from the 5-7 year age category, there was sharp reduction in the number of males owing to higher mortality from poaching, and hence adult males constituted only about 7.5% (Sukumar, 1989). Results from this survey in Sri Lanka however point to a much higher % of bulls as far as the *classified populations* are concerned (Table 7). The proportions of adult bulls in the Eastern, Southern, Mahaweli and North Western were 10.8, 11.2, 12.9 and 17.4 (in the aberrant Central population adult bulls make up 25% of the total).

Group Size
Mahaweli Region

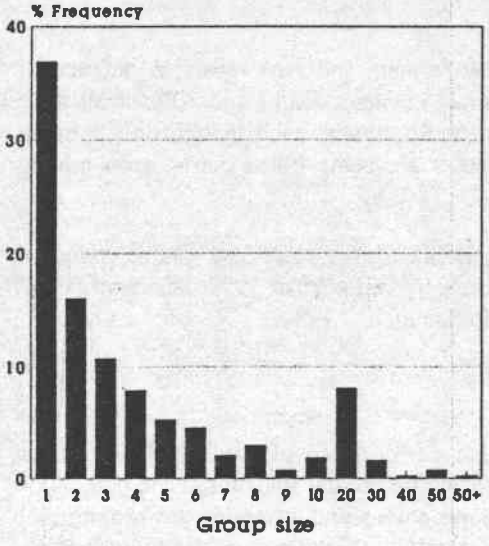


Fig. 9

Group Size
Central Region

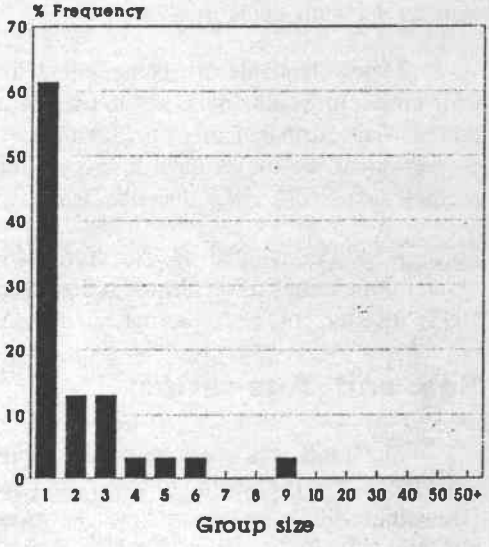


Fig. 10

Activity Pattern
Southern Region

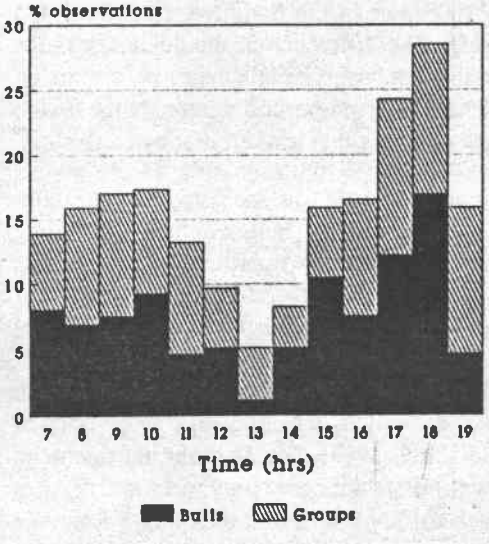


Fig. 11

Activity Pattern
Eastern Region

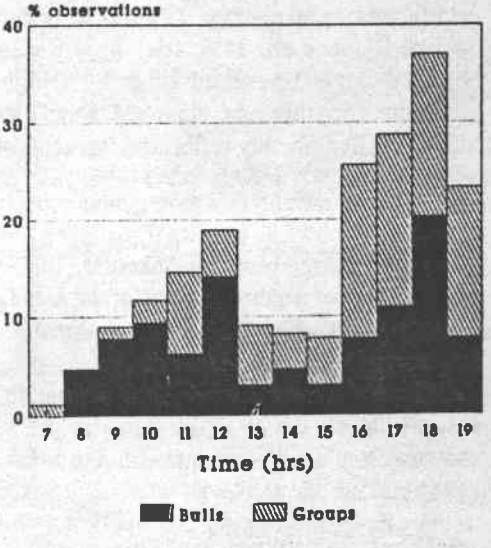


Fig. 12

It is likely that much mortality among elephants in Sri Lanka as a result of escalating human-elephant conflicts could be directed to the subadult males, especially when individuals move from away from herds, as they mature in search of the oestrus females. Future surveys must try to determine the proportions of the two sexes in both adult as well as subadult categories.

Many elephants are being killed today by farmers and pastoralists in defence of their crops. In South India, about 18% of all female elephant deaths and 70% of all male deaths were attributed to man (Sukumar, 1989). In Sri Lanka, even though only a small proportion of the males have tusks, yet many males are being killed during crop raiding as they take more risks than the females, especially those with calves.

Adult-dominanted age structure and female-biased sex ratios are characteristic of several populations of elephants in Sri Lanka (Eisenberg & Lockhart 1972; Ishwaran, 1981; 1993; McKay, 1973; Nettasinghe, 1973; Santiapillai *et al.*, 1984).

Sex and Age-ratios:

Sex ratio is a measure of the reproductive performance of any population and a knowledge of it is essential to understand and interpret other vital statistics of the population (Downing, 1980). In general, the sex ratios among calves and juveniles are roughly 1:1 but they vary in the adults. Table 8 shows the sex ratios of adults from the four Regions. The 1:1 adult sex ratio of the elephant population in the central Region cannot be considered realistic of the area on account of the small sample size (only 24 animals). However, as far as the other three regional populations are concerned, the North Western population has the most number of bulls (Table 8) with 73 bulls per 100 cows. This high percentage of the bulls in this region is perhaps the reason for the high incidence of crop depredations in this area by elephants. The ratios of bulls to 100 cows in the Southern, Mahaweli and Eastern Regions are 34.8, 46.0 & 54.5 respectively. The difference in the adult sex ratios observed might be caused either by a high mortality among subadult males or dispersion of animals in this age class (McKay, 1973). The lower proportion of the bulls in the Mahaweli Region may reflect the fact that this is the category that is often shot by cultivators.

The elephant is a polygynous species, where one bull can successfully mate with a number of cows in oestrus. Thus there is always some "surplus" bulls available for mating with cows. Furthermore, as Sukumar (1989) points out, a certain proportion of adult females would also be either pregnant or in lactational anoestrus, and therefore not available for conception, in which case, the operational sex ratio would not be as disparate as the observed sex ratio in the population.

But at some ratio of adult male to adult female, there will be too few males to ensure that all the available females are successfully mated, resulting in a lower rate of conception and a longer inter-calving interval (Sukumar, 1989). For elephant management, the important question is at what adult sex ratio will this factor come into operation? Except in the case of the Central (aberrant) and North Western populations, in the other 3 Regional populations, the adult male: adult female ratio was between 1:1.8 and 1:2.9 (Table 8). Despite

the low proportion of adult males, as long as the female mortality remains very low, the populations will increase or remain stable even in the face of a decrease in fertility due to higher male mortality.

Age-ratios too are an important source of information for management of elephant populations. They are a measure of the mortality and rearing success of the population (Downing, 1980). On an average, the population of elephants in Sri Lanka is composed of 51.8% adults, 21.8% subadults, 15.7% juveniles and 10.6% calves (Table 6).

Social Organization:

A total of 1,189 observations of elephants were made during the survey period but quite a number of these observations in fact referred to the same animals and/or groups and so the total number of elephants that were observed on 1,189 occasions (about 6,000 animals) should not be confused with the population size of the five Regions. However, these observations were used to work out the frequency of groupings seen among elephants during the survey (Figs. 6 to 10)

The overall pattern of the frequency of grouping is similar in all five Regions, with solitary animals being the most frequently observed category. In the Central Region, solitary animals make up 61.3% of all the observations, while in the North Western and the Mahaweli Regions, solitary animals make up 38 and 37%; and the % of solitary animals in the Eastern and Southern Regions are also similar (42.0 and 42.9 respectively). Almost 90% of the solitary animals are usually adult bulls (Santiapillai *et al.*, 1984). Groupings of 2 individuals were invariably either an adult male/adult female or adult female/calf combination. For the most part of their lives, adult males lead a semi-solitary existence, joining the herds mainly for breeding.

Group Size:

The group size of elephant was found to vary from count to count and also between the different regions. If we ignore the solitary and paired animals, the most frequently observed grouping consisted of 3-6 animals, recorded 104 times out of 406 observations in the Southern Region (26%); 27 times out of 150 observations in the Eastern Region (18%); 48 times out of 171 observations in the North Western Region (28%); and 123 times out of 431 observations in the Mahaweli Region (29%). In addition to this grouping, a larger grouping of between 10 to 20 animals was also observed in all but the Central Region (Figs. 6-10). The average subgroup of 3-6 animals presumably contains a matriarch and/or 1 or 2 adult daughters. In Africa, Douglas-Hamilton (1972) has observed the repeated recombination of individual family units. Laws *et al.* (1975) refer to such a repeatedly recombining group as an "extended family".

Groups of more than 50 animals were seen on ten occasions in the Southern, North Western and Mahaweli Regions. The largest grouping seen consisted of 124 animals in

the Handapanagala area. Such large groupings have no long term cohesion and are composed of several smaller subunits (Ishwaran, 1981). It was found that in Africa, regions with the highest group sizes were the ones in which poaching was prevalent, while those areas most secure from poaching had the lowest group sizes (Eltringham, 1977).

Elephants occur in discrete groupings of two types - the family unit, consisting of closely related adult females and their immature offspring, and the bull herd, which is a loose association of males of all ages above puberty (Eltringham, 1977). Such bull units were also observed during the survey. The largest bull group with nine animals was recorded in Handapanagala indicating a high level of disturbance in the area. These all-male groups have a rapidly changing composition of individuals and are usually associated with disturbed areas. Croze (1974) reports bull herds in Seronera bordering on heavy cultivation outside the Serengeti National Park. Laws (1974) has postulated that group size is a measure of the ecological health of an elephant population, since aggregation of family units and bull herds is the result of stressful conditions. This was also borne out by the study of Ishwaran (1981) who found the mean group size of an elephant population in an area interspersed with human settlements to be larger than that of a similar population living within a nearby national park.

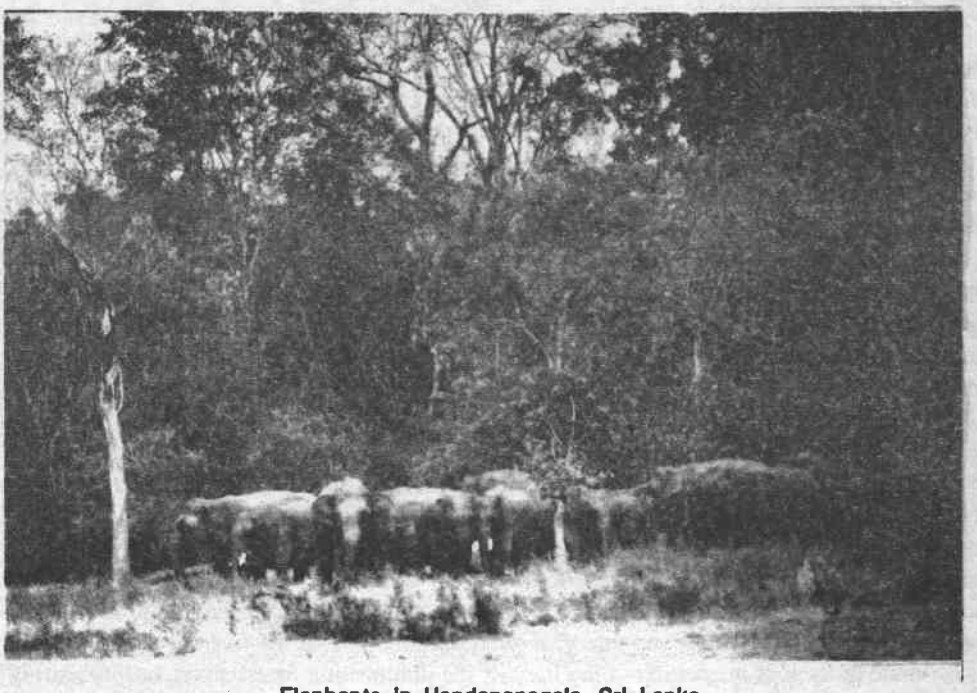
Diurnal Activity:

The diurnal activity patterns of both solitary adult bulls and the mixed groups are illustrated in Figs. 11-15. In all but the Central Region, both bulls and groups clearly show a bimodal pattern of activity, with activity reaching a higher peak during the late evenings about 1700-1800 hrs and a less pronounced peak in mid-mornings. Much of the activity observed refers to feeding. Elephants spend a long time feeding in their habitats as a result of their large body size, intemperate appetite and the relatively inefficient digestives system. Elephants may abruptly disappear from an area, suggesting that they may at least undertake extensive movements within a large home rage (Wyatt & Eltringham, 1974).

Number of Tuskers:

The proportion of male elephants possessing tusks varies enormously among different Asian elephant populations (Sukumar, 1989). In Sri Lanka, Deraniyagala (1955) found that 324 bulls out of a sample of 364 were tuskless (or 89%). McKay (1973) in a much smaller sample of 25 captured bull elephants, found 23 (or 92%) animals to be tuskless.

As can be seen from Table 9, the proportion of tuskers *among adult bulls* varies from 15.3% in the North Western Region to zero in the Central Region. In other words, the percentage of the tuskless males *(maknas)* among the *adult bulls* varies from 100% in Central to about 84.7% in North Western Region.



Elephants in Handapanagala, Sri Lanka
(Photo: Anouk Ilangakoon)

The number of tuskers *as a proportion of the overall population size* in the five regions is given in Fig. 16 Mahaweli Region has the lowest proportion of tuskers (0.89%) relative to the total population size. It is in this Region that several tuskers have been killed in the recent past as a result of escalating human-elephant conflicts, brought about by elephant depredations on cultivated crops. The National average of the percentage of tuskers *among the adult bulls*, appears to be about 7.3 (Table 9), and the two populations in the Southern and North Western Regions have higher proportion of tuskers (10.2% and 15.3% respectively) and thus need greater protection against poaching.

Number of Elephants:

In a survey of this nature, covering enormous areas and involving several hundred people, the data need to be checked rigorously in order to minimize the error due to over counting of animals. The same individual elephant can be counted by several observers placed along its path of movement over several days. The dense and tangled nature of the vegetation also makes it difficult to observe the entire groups moving through the forest and hence many observations will not represent the true size of the groups.

In this analysis, we have tried to reduce the error due to repeated counting of the same individuals by removing as may doubtful observations as possible from the total. In this, we relied heavily on the notes the observers had supplied, especially with reference to the number of calves in the groups seen and any other distinguishing features found on the animals. We recognize that this method is far from perfect but we hope that by providing a *minimum estimate* for the number of elephants in the five regions, such errors could be reduced. By being too critical, we may have pruned down the total to less than the true population size of elephants. But there is no way of checking this on the basis of just one survey. In future surveys, some areas could be cross-checked through indirect methods based on dung deposition and decay, in particular that of Barnes & Jensen (1987), which has been successfully used in tropical Africa and Asia to estimate the elephant numbers and densities.

The survey indicates that there are at least a *minimum* of 1,967 elephants in the five regions. The largest number of elephants are to be found in the Mahaweli region (34.2%) and the lowest number in the Central region (1.5%), as can be seen in Fig. 17. It is however interesting to note that although the Mahaweli region has the highest number of elephants, it has the smallest proportion of tuskers (Fig. 16). While it is impossible to be certain what the *upper limit* of the size of the elephant population in the five regions is, it is clear that there are at least *a minimum of about 2,000 animals in the five regions* surveyed. This estimate in itself is interesting in the light of the diminishing forest cover and increasing human population in Sri Lanka. The island of Sumatra which is more than 7 times the size of Sri Lanka is estimated to have only between 2,800 and 4,800 elephants (Santiapillai & Widodo, 1993).

Conclusion

The preliminary survey of elephants carried out in June 1993, represents an attempt on the part of the Department of Wildlife Conservation to update the status of the elephants in the wild. It recognizes the fact that the current political situation prevailing in the country does not permit an island-wide survey of the elephants, as many areas in the North and East are in the North and East are inaccessible and/or dangerous. Information on the changes in the structure of the elephant population on a yearly basis would be useful if measures aimed at its conservation in Sri Lanka are to be appropriate and effective.

Any real understanding of what is happening to the wild elephant populations in Sri Lanka depends on several factors such as the size of the population, its rate of reproduction, its natural mortality rates, and the number and ages of elephants that are being slaughtered these days by poachers and pastoralists alike. Such information is necessary to predict the fate of the elephant populations. But to obtain such reliable information, scientific research must be carried out at regular intervals. The present survey, carried out by a large number of people represents a scientific basis for the long term monitoring of the elephants in Sri Lanka.

Activity Pattern
Northwestern Region

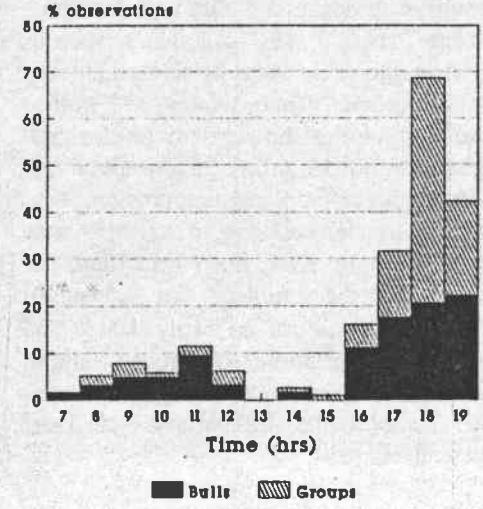


Fig. 13

Activity Pattern
Mahaweli Region

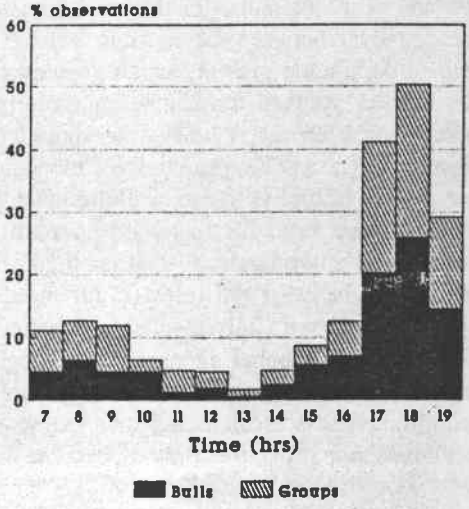


Fig. 14

Activity Pattern
Central Region

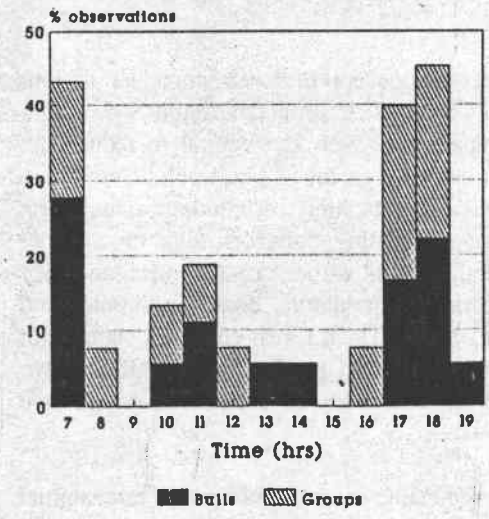


Fig. 15

% of Tuskers
Regions

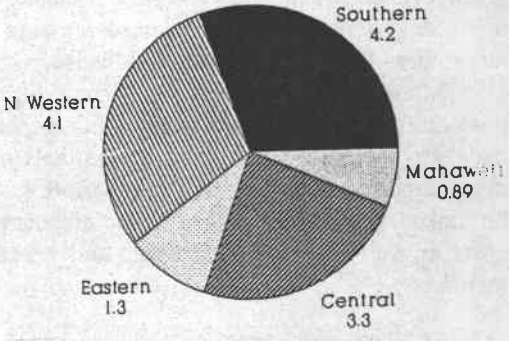


Fig. 16

The objective of elephant conservation is to protect as many individuals of the species as possible in as wide a rage of its habitats as is practical by preventing or minimizing the spatial competition with man and by preventing or controlling predation of elephants by man. The attainment of this objective will be subject to constraints that will determine the boundary between the possible and the impossible (Parker, 1981). Sri Lanka's vigorous human population growth, which generates land hunger shows no signs of slackening; and the island's political turbulence compromises law enforcement. Time, money, and trained manpower often act as brakes on what can be done to minimize the problem of elephant-human conflicts. The root cause of elephant depredations in Sri Lanka is deforestation and conversion of forests to monoculture plantations. Although human population pressure, land hunger and a need for fuelwood have all helped to cause deforestation, it has also been encouraged enormously by bad economics and poor planning. Even the World Bank has realized at last that the forest is far more productive than the scrubland that succeeds it once it is cleared. It is a fallacy to believe that fragile forests can be easily cleared and farmed. Such a belief ignores the ecological costs of deforestation: soil erodes, rainfall diminishes, water supplies become less reliable, rivers silt up, dams get clogged, human-wildlife conflicts escalate and such extinction-prone species as the elephant and other large mammals are often the first to become seriously endangered.

Sri Lanka is rapidly approaching a stage when all the remnants of natural environment will be contained in a patchwork of parks and reserves. Containing elephants within small patches of forest surrounded by dense and at times hostile human populations will inevitably lead to an escalation of conflicts between man and elephant. Many of the protected areas in Sri Lanka are not large enough to accommodate the entire annual home ranges of herds of elephants. Ishwaran (1993) recommends the management of elephant habitat within the reserves to improve grazing opportunities for the elephants, otherwise they will be attracted by the cultivated land outside.

Currently there is considerable interest in the concept of forest corridors to link isolated elephant populations to secure reserves. Corridors, if properly established, would greatly enhance gene flow between isolated populations, which is essential to reduce the in breeding depression. Inbreeding depression is more of a threat to small populations than large ones. But corridors can also cause problems. Unfortunately, as Simberloff and Cox (1987) point out, much of the current literature concerning corridors fails to consider potential disadvantages and often assumes potential benefits without catastrophes, and they may also increase exposure of the animals concerned to predators, domestic animals and more importantly to poachers (Simberloff & Cox, 1987). Thus, forest corridors should not be looked upon as a panacea to the elephant problems in Sri Lanka. Such corridors have costs as well as potential benefits and hence every case must be considered on its own merits.

In areas where the climate is stable and unpredictable natural disasters are rare, animal populations will reach a level close to the carrying capacity of the habitat near the saturation

density *K*. The elephant is an extreme example of a *K*-selected species, with about 22-month gestation period and a large parental investment and therefore as Laws (1981) argues, reproduction is the actual regulatory process, limiting the size of elephant populations. Hence, regular monitoring of the elephant populations will provide the much needed information on recruitment rates.

The June 1993 survey of wild elephants in Sri Lanka carried out by the Department of Wildlife Conservation, despite its short comings, has provided considerable information on the structure, composition; age and sex ratios. It has also indicated areas where more detailed observations would be useful. Future surveys will have to be modified and standardized to be carried out in much shorter time interval in order to minimize the bias of over counting. There is however a danger in becoming over-cerebral in relation to elephant conservation. While basic knowledge clearly has its place, much needs to be done in the field to minimize the human-elephant conflicts.

Recommendations for long-term conservation of the elephant in Sri Lanka need not depend on precise quantification of its populations across the island. It is usually sufficient to know whether they exist in significant numbers within their range and thereafter, it is necessary to establish whether the populations are expanding, declining or remaining stable. The elephant in Sri Lanka must have somewhere to live and something to eat. Both requirements are likely to be in ever shorter supply in the years ahead, given the current trends in human population growth and economic development. On the one hand, people are tempted to have more and more consumer goods and on the other, they are asked to preserve natural resources: the two are incompatible. A population of 125 elephants in a particularly area today is of little significance, if the habitat is to be converted to sugarcane plantations in a few years' time! Popular support for conserving the elephants must be built by communicating the problems confronting elephants, and the role they play in Sri Lanka. Elephant conservation policies, however well rooted they may be in science, can succeed only if they are intelligible to the people concerned.

Conservation of elephants in Sri Lanka should not be viewed as a preoccupation of a few with a single species. It provides a practical means for enhancing the island's overall conservation capacity. As a super keystone species, the elephant plays a large role in structuring habitats and thus maintaining biological diversity. It is also a "flagship species" and its conservation will result in the maintenance of biological diversity and ecological integrity on a very large scale in Sri Lanka.

# Distribution of Elephants
N = 1,967

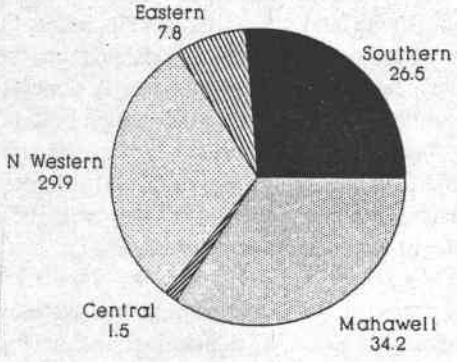
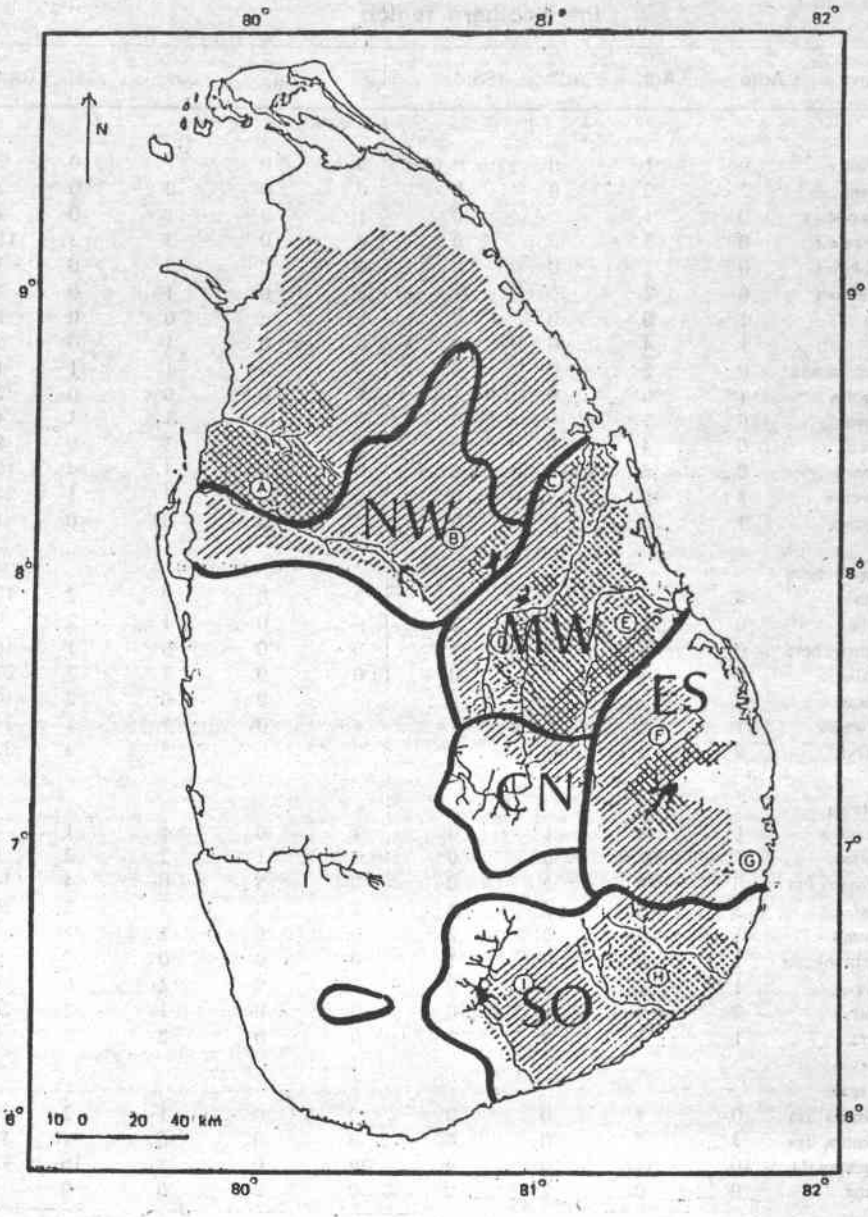


Fig. 17



The approximate boundaries of the four regions (NW=North Western; MW=Mahawell; ES=Eastern; CN=Central and SO=Southern) within which the elephant survey was carried out. The small area west of the Southern region refers to the Sinharaja forest. The hatched areas represent the approximate range of the elephant in Sri Lanka

Table 1. Population structure of elephants in the Southern region

	Location	Adm	Adf	Ad?	SaM	SaF	Sa?	Juv	Cal	Total
	Yala									
1	Nimalawa	0	1	0	0	0	0	1	0	2
2	Palatupana	2	0	0	0	0	0	0	0	2
3	Debragaswewa	0	1	0	0	1	0	1	0	3
4	Meynetwewa	0	5	0	0	0	0	3	3	11
5	Wilapalwewa	0	1	0	0	0	0	2	0	3
6	Mahaseelawa	0	2	0	1	0	0	1	0	4
7	Uraniya	1	0	0	0	0	0	0	0	1
8	Yala	1	4	0	0	0	0	1	0	6
9	Kosgasmankada	0	2	0	0	0	0	1	1	4
10	Rakinawala	1	0	0	1	0	0	0	0	2
11	Pilinnawa	0	1	0	0	0	1	1	1	4
12	Bambawa	0	4	0	0	0	1	3	0	8
13	Heenwewa	0	6	2	0	0	0	4	4	16
14	Banduwewa	2	10	9	0	0	0	2	1	24
15	Sithupauwa	1	0	0	0	0	0	0	0	1
	Lunugamwehera									
16	Paskema	3	5	4	0	3	0	0	2	17
17	Karawila	0	0	6	0	0	0	1	2	9
18	Lunugamwehera	0	6	0	3	0	0	6	1	16
19	Tanamalwila	2	4	7	0	0	0	7	2	22
20	Kitulkotte	0	9	1	2	2	0	0	2	16
21	Ratmalwewa	1	5	6	1	4	0	7	1	25
22	Kuda Oya	0	0	17	0	0	6	5	4	32
	Udawalawa									
23	Kaltota	1	2	1	0	1	0	1	1	7
24	Kaudeliara	1	2	0	0	0	1	2	2	8
25	Veheremankada	0	4	1	0	0	5	0	4	14
26	7th Post	3	6	0	4	2	0	3	2	20
27	Diyawinna	1	0	2	2	0	0	1	1	7
28	Pinagasmankada	1	0	0	1	0	0	0	0	2
29	Galpaya	1	2	0	0	1	0	2	0	6
30	5th Post	2	0	16	0	0	0	1	1	20
31	Mau ara	1	3	0	1	0	0	2	2	9
	Moneragala									
32	Walliamma ara	0	4	0	0	0	0	1	2	7
33	Walliamma ara	3	7	0	0	0	0	0	1	11
34	Handapanagala	10	32	0	9	29	0	28	16	124
35	Tunkema	0	0	2	0	0	0	0	0	2
	Kataragama									
36	Kataragama	0	1	0	0	1	0	0	1	3
37	Deiyanne Kema	0	0	0	4	0	0	1	2	7
38	Galge	0	2	1	0	0	0	1	1	5

continued.....

Table 1. Population structure of elephants in the Southern region *(continued)*

	Location	Adm	Adf	Ad?	SaM	SaF	Sa?	Juv	Cal	Total
39	Pilimigala	0	0	0	2	0	0	0	0	2
40	Katagamuwa	1	0	0	0	0	0	0	0	1
41	Uralu wewa	0	2	2	0	0	0	0	0	4
42	Unamula	1	0	0	0	0	0	0	0	1
	Bundala									
43	Bundala	0	0	2	0	0	0	0	0	2
44	Metigattewewa	4	3	0	0	0	0	0	0	7
45	Mattala	1	3	2	0	0	0	0	1	7
46	Weerawila	3	0	0	0	0	0	0	0	3
47	Ridiyagama	0	2	3	0	0	3	2	2	12
	Sinharaja									
48	Sinharaja	1	0	1	0	0	0	0	0	2
	Total	49	141	85	31	44	17	91	63	521
	%	9.4	27.1	16.3	6.0	8.4	3.3	17.5	12.1	100
	%	ads	52.8%	sad	17.7%					

Legend: AdM = Adult Males; AdF = adult Females; Ad? = adults (unclassified); SaM = Subadult Males; SaF = Subadult Females; Sa? = Subadults (unclassified); Juv = Juveniles; Cal = Calves; ads = adults; sad = subadults

Table 2. Population structure of elephants in the Eastern region

	Location	AdM	AdF	Ad?	SaM	SaF	Sa?	Juv	Cal	Total
49	Ingeniaygala	0	0	2	0	0	0	0	0	2
50	Lahugala	0	2	12	0	0	11	4	2	31
51	Athimale	4	5	0	0	0	5	1	0	15
52	Mullegama	1	3	0	2	2	1	2	2	13
53	Ekgala ara	2	2	0	0	0	0	1	1	6
54	Nilgala	1	0	21	0	0	0	6	2	30
55	Kahatiyangwela	1	1	0	1	1	0	0	0	4
56	Ampara	0	0	0	0	0	5	1	0	6
57	Baduluwela	2	4	3	2	3	3	6	1	24
58	Pallan oya	1	5	5	0	0	4	3	5	23
	Total	12	22	43	5	6	29	24	13	154
	%	7.8	14.3	27.9	3.2	3.9	18.8	15.6	8.4	100
	%	ads	50%	sad	26%					

Table 3. Population structure of elephants in the Mahaweli region

	Location	AdM	AdF	Ad?	SaM	SaF	Sa?	Juv	Cal	Total
59	Kaudulla wewa	2	0	6	0	0	3	2	0	13
60	Tummodera	4	3	0	0	0	3	4	0	14
61	Manampitiya	3	2	0	0	0	0	0	0	5
62	Hatareskotuwa	3	3	0	0	1	0	0	1	8
63	Sungawila	0	0	6	0	0	4	3	0	13
64	Gal oya Jct	4	5	0	0	2	1	0	1	13
	Minneriya									
65	Minneriwewa	2	9	0	5	0	0	0	1	17
66	Badepanwila	0	0	1	0	0	0	0	0	1
67	Katukaliyawa	0	0	0	1	0	0	0	0	1
68	Pubbiliya	2	2	0	0	0	0	0	0	4
69	Elehara	0	1	2	0	0	1	1	0	5
70	Alikanda	0	1	0	1	0	0	0	1	3
71	Raja Bamma I	0	0	1	0	0	0	0	0	1
72	Siyambalapitia	0	0	7	0	0	5	3	1	16
73	Dastota	1	6	0	5	6	3	3	1	25
74	Raja Bamma II	1	0	0	0	0	0	0	0	1
75	Mahaiyawa	1	1	0	0	0	0	0	0	2
76	Colony 200	3	2	0	1	0	0	0	0	6
	Wasgomuwa									
77	Kiri ebbey	1	0	0	0	0	0	0	0	1
78	Kadurupitia	4	6	0	4	5	0	4	3	26
79	Wilmitiya	0	5	0	1	3	0	5	3	17
80	Namini oya	2	2	0	0	0	0	0	0	4
81	Kiri oya	2	2	0	0	1	0	0	2	7
82	Digannawa	2	1	0	0	0	0	1	2	4
83	Laggala	1	2	0	0	0	0	1	1	5
84	M'weliganga	5	6	2	0	0	0	7	6	26
85	Waul ebbey	1	2	0	0	0	0	0	2	5
	Sigiriya									
86	Ambagaswewa	1	1	0	0	0	0	0	0	2
87	Eerige oya	0	1	0	0	0	4	0	1	6
88	Minneriwewa	6	17	5	1	3	12	14	10	68
89	Dehiyatawala	0	4	0	1	0	0	1	0	6
90	Alakolawewa	2	4	2	2	3	2	3	2	20
91	Mailattewa	2	0	0	0	2	0	0	1	5
92	Kosgahaella	0	0	0	0	0	1	1	0	2
93	Pahal Talkot	0	1	0	0	0	0	0	1	2
	Pimburettawa									
94	Yakkure	1	3	0	0	1	0	1	0	6
95	Weeralanda	2	1	4	0	0	0	0	1	8
96	Kandegama	0	0	20	0	0	13	6	4	43
97	Veheragama	1	0	0	0	0	0	0	0	1
98	Palatiyawa	1	1	0	0	0	0	1	0	3

continued.....

Table 3. Population structure of elephants in the Mahaweli region *(continued)*

	Location	AdM	AdF	Ad?	SaM	SaF	Sa?	Juv	Cal	Total
	Ulhitiya									
99	Ulhitiya	0	0	36	0	0	0	3	0	39
100	Kandeganwila	0	0	6	0	0	0	0	4	10
101	Gurukumbura	0	3	0	0	0	2	2	1	8
102	Thimbirana	1	6	0	2	4	0	3	4	20
103	Rathkinda	1	1	0	0	0	0	0	0	2
104	Puwakpale	1	8	0	0	6	1	3	2	21
105	Iddapola	1	3	0	0	0	0	0	0	4
106	Rotalawela	2	0	0	0	0	0	0	0	2
	Maduru oya									
107	Maduru oya	1	12	6	0	0	5	8	12	44
108	Karagammana	0	6	0	0	2	0	1	0	9
109	Henanigala I	0	4	0	3	7	4	6	4	28
110	Henanigala II	0	2	0	0	0	0	1	0	3
111	Kadupara ella	3	2	0	1	1	1	2	2	12
112	Damanewela I	0	4	0	0	0	0	1	1	6
113	Damanewela II	0	10	17	0	0	11	6	4	48
114	Damanewela III	1	0	0	1	0	0	0	0	2
	Total	71	155	121	29	47	76	97	77	673
	%	10.5	23.0	18.0	4.3	7.0	11.3	14.4	11.4	100
	%	ads	51.6		sad	22.6				

Table 4. Population structure of elephants in the North Western region

	Location	AdM	AdF	Ad?	SaM	SaF	Sa?	Juv	Cal	Total
115	Kala oya	2	1	18	0	0	9	8	4	42
116	Katupathewa	0	0	4	0	0	2	1	0	7
117	Galkiriyagama	5	7	10	0	0	7	9	4	42
118	Jayaganga	0	1	0	0	1	0	0	1	3
119	Giribawa	10	11	0	9	5	0	6	7	48
120	Rambewa	0	0	3	0	0	0	0	0	3
121	Medawachiya	10	13	0	8	6	5	3	1	46
122	Ritigala	2	3	0	3	8	0	5	3	24
123	Kebitigollawe	2	2	1	0	0	0	2	1	8
124	Aliwadiya	2	4	0	2	5	0	5	3	21
125	Mihintale	4	4	1	1	2	2	1	3	18
126	Mahawilachiya	4	2	0	0	0	4	1	0	11
127	Kahallepallek	3	0	6	0	12	0	10	6	37
128	Kekirawe	15	10	20	0	0	0	8	5	58

continued.....

Table 4. Population structure of elephants in the North Western region *(continued)*

	Location	AdM	AdF	Ad?	SaM	SaF	Sa?	Juv	Cal	Total
129	Thirappane I	2	3	6	0	0	0	4	1	16
130	Thirappane II	4	1	1	1	1	0	2	0	10
131	Galengb'wewa	2	3	0	0	0	0	1	1	7
132	Tantirimale	6	12	0	0	0	0	2	3	23
133	Hakwtunawa	2	4	10	0	0	14	4	0	34
134	Hunuwilagama	0	0	0	1	0	5	1	1	8
135	Herathgama	0	0	2	0	0	0	0	0	2
136	Galgamuwa	0	0	11	0	0	6	1	0	18
137	Kokkawidawewa	0	1	0	1	1	0	1	0	4
138	Wilpattu I	2	1	0	1	1	1	0	0	6
139	Wilpattu II	1	0	0	0	0	0	0	0	1
140	wilpattu III	1	3	1	0	0	0	0	1	6
141	Wilpattu IV	0	4	2	1	1	0	0	0	8
142	Nawagathgama	3	6	0	2	4	0	5	3	23
143	Puttalam	0	0	3	0	0	0	0	0	3
144	tabbowa	1	1	0	0	0	0	0	1	3
145	Karuwelagasw	2	20	2	3	0	5	11	6	49
	total	85	117	101	33	47	60	91	55	589
	%	14.4	19.9	17.1	5.6	8.0	10.2	15.4	9.3	100
	%	ads	51.4		sad	23.8				

Table 5. Population structure of elephants in the Central region

	Location	AdM	AdF	Ad?	SaM	SaF	Sa?	Juv	Cal	Total
146	Minipe	2	3	0	0	1	0	2	1	9
147	Kirthibanda	1	0	0	0	0	0	0	0	1
148	Unagolla	1	0	0	0	0	0	0	0	1
149	Bolaganthawela	0	0	4	0	0	1	1	9	6
150	Bandaraketiya	0	1	2	0	0	0	1	0	4
151	Heenganga	1	0	0	0	0	0	0	0	1
152	Uwaparanagama	0	2	0	0	1	0	2	0	5
153	Haldumulla	1	0	0	0	2	0	0	0	3
	Total	6	6	6	0	4	1	6	1	30
	%	20	20	20	0	13.3	3.3	20	3.3	100
	%	ads	60		sad	16.7				

Table 6. Population structure of elephants in the five regions

		AdM	AdF	Ad?	SaM	SaF	Sa?	Juv	Cal	Total
5	Regions	223	441	356	98	148	183	309	209	1,967
	%	11.3	22.4	18.1	5.0	7.5	9.3	15.7	10.6	100

Table 7. Population structur e of the *classified elephants*

Region	AdM	AdF	Sad	Juv	Cal	Total
Southern	49	141	92	91	63	436
Eastern	12	22	40	24	13	111
Mahaweli	71	155	152	97	77	552
N Western	85	117	140	91	55	488
Central	6	6	5	6	1	24
Total	223	441	429	309	209	1611
%	13.8	27.4	26.6	19.2	13.0	100

Table 8. Age and Sex ratios of the *classified elephants*

Region	Number	Bulls	Cows	Calves	Sex ratio
Southern	436	34.8	100	44.7	1 : 2.9
Eastern	111	54.5	100	59.1	1 : 1.8
Mahaweli	552	46.0	100	50.0	1 : 2.2
N Western	488	73.0	100	47.0	1 : 1.4
Central	24	100.0	100	17.0	1 : 1.0

Table 9. Proportion of tuskers among the elephants

Region	Tusker	No. adm	% Tusker	% Maknas	SadT	JuvT	Total
Southern	5	49	10.2	89.8	12	5	22
Eastern	1	12	8.3	91.7	1	0	2
Mahaweli	2	71	2.8	87.2	0	4	6
N Western	13	85	15.3	84.7	4	7	24
Central	0	6	0	100.0	0	1	1
Total	21	223	-	-	17	17	55
average	-	-	7.3	90.7	-	-	-

Note: adm = adult male; SadT = Subadult Tusker; JuvT = Juvenile Tusker

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Elephants in the Ruhuna National Park, Sri Lanka.
(Photo: Chrles Santiapillai)

A NOTE ON THE SURVEY OF ELEPHANTS IN SRI LANKA

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Elephants have been associated with Sri Lankan culture, religion and folklore for so may centuries in the past, that it would be difficult to imagine the island without its elephants. However, their long-term future in the wild will depend not only on the availability of suitable habitats, but also on the degree of support given to elephant conservation in Sri Lanka by the rural people who live among the animals as well as the urban people who believe that without elephants, the country would be a poorer place. Throughout its range in Asia, the elephant is facing the threat of extinction in the wild, primarily as a result of human encroachment upon the habitat.

It was to assess the status of the elephants in the wild that a survey was carried out in June 1993 across much of the island. Such a survey was long overdue. It was undertaken by the staff of the Department of Wildlife Conservation, given the need to update the information on the structure, composition and abundance of the elephants which would be useful for their management in the wild. It was also carried out with the view to training the field staff on monitoring elephants on a regular basis.

It may seem an impossible task, but surveys of this nature have been carried out in many parts of India by dividing elephant habitats in the wild into blocks, which are then searched for elephants by trained staff. The main drawback with this method is that, even in the relatively open habitats in Sri Lanka, it is difficult to ensure that all the elephants within a survey area have been recorded or that elephants have not moved from one survey unit to another in the course of the day. But the main objective was not to estimate the total number of elephants but determine the structure and composition of the elephant populations in as large an area as possible so that future surveys could monitor the changes in them, in particular changes in the proportion of the calves and tuskers - two of the most vulnerable categories. Estimation of minimum population size was incidental to the main objective.

The success of this exercise was due to the concerted efforts of the entire field staff of the Department of Wildlife Conservation and the assistance given by numerous volunteers from NGOs, Universities, Government Departments and concerned individuals. Finally, I would like to acknowledge the help given by Messrs W. Hendavitharana, Sarath Dissanayake of the Department of Wildlife Conservation; Mangala de Silva and Charles Santiapillai from the Department of Zoology, University of Peradeniya in organising this survey, training the field staff and analysing the data.

THE SURVEY OF ELEPHANTS IN SRI LANKA: A REVIEW

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As opposed to the 1970s and early 1980s when a number of pioneering publications on the Asian elephant came from Sri Lanka, there has been relative calm on the elephant front in the country during the past decade. It was thus especially heartening to read this report on wild elephants in the island country based on a survey carried out during 1993 by the Department of Wildlife Conservation.

The survey was carried out over a six day period during June 1993 by 800 personnel including volunteers from NGOs in five regions, namely, Northwestern, Mahaweli, Eastern, Central and Southern, where political conditions permitted field work. The method used was to divide each region into several smaller blocks and assign a party of five persons to perambulate each block. The elephants encountered were sexed and classified into one of four age classes (calf, juvenile, sub-adult and adult) whenever possible. Distinguishing marks on elephants were noted in order to avoid double counting within a block.

The survey revealed that a minimum of 1967 elephants inhabit the above five regions (there could be some more elephants in the northern region which could not be covered). More important than this the report presents some impressive data on the sex ratio and population structure of the Sri Lanka elephants. With about 93% of the males being tuskless (and therefore immune to ivory poaching), the adult sex ratios of male to female ranging from 1:1 to 1:2.9 are among the least skewed anywhere in Asia. This is therefore not an issue at all Sri Lanka.

There are also interesting data on the numbers of calves in the population; such data can potentially be translated into crude estimates of fertility if they are expressed as proportions of the mature female segment of the population (this may not exactly correspond to the "adult" class in the report as some of the "sub-adult" females may also have reproduced).

If the report had mentioned the total area in each region that was covered in the survey, the population estimates could have been converted to densities. I have the following suggestions for surveys in future years:

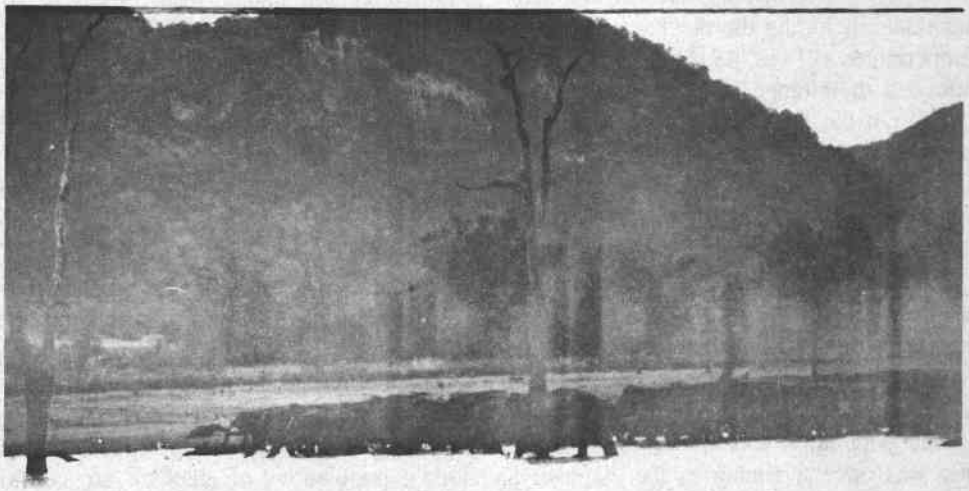
a) Such exercises can be carried out during two seasons so that seasonal shifts in elephant populations can be documented. Such data may be useful in understanding crop raiding behaviour for instance.

b) Location of elephant groups marked on maps can be computerised (only latitudes and longitudes need be entered along with group size) and printed in order to get a qualitative picture of elephant concentrations on the island.

c) The surveys can be supplemented with estimates of elephant "densities" using both direct and indirect methods in selected areas. This would provide an objective basis for population estimates that can be compared with the minimum estimates.

d) If such surveys are continued for at least 3 to 4 consectutive years, the population structure data such as number of calves can provide useful insights into the demography of the populations in different regions;

The 1993 survey is hopefully the beginning of a more sustained effort in future years in documenting Sri Lanka's elephant populations. This could evolve into a national data base that would be invaluable in planning for the management and conservation of elephants and their habitats.



Elephants in the Handapanagala Lake
(Photo: Anouk Ilangakoon)

DISTRIBUTION OF ELEPHANT IN XISHUANGBANNA DAI AUTONOMOUS PREFECTURE, CHINA

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Introduction

Until about the end of the 10th century AD, the Asian elephant *(Elephas maximus L.)* enjoyed wide distribution and good numbers in the Chang Liang (or Yangtze) river valley where it was so numerous that considerable number of animals were hunted for their ivory and hide by non - Chinese (Laufer, 1925). The hills of the northern part of China were once heavily forested and hence provided suitable habitat for a variety of large mammals including the elephant. Given the ability of the elephant to withstand low winter temperatures (Elwes, 1916), it is not surprising to know that the animals may have once extended their range in China as far north as the Huang He or the Yellow river (Olivier, 1978). On the basis of its apparent darker colour and reddish ivory, Deraniyagala (1955) ascribed it to a different subspecific status naming it as *Elephas maximus rubridens* to distinguish it from the forma typica *Elephas maximus maximus* of Sri Lanka and *Elephas maximus indicus* found in rest of the Asian mainland.

In a country such as China, where for more than 70 centuries the human population has been engaged in tilling the land, agriculture is and had always been the most important form of human activity exerting the greatest impact on the land (Zhao, 1986). One of the consequences of the rapid increase and spread of the human population in China has been the elimination of many large mammalian populations from their former range. Increasing human population and increasing agricultural land use have considerably reduced the area that was once available to the elephant and today, populations of elephant are confined to the southern part of the Yunnan Province in the Xishuangbanna Dai Autonomous Prefecture (Fig. 1) where the remote and yet forested hills provide the last refuge (Xu, 1987; Santiapillai & Jackson, 1990).

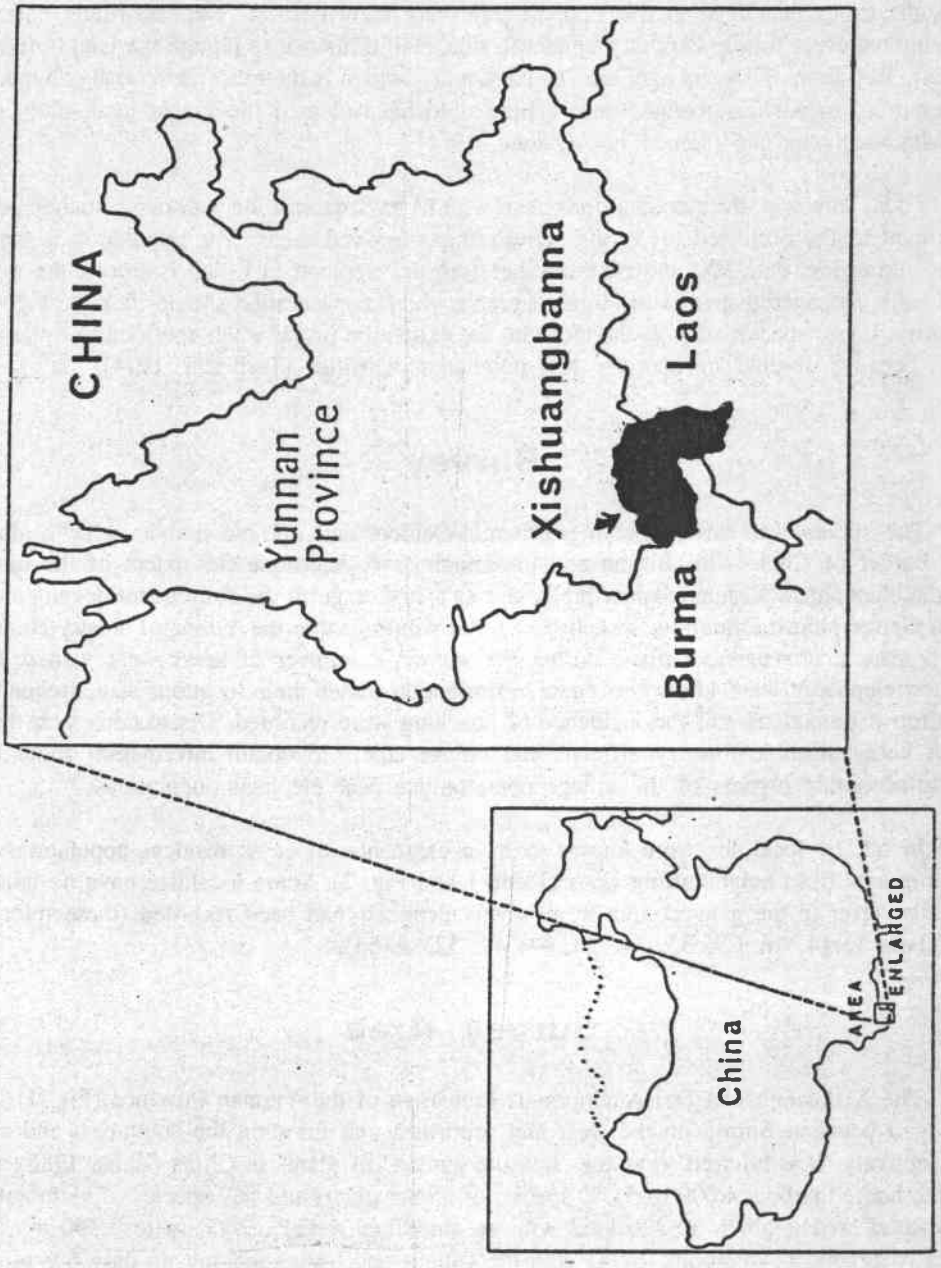


Fig. 1. Map of China showing the relative position of Xishuangbanna Dai Autonomous Prefecture in the Yunnan Province.

The south-western province of Yunnan had a great reputation as an elephant area. Marco Polo referred to it as "swarming with elephants and other wild beasts". As early as 200 BC, the tribes that lived in the Yunnan area were known as an "elephant-riding nation" and almost every family kept an elephant to ride, haul timber or to plough the land (Olivier, 1978). Two thousand years ago, the Dai nationality, which is the most numerically abundant community in Xishuangbanna, were supposed to have cleared the jungle land, ploughed it with elephants and planted rice (Zheng, 1981).

Today however, the elephant finds itself with its back against the wall in Xishuangbanna, confined to the protected areas and some remote forested areas. The population is small (numbering less than 500 animals) and therefore the elephant in China is among the most seriously endangered species of large mammals whose conservation should rank the highest priority. Large species such as the elephant are extinction prone when confined to a limited area because of their intrinsically low population densities (Terborgh, 1974).

Survey

The survey was carried out between mid-October and mid-November in 1991 along the border of China with Burma and Laos mainly to determine the extent of the range of the elephant in Xishuangbanna Prefecture as a first stage in the subsequent development of a Geographic Information System (GIS) that would enable the Yunnan Forestry Bureau to prepare a management plan. During the survey, a number of areas were visited and where elephants were known to occur, information about their location, size, frequency of crop depredations and the incidence of poaching were recorded. Discussions were held with knowledgeable forestry officials and village chiefs to obtain information about the socio-economic aspects of the village communities near elephant populations.

In all, 64 localities were known to have elephants either as resident populations or as migrants from neighbouring Laos (Table 1 and Fig. 2). Some localities have no names as they refer to the general area from where elephants had been recorded (these refer to numbers 1, 14, 26, 27, 33, 34, 38, 44, 49, 52, & 55).

Survey Area

The Xishuangbanna Dai Autonomous Prefecture of the Yunnan Province (Fig. 1) lies wedged between Burma on the west and southwest and Laos on the south-east and east respectively. It is referred to as the "treasure garden" of plants in China (Zhao, 1986) and is the home to about 4,000 to 5,000 species of higher plants and 539 species of vertebrates. The total area is about 19,220 km2 with an altitudinal range of 400 m to 2,300 m. The area is largely mountainous (64%) with the valleys and basins making up only 6% of the area (MacKinnon, 1987). Only about 23-31% of the original forest cover still remains (Zhao, 1986).

One of the conservation problems in Xishuangbanna that has a direct impact on elephant conservation is the conversion of forests to mono-culture rubber plantations. Over 67,000 ha of the Prefecture is under rubber plantations with the possibility of them increasing to 100,000 ha (MacKinnon, 1987). Conversion of forests to rubber plantations, have had a devastating effect on the animal populations especially the large mammals such as the tiger and elephant which on account of the large body size and home ranges are often the first to suffer from range attrition.

Rubber is grown extensively throughout the Prefecture below 900 m altitude. However, the production of rubber is energy consuming: to produce one ton of rubber requires the burning of two tons of firewood in an area characterised by the lack of coal and limited use of other energy sources (MacKinnon, 1987). Forests are the principal source of fuel for both domestic as well as industrial needs in Xishuangbanna. Annual deforestation rate is estimated to be 55,000 ha (Santiapillai & Li, 1991).

Table 1. List of the localities where elephants occur (see Fig. 2)

Number	Locality	Number	Locality
1.	nr. Lancang	2.	Wan Jiao Shan
3.	Yako	4.	Ba Jiao
5.	Kuon Han	6.	Mau Po
7.	Lien Hua Tang	8.	Nang Hang Liu
9.	Da He Shan	10.	Jiang Biao
11.	Da He Bien	12.	Jing Shang
13.	San Cha He	14.	north of San Cha He
15.	Shang Guan Ping	16.	Hong Shan
17.	Do Lok Tang	18.	Yang Liao Pa
19.	Shang Mau Cao	20.	Man Mu Tien
21.	Da Huang Be	22.	Tiao He Ba
23.	Gou Shan	24.	Shu Ling Jai
25.	Ban Ju Lung	26.	west of Xiaohei river
27.	East of Xiaohei river	28.	Ma Ling Su
29.	Man You	30.	Long Fau
31.	Shing Fa	32.	An Lah
33.	near Xiaohei river	34.	near Xiaohei river
35.	Man Ling	36.	north of Man Sa
37.	West of Mahei	38.	Lao border
39.	Lao border	40.	near Yi Tan
41.	Xiang Guen	42.	Hui Lo
43.	Ye Niew Tong	44.	Lao border
45.	Lan Nang	46.	Lan Niang
47.	Da Lung Ha	48.	Mo Xie
49.	Lao border	50.	Ma Long
51.	Dung Fang Hung	52.	west of Shangyon
53.	Hui Bing	54.	Long Man
55.	Lao border	56.	Pham Po Sa He
57.	Sang Tsung Liang	58.	Da Bau Bau
59.	Man Fen	60.	Da Guang
61.	Sang Tien Fang	62.	Lao border
63.	Nong Kwang	64.	Hui Ma

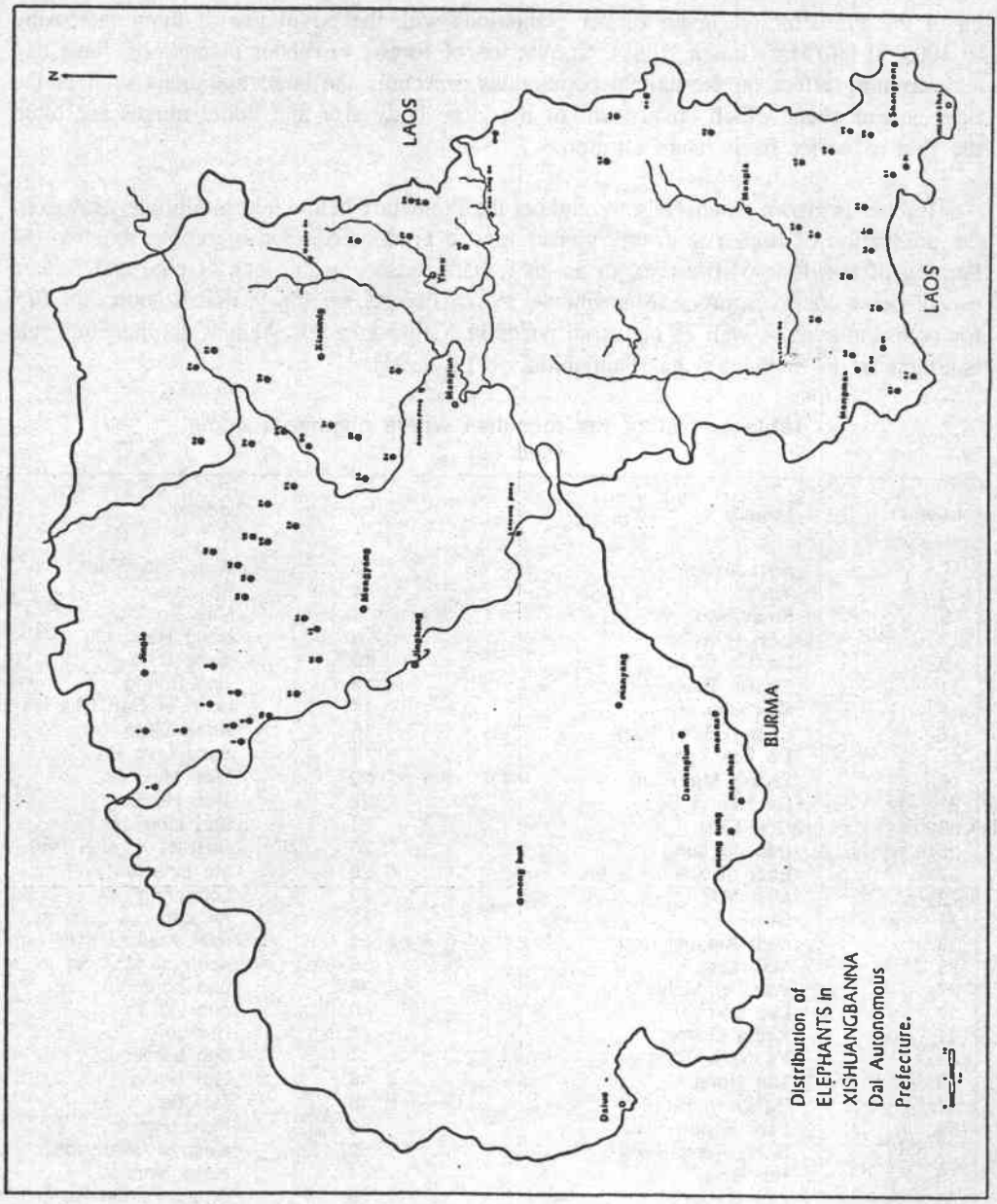


Fig. 2 Localities where elephants are reliably known to occur in Xishuangbanna Dai Autonomous Prefecture. (The numbers refer to the localities listed in Table 1).

Elephant Distribution

The principal finding is that elephants do not occur west of the Lancang (= Mekong) river in Xishuangbanna. There is one record of a single animal seen on the western bank of Lancang river in the north but this animal must have temporarily moved out of Mengyang reserve during the dry season. They are also mostly absent between the Nan Xing river south of Menglun reserve and Lan Na river just north of Shangyong reserve, except in a patch of forest along the border with Laos in the Mengla reserve (localities 41-45 in Figs. 2 & 3).

Another observation is that contrary to what was supposed in the past, there are no elephants along the border with Burma. All along the survey route from Manyang in the south-west along the border with Burma, the hills have been cleared of forests and a system of shifting cultivation appears to be the main form of land use by the hill tribes in the area. Elephants must have been extirpated along the Burma border over 30 years ago. We visited Damenlung, Ma Na, Man Shan and Meng Sung along the Burma border but there were no reports of elephants en route. Rubber plantations were extensive. Only at Man Shan was there a tract of undisturbed forest but even here there were no reports of elephants, although bears and gaur were reported to be plentiful.

The second part of the survey was carried out east of the Lancang river and along the border with Laos. Distribution of elephants was plotted on maps with the scale of 1:200,000 and 1:250,000.

Elephants occur in high and low densities across the survey areas. There are three areas of relatively high elephant density (about 0.12 to 0.49 per km2), they are: (1) Mengyang Nature Reserve in the north, (2) Shangyong Nature Reserve in the Southeast and (3) the area along the Xiaohei river from Menglun in the south to the north-eastern corner of Mengyang (Fig. 3). Other areas depicted in Fig. 3 represent those areas where elephants are either seasonal migrants from neighbouring Laos or areas of resident populations of elephants occurring in low densities.

It appears from Fig. 3 that the elephants in Xishuangbanna are distributed possibly in four large but discontinuous blocks. Mengyang Nature Reserve with an area of 99,733 ha supports about 100-120 elephants. The southern reserve of Shangyong with an area of 30,533 ha is known to be even richer in elephants and other large mammals such as the Gaur *(Bos gaurus)*. Given the mixture of forests, bamboo and grasslands available in this area (Fig. 4), Shangyong is likely to support a larger elephant population (between 130-150 animals) despite its smaller size. Along the Xiaohei river, the riparian forests are known to support an equally high population of about 100 animals seasonally. Mengla although large (92,933 ha) does not support a high density of elephants. The animals are restricted to the montane forests along the border with Laos up to an altitude of 1,400 m or more.

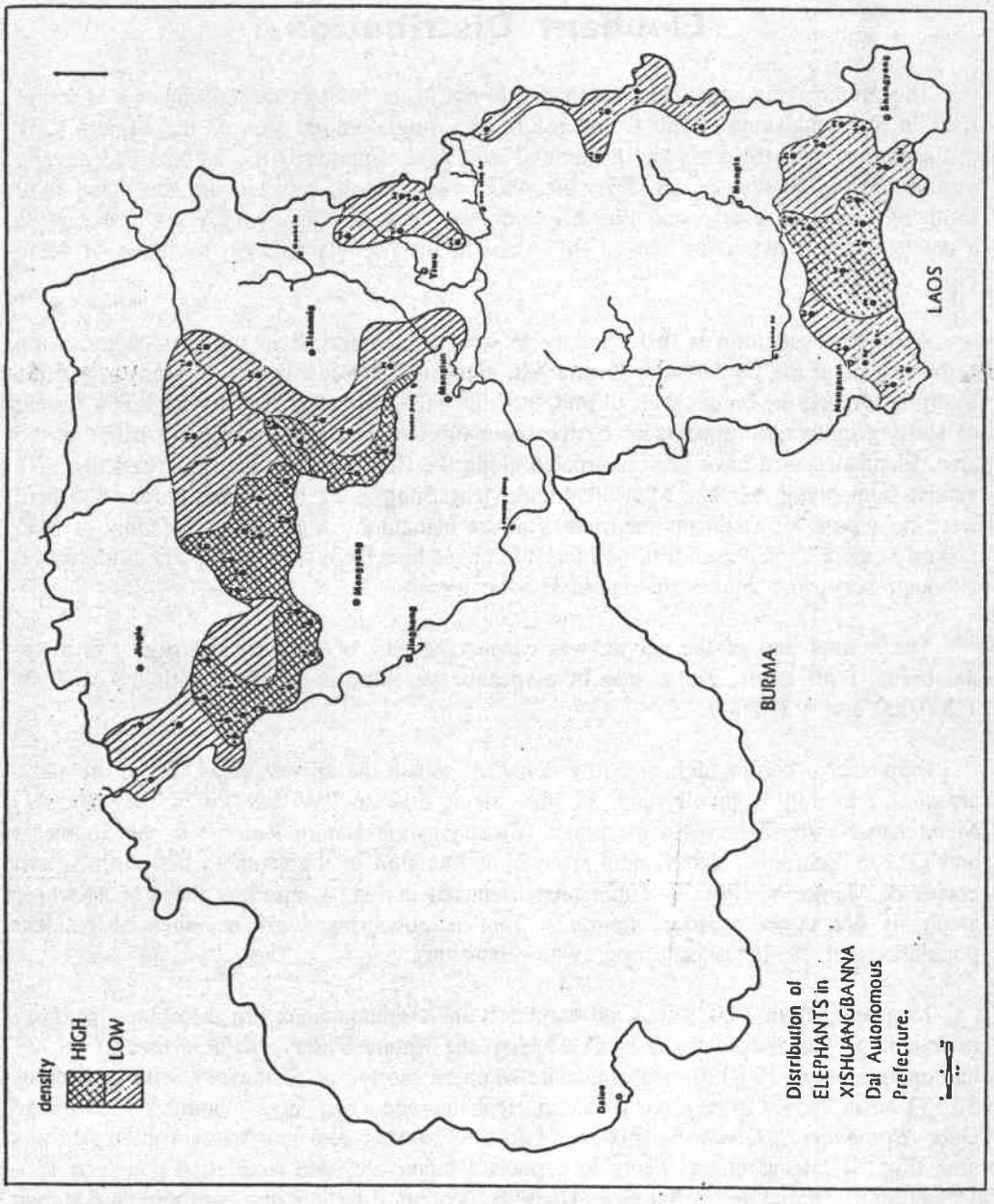


Fig. 3 Distribution of elephants in Xishuangbanna Prefecture. Shaded areas represent the maximum extent of the elephant populations, while cross hatched areas denote areas of relatively high elephant densities.

Food resources

The elephant population in Xishuangbanna ranges from 400 m along the Lancang river valleys to over 1,400 m along the border areas with Laos in the east. The altitudinal range of the mountains of Xishuangbanna is that most of the area is rich habitat for the elephant in the undisturbed stage. There are food resources available to the elephant at all levels. The bulk of the food of the elephant consists of bamboo which is plentiful throughout the Prefecture (Fig. 4). Among the most preferred food items are the bamboo *Dendrocalamus strictus* and wild sugar cane *Saccharum sinensis* which grow in abundance (Santiapillai & Li, 1990). However, in the vicinity of elephant ranges, farmers report crop losses through depredations by the elephant, wild pig and gaur. Elephants are a constant menace to farmers cultivating such palatable food items as sugar cane, corn and rice. The village of Ma Ling Si (No: 28) north-west of Xianmig suffers yearly crop depredations by elephants.

Fig. 4 represents the extent of the forest and bamboo within the known range of the elephant population. Elephants are rather plentiful in the western part of Mengyang reserve given the abundance of bamboo in this area. The south-eastern part of Mengyang consists mostly of secondary forest and it too provides optimum habitat for the elephants. Further down in the Shanyong reserve, a combination of forests, bamboo and grasslands enable the smaller reserve to support a much larger population.

The problem of dotted human settlements with their agricultural plots throughout the reserves provides another serious conservation problem vis-a-vis the elephant. Mengyang reserve is inhabited by about 40 villages where about 1,200 people live. Their farms are often raided by elephants leading to substantial loss of revenue. In 1989 alone, 21 villages in Mengyang reserve suffered elephant depredations in which about 250,000 kg of field rice was lost (Santiapillai & Li, 1990). Resolving the conflicts between man and elephant is one of the principal concerns of the Forestry Bureau in Xishuangbanna.

Poaching

Given the importance of wildlife products in China's traditional medical practices, and the commercial value of the elephant's tusks, poaching was considered to be one of the serious threats facing the elephants in Xishuangbanna (Xu 1987). But within the past few years, the situation appears to have improved substantially with no recent reports of elephants being killed for their ivory or gall bladder. This is all the more surprising given the easy availability of home-made firearms and guns. Poaching of elephants for ivory needs the co-operative efforts of a number of people and once an elephant is killed and tusks removed, it would be difficult to stop the news from reaching the village chiefs and other authorities through the "bush telephone" This is perhaps the main reason why there is hardly any poaching of the tuskers in Xishuangbanna.

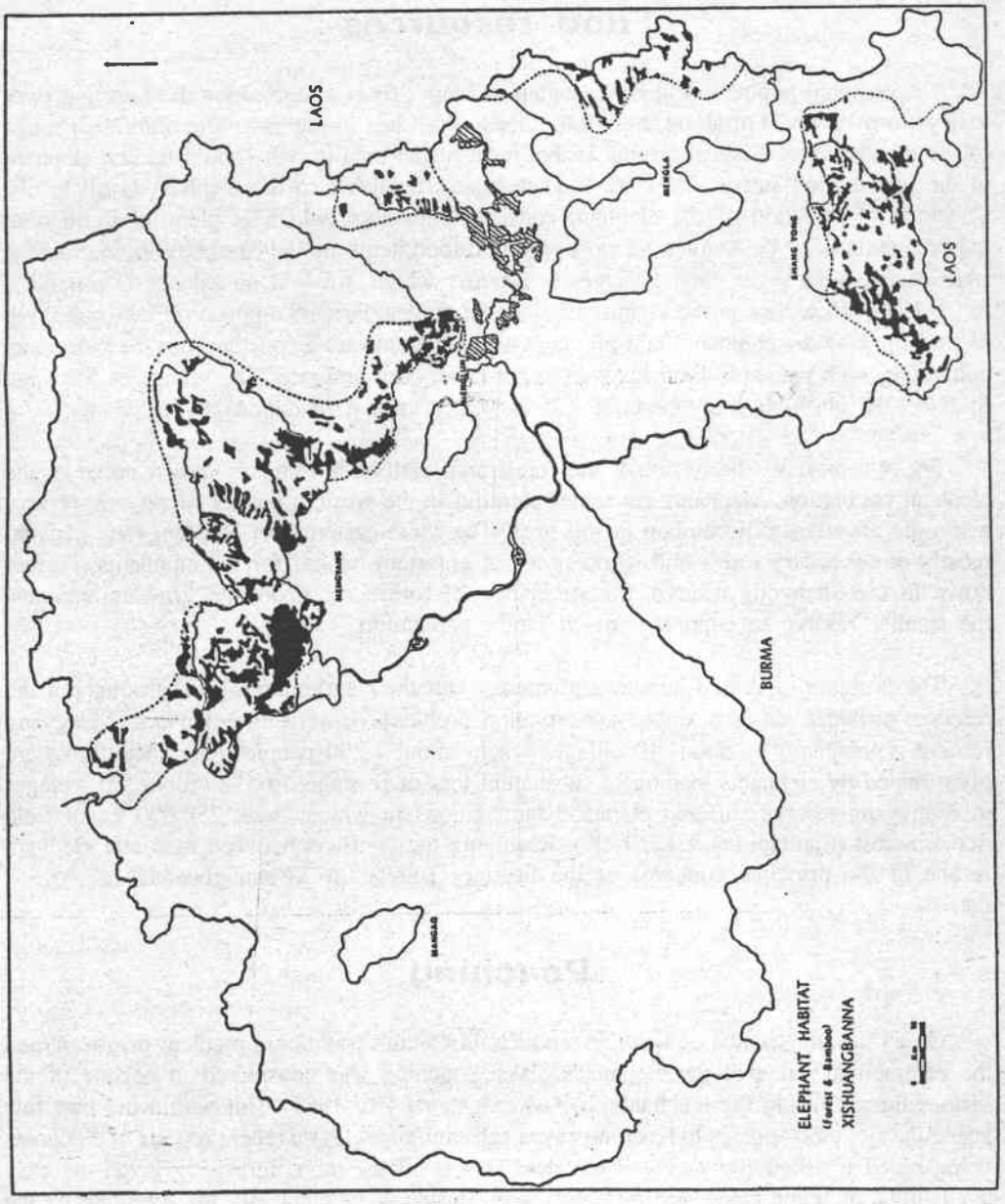


Fig. 4 The extent of forest and bamboo habitat (shaded black) available to the elephant within the known range in Xishuangbanna. The hatched areas represnt forest blocks that could form a corrdor to facilitate the free movement of elephants from Mengyang reserve to the Laotian border and back.

Conclusion

Elephants occur in four of the five protected areas namely, Mengyang, Menglun, Mengla and Shanyong. They are absent in the Mangao reserve west of Lancang river. About 300 animals are estimated to occur in Xishuangbanna. The situation in Yunnan province has reached a critical stage. In the past 30 years, 50% of the forests have disappeared and the remainder is fragmented (Zu, 1987). Elephant populations are small, scattered and confined to areas surrounded by human settlements. Although 250,000 ha of forests have been set aside in Southern Yunnan for Conservation of elephant, the secondary vegetation which provides the major source of food for the animals, is not well represented within the area; furthermore the whole area is surrounded by croplands, rubber plantations and human settlements (Zu, 1987) leading to constant conflicts between man and elephant.

The long term prospects for the population of elephants in Xishuangbanna will depend on the degree of protection given to their habitat and on how successful the Forestry Bureau is in resolving the human-elephant conflicts in the area. Over large areas of Xishuangbanna, there is no longer adequate room for elephants to move about and adjust their densities to changing vegetation patterns. Their ranges are being compressed year by year as a result of human population growth and the demand for even larger areas for agriculture. The expanding human population is essentially being maintained by a subsistence economy. The changes in the land-use patterns are therefore resulting in the continuous contraction of elephant range. This serves also to cut off certain channels of response such as emigration and dispersion (Watson & Bell, 1969). The animals have lost so much of their original habitat to man in Xishuangbanna that emigration can no longer be considered a mechanism for regulating the population size. One way of overcoming this dilemma would be to establish forest corridors if possible to link contiguous elephant populations to allow for emigration, dispersion and inter-breeding. Fig. 4 illustrates one such possibility where the Mengyang population could be linked to the small population that occurs along the Laotian border through the establishment of a forest corridor - if such a feat is indeed possible. If such bolt-holes are not available to the elephants in Xishuangbanna, they may seek refuge in one or two of the protected areas such as Mengyang and Shangyong, thereby increasing their densities within these areas. The concentration of elephants in this manner into limited areas could lead to a build up in their densities even though absolute population size may be on the decline (Laws, 1981).

Another consideration for mangers must be the long-term viability of small populations of elephants. In general, the smaller the population size, the greater is its vulnerability to demographic, environmental and genetic sotochasticity (Shaffer, 1981; Gilpin & Soule, 1986). For long-term viability an effective population size of 500 has been suggested (Franklin, 1980; Frankel & Soule, 1981). However, not all small populations are *ipso facto* doomed. Although the effects of inbreeding depression are real they are also transitory. They are minimised if numbers recover quickly from bottlenecks. The population of 40± wild cattle at Chillingham in England after 800 years (about 120 generations) of continuous

inbreeding are fit and thriving (Whitehead, 1953). In the case of the elephants, given their longevity and longer generation interval, it would take much longer for any inbreeding to reach any appreciably deleterious level. A population of long lived elephants would require a very small genetically effective population size (Ne), while a short-lived species such as a field mouse may require a large one to preserve 90% heterozygosity after 200 years. The only long-term hope for the elephants in Xishuangbanna therefore rests on the effective protection that can be accorded at present to the four separate populations identified in the survey.

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PRESENCE OF LIVER FLUKE *Fasciola jacksoni* IN A SRI LANKAN ELEPHANT

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In 1961, for the first time in Sri Lanka, Professor C.H. Fernando (Faculty of Veterinary Medicine & Animal Science, University of Peradeniya) reported the presence of liver fluke *Fasciola jacksoni*. At that time the only specimen available had been found in a dead elephant and due the circumstances under which it was found the specimen was not in a good state. The presence of this fluke had been recorded many times in India.

In September 1992, for the second time in Sri Lanka, the same parasite was found during a post-mortem of a female baby elephant of about 3 years of age. This animal was brought to the Zoo from Morawewa in September 1992 by Air Force Officers after keeping it at Anuradhapura for a few days. It had been abandoned by a herd. It was found dead within a few hours of arriving.

During the post-mortem, which was held at the Zoo on the same day, the liver was found to be much enlarged and discoloured. Its edges were rounded due to oedema and abscesses were seen on the surface. On incising the abscesses large quantities of pus oozed out. When the liver was cut, chocolate coloured semi-solid material was seen and within this soft material, were a large number of flukes. Bile duct was thickened and fibrosed.

Four specimens were taken to the Faculty of Veterinary Medicine and Animal Science (University of Peradeniya) to be photographed. Using the fact that *Fasciola jacksoni* was found at a post-mortem carried out at the Zoo, the presence of this parasite was reported at the Scientific sessions of the Sri Lanka Veterinary Association under the title "Some record of parasites occurring in free ranging Elephants in Sri Lanka."

The flukes were of the size of a nail of a human for- finger. It was dark brown in colour with a smooth surface to the naked eye on microscopic examination, but was found to be covered with minute dermal spines. It had a narrow cephalic cone at the anterior end. The oral sucker was smaller than the ventral sucker which was situated at the level of broad shoulder. Digestive apparatus had a pharynx, a short oesophagus which bifurcated at the lower end. These two branches thus formed were seen to be branching repetitively and the caecal terminations occupied nearly the whole extent of the body internally on either

side. These canals were separated from each other until they approached the tail end. These parasites were hermaphroditic. In the gap between these canals were both male and female sexual organs.

This baby elephant may have ingested metacercaria most probably by drinking muddy water which they would have infested upon completion of the development in the snail. The encysted form of metacercaria is the most infective stage to the primary host. Success of the metacercaria is dependant on the entry into a suitable primary host. After entering the body, the metacercaria become excysted in the intestine and reach the liver. They migrate all over the organ and thrive on liver parenchyma. They travel along the narrow ducts, irritating them and thus bringing about their thickening and decreasing their calibre.

The essential lesion is progressive cirrhosis which ultimately produces a fibrotic liver. Thus the liver gradually ceases to function. Since the liver is essential for continuance of life these alterations cause death. This is one of the most important of all the parasites infesting elephants.

HEMATOLOGY, PLASMA, AND SERUM BIOCHEMISTRY VALUES IN DOMESTICATED ELEPHANTS *(ELEPHAS MAXIMUS CEYLONICUS)* IN SRI LANKA

Indira D. Silva and Vijitha Y. Kuruwita

This study was conducted to further strengthen knowledge of hematology and blood chemistry of Asian elephants *(Elephas maximus ceylonicus)*. Blood sample collected from 108 healthy, domesticated elephants, without chemical immobilization and with a male: female ratio of 1.16, were analyzed for cellular and biochemical measures using standard hematologic techniques. The mean values obtained for these measures were comparable to those reported for domesticated Asian elephants in other countries. The ranges of erythrocyte measures were: packed cell volume, 25-45%; erythrocyte count, 1.7-5.0 x 10^6/µl; hemoglobin concentrations, 7.4-15.4 g/dl; mean corpuscular volume, 81-160 fl; mean corpuscular hemoglobin, 24-56 pg; mean corpuscular hemoglobin concentration, 23-39 g/dl; and sedimentation rate, 64-148 mm/hr. A higher mean and a wider range were observed for the erythrocyte count when compared to other reports. The leukocyte count varied from 4 to 21 x 10^3 /µl, and lymphocytes were present in largest proportions (38%). Equal proportions (approximately 25%) of heterophils and monocytes were found in peripheral blood, and both of these leukocyte exhibited peroxidase activity in their cytoplasmic granules, whereas lymphocytes did not. The nuclei of granulocytes were poorly segmented, and heterophils had reddish cytoplasmic granules. Approximately 80% of monocytes had segmented nuclei. The platelet count ranged from 0.8 to 4 x 10^5/µl, a range that was narrower when compared with other reports. Total plasma protein concentration ranged from 6 to 13 g/dl, with a fibrinogen concentration of 0.04-2.8 g/dl. There were no significant differences between values for males and females. Likewise, there were no differences in blood values between these domesticated elephants and the free ranging, chemically immobilized elephants that were studied separately. (source: *Journal of Zoo and Wildlife Medicine* 24(4): 440-444, 1993)

ELEPHANT MORTALITY IN SRI LANKA

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There is considerable publicity given in the press these days to the number of elephants that are being killed in Sri Lanka. The sustained interest by the media over the plight of the elephant underlines the strong emotion the animal arouses among Sri Lankans, and the extent of the support its conservation enjoys in Sri Lanka. There has also been some degree of criticism of the Department of Wildlife Conservation over its inability to resolve the human-elephant conflicts in the island and stop the slaughter of elephants. Much of the criticism against the Department of Wildlife Conservation is unfortunately rather unfair. The Department of Wildlife Conservation alone cannot be held responsible for the escalation of the human-elephant conflicts and the subsequent loss of lives among human beings and elephants.

It is a truism that, at any but the lowest density, large wild animals and human beings are fundamentally incompatible. As the densities of both large mammals and man increase, this incompatibility increases as well (Ferrar, 1983). In Sri Lanka, increasing human population and increasing agricultural land use have substantially reduced the area once available to wildlife. The situation in Sri Lanka, has changed from one in which man lived in small settlements in areas surrounded by elephants to one in which elephants are forced to inhabit small patches of forest surrounded by a landscape dominated by man. The elephant habitat is contracting as a result of conversion of forests and changes in land use patterns. Conversion of forests also serves to cut off certain channels of response available to the elephants, such as emigration and dispersion (Watson & Bell, 1969). The obvious result of a decrease in a species' range, is a decrease in its resource base, and for elephants, with their large body mass and intemperate appetite, this means that their flexibility to buffer the effects of local resource depletion by moving out is lost (Croze *et al.*, 1981). The long-term prospects for survival of such "pocketed" herds of elephants are grim (Seidensticker, 1984). The rapidly expanding human population of Sri Lanka is essentially being maintained by an agricultural economy. Thus, over large areas in the island, there is no longer room available for the elephants to move about and adjust their densities in response to changes in the agricultural landscape. When elephants lose their range, they die (Parker & Amin, 1983).

But the loss of elephants should not be viewed in isolation or as a recent phenomenon. Even when the human population was half its present size in Sri Lanka, wild elephants were killed by the hundreds by farmers in defence of their crops. Between 1945 and 1951,

according to the statistics given by the then Warden of the Department of Wild Life, Mr C. W. Nicholas (1952), on an average 100 elephants were shot as well as captured annually. In addition, 50-70 elephants were shot in defence of crops. Therefore the annual loss of elephants then amounted to between 150 and 170 (Nicholas, 1952). Between 1951 and 1969, a total of 1,163 elephants were lost in the wild (Figs. 1 & 3), of which 639 animals (or 55%) were killed in defence of crops (Table 1 & Fig. 2). Thus on an average, between 1951 and 1969, about 61 animals were lost annually (range: 27-121). This number includes the animals that were killed as crop raiders, those that died of natural causes and the ones that were captured. Fig. 2 gives the percentage loss of elephants (killed in defence of crops as well as by poachers between 1950 and 1970). On an average, about 34 animals were killed every year during this period.

Table. 1. Number of elephants lost in the wild in Sri Lanka (1951 - 1969)

Year	Number lost (total)	Number killed in crop defence & by poachers	% loss
1951	121	54	44.6
1952	75	39	52.0
1953	82	56	68.3
1954	81	51	63.0
1955	84	48	57.1
1956	79	24	30.4
1957	74	40	54.1
1958	51	23	45.1
1959	58	23	39.7
1960	35	28	80.0
1961	34	17	50.0
1962	27	16	59.3
1963	27	19	70.3
1964	47	27	57.4
1965	61	37	60.7
1966	62	40	64.5
1967	53	30	56.6
1968	43	21	48.8
1969	69	46	66.7
Total	1,163	639	
average	61	33.6	

The elephant population of Sri Lanka during the early fifties, according to the then Warden, Mr C. W. Nicholas (1952) was "popularly estimated at various times during the last few years to be 2,000 to 3,000", although in his opinion, Mr Nicholas himself felt that the population was "not much more than 1,000". He was very concerned at the high rate of loss of elephants in the wild even than and cautioned that at that rate of depletion, "the extinction of the Ceylon elephant will become inevitable". Concerned by the high losses of elephants in the wild, he recommended that "methods of driving wild elephants away from fields and *chenas*, without having recourse to shooting, should be tried out". Even at that time, Mr Nicholas recognized the need to protect the cultivators' crops if elephant conservation were to succeed. In the past, the defence of crops lay in vigilance during the nights by a number of people. Today however, the gun has replaced group vigilance.

One of the questions that Mr Gamini Punchihewa (1989), author of *"Souvenirs of a Forgotten Heritage"* often put to the villagers in Eastern Sri Lanka was how they managed to save their crops from the elephants at a time when there ware relatively more elephants than people in the areas where they lived? The answer he got from them was one of simple common sense. He was told: "Those days, a few people existed and in one *yaya* (a tract) or stretch of land, we cleared the jungle, and prepared the land for *chenas*, we put stockade fence, and we always avoided elephant paths. If we did come across them we fortified these vulnerable points with giant jungle logs. We kept watch from the heights of trees. We had our *tuwakku* (the muzzle loaders) and we had our *mantharams* (charms). Those days, except a *hora aliya* (a rogue elephant) we never shot other elephants. .....Today, most of these so-called farmers come from towns, they do not keep watch but sleep and only when they awake do they know what had happened to their crops" (Punchihewa, 1989).

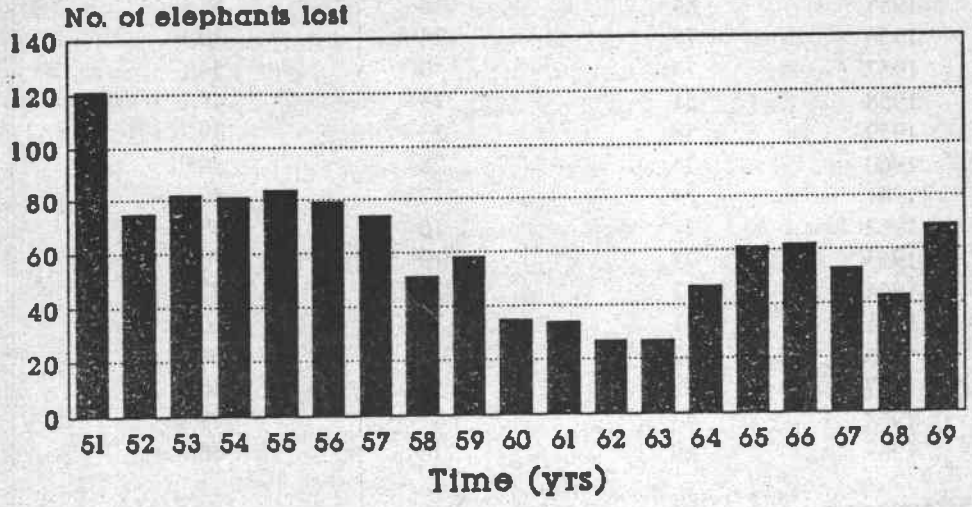


Fig. 1 Elephant Mortality in Sri Lanka

The situation today as far as the *number of elephants killed annually* is concerned, does not appear to be too drastically different from what it was about three or four decades ago. Between 1990 and 1993, a total of 165 elephants were lost in the wild of which 94 animals succumbed to gun shot injuries (Jayantha Jayewardene, pers. comm). Given the current high human population and low forest cover, it is indeed remarkable that elephant mortality in Sri Lanka has not increased substantially as one would have expected. The human-elephant conflicts in Sri Lanka are the result of many factors but deforestation remains the root cause of elephant depredations. In 1950, more than 50% of Sri Lanka was under forest cover. Even then between 150 to 170 elephants were killed annually (Nicholas, 1952). Today, the forest cover has declined to less than 24% (Geiser & Sommer, 1982), while the human population has increased from 6 million in 1950 to about 17 million. Elephants need natural forests to live and it would be unrealistic to expect the continued survival of elephants in large numbers across the island, in the face of declining natural forest cover. The highest percentage of forest cover today is found in the lowlands of the Dry Zone, which are precisely the areas where the elephants occur (Erdelen, 1988). Given this background, the overwhelming emphasis in any conservation policy must be in maintaining forest cover over large areas uninterrupted by human settlements and roads, where remoteness, difficulty of terrain and density of cover provide natural protection. But no area in Sri Lanka is really remote any longer and hence the long-term future of elephants in Sri Lanka must lie within the system of protected areas that can be managed. The island is rapidly approaching a stage when all the remnants of natural environment will be contained in a patchwork of national parks, wildlife sanctuaries and reserves.

Elephant numbers will inevitably shrink in the face of human population growth and attendant development needs, even without poaching. Problems related to elephant conservation in Sri Lanka stem directly or indirectly from human demography. All the gains in agriculture, literacy and health care are being undercut be one basic fact: Sri Lanka's human population more than quadrupled from 3.6 to 15.2 million, between 1900 and 1982. Today, the population is estimated at 17 million, equivalent to a population density of 259 individuals per square kilometre. By the year 2000, Sri Lanka may reach a population of 20.8 million, with a density of 318 individuals per square kilometre. (Erdelen, 1988). The trend in natural forest cover runs counter to the human population growth. However, aspirations by people to enhanced standards of living often cause greater pressures on undisturbed natural environments than sheer growth of human numbers (Myers, 1975). On the one hand people are tempted to have more and more consumer goods and on the other, they are asked to conserve natural resources: the two are incompatible.

It would be unfair to expect the Department of Wildlife Conservation alone to save the elephants in Sri Lanka. Conservation of elephants requires the participation of the public and private sectors. Conservation groups can play a useful role by helping the department of wildlife Conservation in mitigating the human-elephant conflicts. Many conservation groups do indeed play an important role by mobilizing public support in their flight to prevent the depletion of the wildlife resources. But as the late Felipe Benavides, the first recipient of the Getty Prize for Conservation once remarked, ***"Conservation***

organizations are like mushrooms: they grow up any time, they can be found everywhere. Some of them are very good, several are poisonous". There are a few private organizations, limited both in terms of scope and membership, who no longer view conservation as an objective in itself but rather as a means of amassing political and financial power. Such organizations can do more harm than good for conservation.

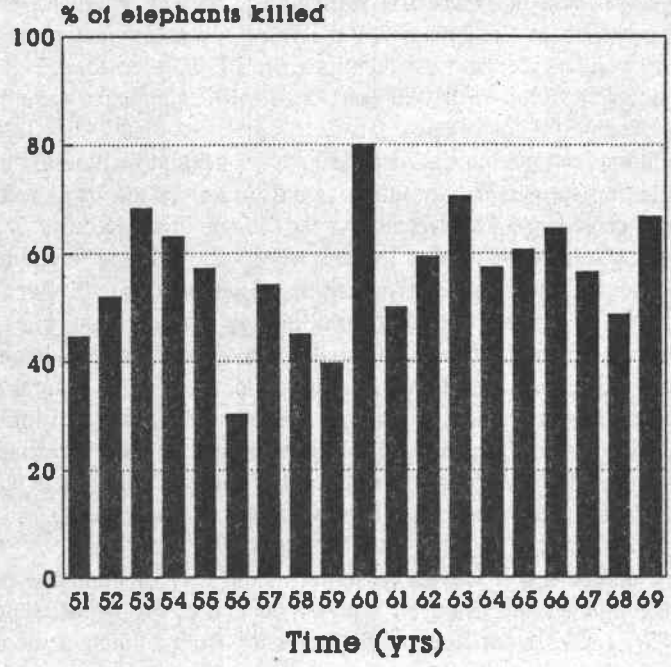


Fig. 2 Elephants killed between 1951 and 1969 in Sri Lanka

One must not forget the good work done in the past by the Department of Wildlife Conservation in Sri Lanka often with meagre resources. The guards work under difficult and trying conditions, far away from their families. Despite their low wages, they remain dedicated to their work. It is mainly due to their efforts that Sri Lanka still supports a viable elephant population in the wild. The guards and rangers are the "eyes and ears of the protected areas". But their work hardly ever gets a mention at National or International Conferences. Some of them have even lost their lives in the call of duty.

Time, money and trained manpower often act in many cases as brakes on what can be achieved in the field to resolve the human-elephant conflicts. The Department of Wildlife Conservation is the custodian of not only the elephant but all the species of wild fauna and flora as well. The emphasis on elephants provides a practical means for enhancing the overall conservation capacity of Sri Lanka. The Asian elephant is a "flagship species" and as such its conservation would maintain biological diversity and ecological integrity over a large area in Sri Lanka.

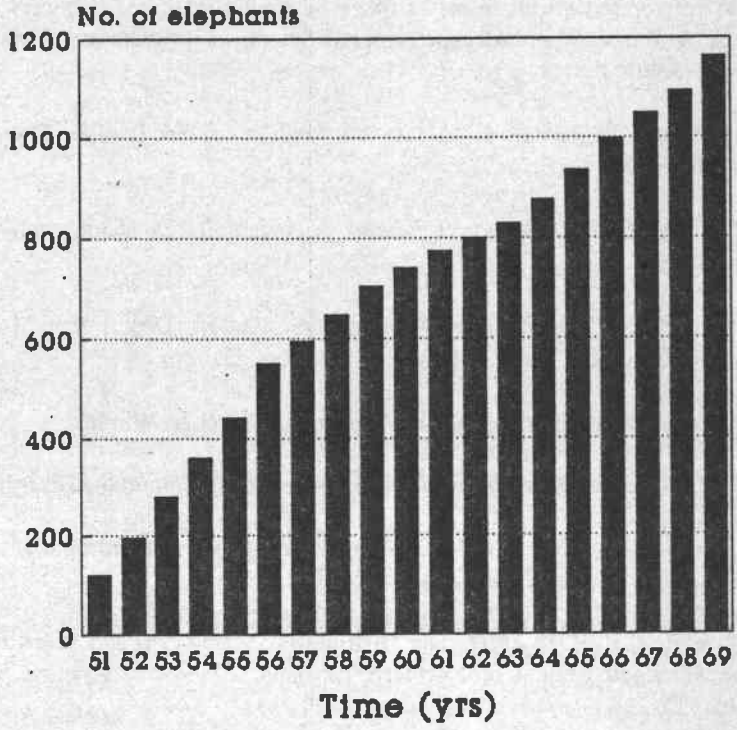


Fig. 3 Cumulative total of the number of elephants killed in Sri Lanka (1951-1969)

Elephant mortality in Sri Lanka must be discussed against the background of natural forest conservation. The two issues are linked. Every time an elephant is killed, the tragedy is given wide publicity by the news media. However, whn forests are destroyed or converted to other land uses, the public does not seem to show much cncern. If the elephant is to survive in Sri Lanka. then some sort of accommodation between man and elephant must be reached. Both have to live together by mutual adjustment. The communites that suffer from elephant depredations must be properly compensated for their losses. The local communities must be encouraged to participate fully in decisions affecting their land and resurces. Elephant conservation will be ineffective in the absence of widespread public awareness of the problems and their support for solutions.

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POST-MORTEM REPORT ON A WILD ELEPHANT FOUND DEAD IN WASGOMUWA NATIONAL PARK, SRI LANKA

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Sri Lanka has between 2,500 and 3,000 elephants in the wild distributed both within and outside the system of protected areas. As a result of increasing human population and decreasing forest cover, the conflicts between man and elephant have escalated, with losses on both sides. Elephants are killed in crop defence by farmers. In 1993 alone, more than 35 elephants succumbed in the wild to gunshot injuries. In addition to such losses a few elephants also die of diseases transmitted by domestic livestock. This report deals with a death of an elephant in Wasgomuwa National Park.

Wasgomuwa National Park, with an area of 37,063 ha is situated between the Amban Ganga and Mahaweli Ganga across the North Central and Central Provinces of Sri Lanka. The park is the home to some 150 elephants *(Elephas maximus)*. Possibly the biggest management issue is the tendency for some of these elephants to cross the eastern and southern boundaries into adjacent agricultural areas (IUCN, 1990). Another serious management problem concerns the domestic cattle which compete with wild herbivores for pasture. These are also a source for transmitting infectious diseases to the wildlife. One such incidence involved the death of a wild elephant in December 1993.

The incident

On 29 December 1993, a wild elephant was found dead in Wasgomuwa National Park, and the cause of death was uncertain at that time. There were no external injuries on the body. Blood oozed from all external orifices. Some two weeks before another wild elephant had died showing the same signs. By 31 December when the dead elephant was examined, putrefaction had already started. A team of veterinarians from the Faculty of Veterinary Medicine, University of Peradeniya also assisted in the post-mortem.

Observations

After a thorough examination of the carcass, the possibility of death due to (a) poisoning, (b) snake bite, or (c) electrocution was ruled out. Therefore the death of this

elephant was thought to be due to some infectious disease. The posture of the carcass and other signs on the premises in the vicinity indicated no signs of struggle before death. Thus the death was sudden. The first suspicion on a death of this nature is anthrax. In such cases, if the carcass is cut open or slashed by carrion eaters, the anthrax bacilli exposed to oxygen, sporulate. Spores can live up to 60 years in the soil and could re-infect other wildlife. If the carcass is not opened, the anthrax bacilli cannot sporulate and they will soon disintegrate from the action of putrefying bacteria. Therefore no animal suspected to have died of anthrax should be cut open.

Samples of swabs and blood smears were made from the small split opened on an ear vein. Small piece of ear was collected for Ascoli test (specific precipitin test for *Bacillus anthracis).* Blood smears stained with different stains showed bacterial rods resembling *B. anthracis*, but with vast number of putrefying bacteria further laboratory tests were necessary before anthrax could be confirmed. Haemorrhagic septicaemia (HS) or pasterurellosis caused by another bacterial rod *Pasteurella multocida* (synonym *P. septica*) shows symptoms and lesions closely resembling those of anthrax. Therefore to confirm the causative agent, laboratory diagnosis was essential.As anthrax could not be ruled out, precautions were taken in time to dispose of the carcass. The carcass was burnt to ash, and lime sprinkled. Oozed blood was drained to a deep pit and topped with lime and closed with soil.



A dead elephant in Wasgomuwa National Park.
(Photo: V. W. S. M. Vasanthathilake)

Discussion

In the laboratory, it was confirmed that the disease was caused by *Pasteurella multocida*. Anthrax was therefore ruled out much to the relief of all concerned. Unlike anthrax, Haemorrhagic septicaemia bacteria cannot live in the soil for more than 24 hours. But the organisms may be picked up by cattle and buffalo and carried in the throat without producing any ill effect. However, when these animals become stressed, the organisms will start to multiply and produce the disease and contaminate food and water by the saliva and dung and thus spread the disease. It affects cattle, buffalo, elephant and to some extent even the pigs. The disease is much more prevalent during the early rains towards the close of the monsoon. It is common in low lying lands subject to inundation and on those areas submerged by extraordinary floods. When animals are exposed to wet conditions and chilly weather, or exhausted by heavy work, they contract the disease. Outbreaks of the disease in elephants do not last very long, usually between 10-15 days. Duration of the illness may last from 3 to 36 hours. There are several types of *Pasteurella multocida* (i. e. A, B, C, D, or E type). After the confirmation, the samples were sent to the Veterinary Research Institute in Gannoruwa, Sri Lanka for the typing.

Before this post-mortem, two other wild elephants died from causes unknown. There was also a report on the death of a domestic cattle inside the park. Subsequently, on 17 January 1994, one more wild elephant died at Elehara, close to the Wasgomuwa National Park. The disease occurs chiefly in either areas where veterinary assistance is not readily available or where farmers do not get their cattle vaccinated against Haemorrhagic septicaemia in time. The vaccine is highly effective for 12 months and even in the face of an outbreak, it can reduce losses substantially. A dried vaccine of the types B and E area also in use. Management authority must take prompt action to stop the movement of domestic cattle into protected areas to prevent the outbreaks of epidemic diseases fatal to wildlife. Wild animals are susceptible to a vast number of diseases and parasitic infestations. Diseases of domestic animals which have been found to infect wildlife with fatal consequence include rinderpest, antharx, salmonellosis, and tetanus. A high standard of hygiene in the livestock must be a high priority if the human settlements in the vicinity of any protected area continue to keep free-ranging stock (Ashby & Santiapillai, 1987).

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BOOK REVIEW

THE ELEPHANT IN SRI LANKA. By Jayantha Jayewardene

The Wildlife Heritage Trust, 1994
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In his book, *"The Elephant in Sri Lanka"*, Jayantha Jayewardene attempts to trace the decline of the elephant's range and numbers, critically considers its current status and recommends solutions to resolve the escalating conflicts between man and elephant. It is a book that is aimed at every concerned individual in the island and makes no pretence to be a scientific treatise. Since the publication in 1867 of Sir J. Emerson Tennent's classic account of the elephant entitled, *"The Wild Elephant and the Method of Capturing and Taming it in Ceylon"* much has happened to the elephant and its habitat in Sri Lanka and Jayewardene's book addresses the issues that have led to the remarkable decline in elephant numbers.

The book begins with an introduction on the evolution of the species *Elephas maximus* and its relationship with its African cousin, *Loxodonta africana*. It highlights the fact that while there are over half a million African elephants, distributed in 33 countries, across a range of 4.5 million km2, the Asian elephant by contrast numbers less than a tenth of the African Elephant and occurs in 13 countries, across a range of just 500,000 km2. This underlines the fact that the Asian elephant is far more seriously endangered than its African cousin.

The book traces the fortunes of the elephant in Sri Lanka from historical times when it was held in high esteem by the kings who used it in war and peace. King Dutugamunu rode to war on the elephant known as *Kandula*. The book refers to the status of the elephant in Sri Lanka under the Portuguese, Dutch and the British Colonial Powers. It deals with the senseless slaughter of elephants that was carried out by the British under

the guise of sport hunting. One Major Rogers was credited with the slaughter of over 1,500 elephants during his time (or at the rate of one animal killed every day for four years!). Elephants were so numerous then in the island that rewards were paid by the Government for the animals that were killed. In addition, elephants were also captured for export to other countries. Between 1853 and 1884, a total of 2,890 elephants were exported from Ceylon.

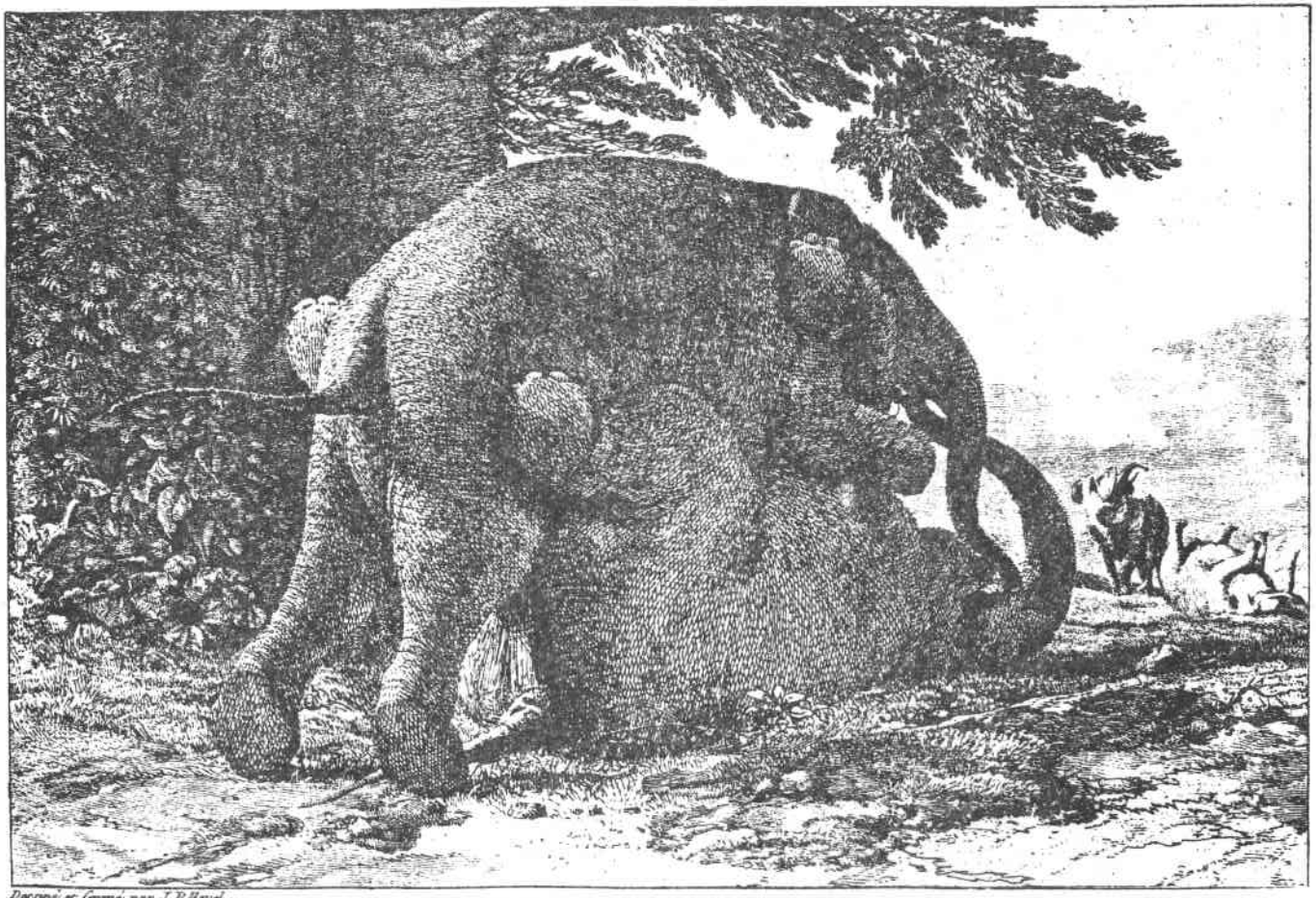
Jayewardene discusses the two subspecies of elephants known in Sri Lanka, *Elephas maximus maximus*, the forma typica and the *Elephas maximus vilaliya*, the Marsh elephant. The Marsh elephant's habitat used to be the fertile lower valleys of the Mahaweli Ganga, much of which had been developed under the Accelerated Mahaweli Development Programme. The Marsh elephant is characterized by its stockier build and the rarity of tuskers. The survey carried out by the Department of Wildlife Conservation in 1993, showed that only 2.3% of the bulls in the Mahaweli Region had tusks.

There are sections in the book that deal with feeding, reproduction, social organization and the phenomenon of "musth". One of the most useful chapters in the book is that dealing with the elephants in captivity. A census in 1946 revealed that there were 736 elephants in captivity. Today however, the number seems to have declined by 50% paralleling the decline of the elephants in the wild. For those interested in managing elephants in captivity, there is considerable discussion on the basic commands used by the mahouts in handling elephants. The poor breeding performance of the elephants in captivity at the Pinnawala Elephant Orphanage is obvious from the records of the births given in the book.

The book is particularly useful in the wealth of information it provides on the number of elephants that were captured, translocated, driven and sold over the past several decades. Jayewardene gives a fascinating account of the elephant kraals, quoting early sources. The book deals extensively with mitigating elephant-human conflicts in Sri Lanka.

Jayewardene has had several years of experience in observing and studying the elephant in the wild in Sri Lanka. His book makes a strong case for the conservation of the species at a time of dwindling forest cover and expanding human population. The urgency of protecting what is left of Sri Lanka's once magnificent population of elephants is amply outlined by the author. For the most part, this book is clealy written and easily understood by anyone. In particular, wildlife conservationists may find it useful. The book was designed to reach a large audience. Given the care with which the publishers have produced the book, it will certainly be read by everyone interested in conserving the elephant in Sri Lanka.

Charles Santiapillai



Elephants Mating - A French Conception!
from: Histoire Naturelle des deux Eléphans, male et femelle, du Museum de Paris.
par J. P. L. L. Houel, 1803.

GAJAH

Journal of the Asian Elephant Specialist Group
No. 12, June 1994

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The Wildlife Heritage Trust, Colombo, Sri Lanka. 1994.
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Compter Typesetting & Offest Printing by Bravi Press, 274, D. S. S. Veediya, Kandy, SRI LANKA.