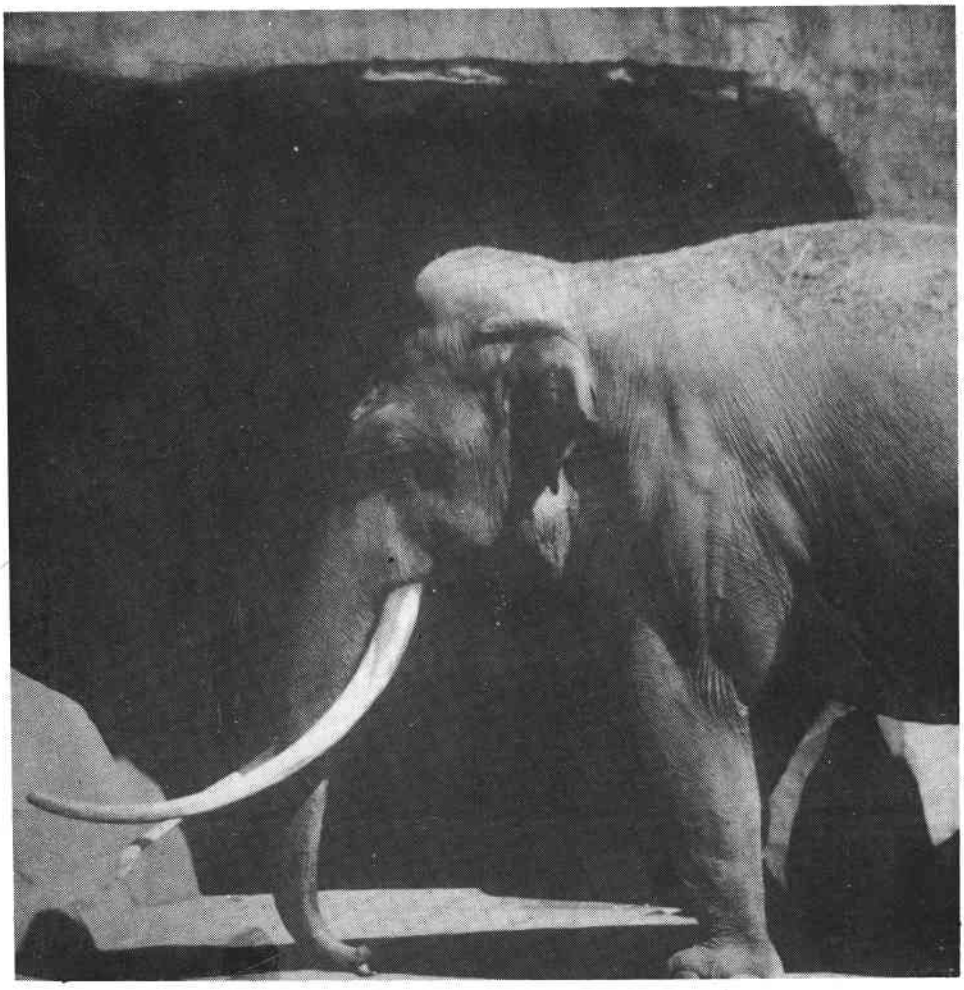
# GAJAH

JOURNAL OF THE ASIAN ELEPHANT SPECIALIST GROUP



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# GAJAH

## JOURNAL OF THE ASIAN ELEPHANT SPECIALIST GROUP

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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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# COMMENTS ON ELEPHANTS IN BURMA*

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## ABSTRACT

*This draft is a set of notes rather than a formal report, offering a few suggestions on the population dynamics of wild elephants and timber elephants. The major problem is that the timber elephants do not constitute a self-perpetuating population, that they must be augmented continuously by capture of wild elephants, but that these appear to be declining such that their capacity to provide enough animals is progressively eroded. Demographic analysis suggests that the reason for the timber elephants' inability to maintain numbers has nothing to do with their death rate. This is not high. Burmese veterinary treatment of elephants is of a very high standard. The reason lies instead with the low birth rate. If this could be raised above 8 births per year, per 100 females of breeding age, the population of timber elephants would be self sustaining. Suggestions are offered for how this might be done, but it is best left to the knowledge and experience of the Veterinary Officers. The current capture rate of about 120 elephants per year from the wild population is probably above the maximum sustainable yield. The wild population seems to be declining at about 5% per year. Suggestions are made for determining current numbers, trend, and sustained yield, and for halting the decline of wild elephants.*

## INTRODUCTION

This draft is more a set of notes than a formal report. The writer is keenly aware of the Burmese expertise on elephants and would not presume to advise men who know much more than he does about this subject. The purpose of these notes is therefore only to give an outline of potential problems as he sees them. Sometimes the perspective of an outsider, however poorly informed, can reveal problems not immediately obvious to men closer to the subject. These notes are offered in that spirit of humility. They will contain mistakes reflecting the writer's lack of detailed knowledge, and for these he asks forgiveness, but they may also contain one or two ideas that can be used.

[* This paper refers to the situation of elephants in Burma in 1980].

## PROBLEMS

Burma contains two populations of elephants. The first comprises the timber elephants, a population of known size and demographic characteristics, under intense and skilful veterinary care, which would decline progressively unless captured recruits were added each year. The second comprises the wild elephants, a population whose demographic characteristics are unknown, whose size is not known precisely but is probably in the region of 3,000, and whose rate of increase or decrease is unknown. From this population about 120 elephants are captured each year to add to the timber elephant population.

These questions immediately arise: 1. Why cannot the population of timber elephants maintain itself without artificial recruitment from the wild population? 2. Can the wild population sustain, without declining, an offtake of 120 elephants per year?

## DEMOGRAPHY OF TIMBER ELEPHANTS

This section investigates the population dynamics of the timber elephants in an attempt to locate the reason for their inability to hold numbers stable. The data used are not exhaustive and hence the conclusions are only approximations.

### *Mortality*

On p. 78 of his excellent book *"Burmese Timber Elephant"*, U Toke Gale (1979) gives the incidence of death by age-class for 714 timber elephants. These data are used here to investigate the mortality pattern. Table 1. gives U Toke Gale's figures in the second column and rate of mortality per year in the third. The rate of mortality is the percentage of elephants within a stated age-class at the beginning of the year that will die before the end of the year. It is a different statistic from the percentages given by U Toke Gale, which are the deaths in an age-class as a percentage of total deaths recorded.

**Table 1.** % Mortality Rate in Timber Elephants.

| Age-class (years) | Deaths recorded | % mortality rate per year |
|---|---|---|
| 0 - 9 | 78 | 1.2 |
| 10 - 17 | 27 | 0.5 |
| 18 - 35 | 185 | 2.0 |
| 36 - 54 | 222 | 3.8 |
| 55 - 70 | 201 | 25.0 |
| Total | 714 | |

These figures cast doubt on the commonly expressed opinion that the mortality of timber elephants is excessively high. The mortality pattern revealed above is not much different from that of wild African elephants. The veterinary treatment of elephants is of such a high standard in Burma that little more could be done by chemotherapy to reduce the already low rate of mortality. At present there is one veterinary assistant to about 40 Timber Corporation elephants and one veterinary officer to about every 15 veterinary assistants. Veterinary treatment and training in Burma is modern, highly developed, and backed by an elaborate recording system. Detailed records are kept on the health and treatment of each timber elephant. Burma could teach other countries a lot about veterinary care of elephants but there is little or nothing on this subject that other counties could teach Burma.

**Table 2.** Life table for timber elephants as approximated from U Toke Gale's data

| x | $l_x$ | $d_x$ | $q_x$ |
|---|---|---|---|
| 0 | 1.000 | 0.109 | 0.109 |
| 1 | 0.891 | 0.083 | 0.093 |
| 2 | 0.808 | 0.147 | 0.182 |
| 3 | 0.661 | 0.160 | 0.242 |
| 4 | 0.501 | 0.162 | 0.323 |
| 5 | 0.339 | 0.287 | 0.847 |
| 6 | 0.052 | 0.051 | 0.981 |
| 7 | 0.001 | 0.000 | 1.000 |

**Notation:**

x = Age in decades; $l_x$ = Probability at birth of surviving to age x; $d_x$ = Probability at birth of dying in the decade x of age; $q_x$ = Probability at age x of dying in the next decade of age.

**Assumptions:** Population has a stationary age distribution and zero rate of increase.

## *Birth rate*

U Toke Gale stated (p. 71) that a healthy female can produce three to five calves in her lifetime at a spacing of five to seven years between births. That approaches the rate of breeding in the wild and represents a maximum that could be hoped for from a captive population. If a female bred at intervals of seven years, and her chances of dying at any age were those given in the previous section, on average she would produce 3.88 calves in her lifetime (Table 3).

The birth rate of timber elephants might reach this level for some females but the average is much lower. The timber elephants in the Prome area produced only 15 calves in 1979 from 283 females of breeding age. That is a birth rate of 5.3 per 100 breeding

females and implies an average calving interval of 18.9 years. Applying again the mortality rates of the previous section we arrive at a figure of 1.44 calves produced in the lifetime of an average female.

## *Rate of Increase*

A rate of increase or decrease can be calculated from the mortality and birth data presented previously. If the timber elephants each bred at intervals of seven years, but the rate of mortality was the same as now, the population of timber elephants would increase at 2.3% per year (Table 3). However, with current mortality rates and the birth rate implied by the 1979 data from the Prome area, the captive population would decrease at 1% per year (Table 4).

This analysis highlights two facts, one obvious, the other less so: (a) the population of timber elephants cannot sustain itself and must be augmented continuously by capture of wild elephants and, (b) the reason seems to lie exclusively in a low birth rate rather than an excessive death rate.

## *Reasons for the Low Birth Rate*

The writer does not have the information necessary to determine precisely why the birth rate of timber elephants is below the replacement rate. The veterinary officers would have a much better idea. However, from the little information available to him he offers the following suggestions:

Although mating is not actively discouraged it is also not greatly encouraged. The attitude is to "let nature take its course". Unfortunately the course of nature is deflected by some of the management practices designed to increase efficiency at elephant camps. The effect of these will now be examined. U Toke Gale's data on p. 67 of his book shows that the commonest period of birth is October-March (average is December-January) which accounts for 68% of total births. Taking the period of pregnancy as 21 months the corresponding peak period of mating is January to June, the average being March-April. That period coincides both with the peak of *musth* and with the annual rest period. Leaving aside the question of whether *musth* is related physiologically to reproduction, we note that the rest period is not conducive to mating. The elephants are widely scattered among rest camps; these camps often contain elephants of only one sex, and males in *musth* are restrained from friendly encounters with females. These practices are designed to increase the peace and efficiency of the elephant camps, but their incidental effect may be to reduce the birth rate. *It is no coincidence that the highest birth rates among timber elephants are in areas where wild elephants are also present.*

Table 3. Rate of increase analysis for a population of timber elephants with a calving interval of 7 years (ideal case)

| x | $l_x$ | $m_x$ | $l_x m_x$ | $l_x m_x x$ |
|---|---|---|---|---|
| 0 | 1.000 | 0.000 | 0.000 | 0.000 |
| 1 | 0.891 | 0.286 | 0.255 | 0.255 |
| 2 | 0.808 | 0.714 | 0.577 | 1.154 |
| 3 | 0.661 | 0.714 | 0.472 | 1.416 |
| 4 | 0.501 | 0.714 | 0.358 | 1.432 |
| 5 | 0.339 | 0.714 | 0.242 | 1.210 |
| 6 | 0.052 | 0.714 | 0.037 | 0.222 |
| | | | 1.941 | 5.689 |

$m_x$ = number of female live births per female of age x, in next 10 years.
Generation length (T) = 2.931 decades;
Instantaneous rate of increase (r) = 0.226 per decade and hence r = 0.0226 per year.
% Finite rate of increase per year = 2.28%

## WILD ELEPHANTS

Since the timber elephant population must be augmented continuously from the wild population, knowledge of numbers, trend and permissible offtake of wild elephants is of considerable importance in planning future forestry operations.

### *Trend*

The Forest Department estimated that in the period 1956-60 about 9,000 wild elephants lived in Burma. This figure is quoted in U Toke Gale's book and also in the book by *"Kyaw Gyi"* (U Khin Maung Kyaw) on Wildlife Sanctuaries in Burma. By 1972 the estimate had been reduced to 6,000, and the commonest opinion expressed now is that about 3,000 wild elephants remain. Analysis of these data by linear regression (y transformed to natural logarithms) indicates that between 1960 and 1980 the population of wild elephants decreased at an annual rate of about 5.2%. However, U Toke Gale (p. 87) gives Forest Department estimates of annual increase as 5% between 1956 and 1960, and a figure of 7% is often mentioned as the rate of increase associated with the 1972 estimate of numbers. Obviously the population cannot be *decreasing* at 5% a year, as calculated by the trend in official estimates of numbers, and also be *increasing* by about the same amount as implied by the annual increase estimates.

A brief diversion is needed here to resolve that paradox. Up until about 1974 wildlife managers throughout the world calculated an "annual rate of increase" from the proportion of juveniles in the population. The technique was called the *"surplus production method"* or *"age-ratio method"*. Apparently this was the technique used to calculate the 5% and

7% "rates of increase" for the wild elephants in Burma in 1960 and 1972.

Subsequent work, both theoretical and practical, has proved conclusively that this method is based upon a fundamental error of logic and that the "rate of increase" estimated thereby has no necessary relationship to reality. It has now been shown several times that a declining population will always appear to be increasing according to the surplus production method. Consequently the figures of 5% and 7% rate of increase should now be quietly forgotten - the regression estimate of a 5% rate of *decrease* per year since 1960 is presently the best estimate available.

Table 4. Rate of increase analysis of timber elephants given the birth rate in the Prome area in 1979 (prevailing case)

| x | $l_x$ | $m_x$ | $l_x m_x$ | $l_x m_x x$ |
|---|---|---|---|---|
| 0 | 1.000 | 0.000 | 0.000 | 0.000 |
| 1 | 0.891 | 0.106 | 0.094 | 0.094 |
| 2 | 0.808 | 0.265 | 0.214 | 0.428 |
| 3 | 0.661 | 0.265 | 0.175 | 0.525 |
| 4 | 0.501 | 0.265 | 0.133 | 0.532 |
| 5 | 0.339 | 0.265 | 0.090 | 0.450 |
| 6 | 0.052 | 0.265 | 0.014 | 0.084 |
| | | | 0.720 | 2.113 |

T = 2.935 decades
r = -0.112 on decade basis
= -0.0112 on yearly basis

% Finite rate of increase = 1.0% *decrease* per year

## *Offtake*

The allowable offtake of wild elephants has been set by the Forest Department at 200 per year. (Presumably this is the estimated but erroneous 7% rate of increase multiplied by a population estimate of 3,000). The actual offtake is around 120 per year because not enough elephants can be caught to fill the allowable quota. Hence about 4% of the wild elephants are taken each year.

As mentioned previously, the *"surplus production method"* of estimating rate of increase and allowable offtake has proved to be disastrously wrong. No method using age-ratios alone reveals anything about rate of increase or safe offtake. The appropriate alternative methods call for a monitoring of the dynamics of the population as it is harvested.

The most important statistic is the population's size, or an index of population size, estimated every two or three years.

Without those data no precise estimate of allowable offtake can be made, but it is possible to make a tentative estimate of the maximum sustained yield if a few assumptions are made and statistics from African elephants are used in place of those from Burma. (Note to chief Veterinary Officer: the demography of African elephants is similar to that of Asian elephants, despite their being in different genera. The writer has calculated maximum sustained yield on the assumption that wild elephants have a logistic pattern of population growth, that the intrinsic rate of increase is $r_m$=0.05 on an annual basis, and numbers are currently stable at half carrying-capacity density). Despite making the assumptions purposely optimistic the calculations lead to a maximum sustainable offtake of only $2^1/_2$% per year, say 75 elephants. The current offtake of 4% per year is almost certainly high enough to cause a continuous decline in the number of wild elephants in Burma.

In fact the problem may be more serious than these calculations imply, for two reasons: Firstly, the wild elephants appear to be declining faster (5% per year) than would be predicted as an effect of excessive offtake. Changes in habitat and food supply, and perhaps some illegal offtake, appear to be implicated. Secondly, although there might be a total population of about 3,000 wild elephants in Burma, these are not all accessible to capture. Most wild elephants are caught in two areas only, and in these areas the rate of offtake must be very much greater than the 4% per year estimated fro Burma as a whole. To work, offtake quotas must be estimated according to the numbers actually available for capture. For this purpose wild elephants in "black" areas do not form part of the catchable population and should not be included in estimates of sustained yield.

**Table 5.** Rate of increase analysis for a population of timber elephants that is stable. Average calving interval is 12.5 years between conceptions (replacement case)

| x | $l_x$ | $m_x$ | $l_xm_x$ | $l_xm_xx$ |
|---|---|---|---|---|
| 0 | 1.000 | 0.000 | 0.000 | 0.000 |
| 1 | 0.891 | 0.160 | 0.143 | 0.143 |
| 2 | 0.808 | 0.400 | 0.323 | 0.646 |
| 3 | 0.661 | 0.400 | 0.264 | 1.983 |
| 4 | 0.501 | 0.400 | 0.200 | 2.004 |
| 5 | 0.339 | 0.400 | 0.136 | 1.695 |
| 6 | 0.052 | 0.400 | 0.021 | 0.312 |
| | | | 1.087 | 6.783 |

T = 6.240 decades; r = 0.013 on a decade basis; = 0.0013 on a yearly basis

% Finite rate of increase = 0.13% per year.

Note that the finite rate of increase is essentially zero. Hence the population is maintaining itself. This is achieved by a birth rate per year of 8 calves per 100 females of breeding age. That estimate can be refined with the help of data on mortality in the period 1970-80.

## SUGGESTIONS

The major problem is that the timber elephants do not constitute a self-perpetuating population, that they must be augmented by capture of wild elephants, but that these appear to be declining such that their capacity to provide a sustained offtake of the required size is eroded progressively. Little foresight is needed to predict the future effect on teak extraction if that summary is even approximately true. A major requirement is to find out how closely this provisional conclusion, based as it is upon approximations and assumptions, describes the real position and future trend.

### *Timber Elephants*

A full demographic analysis of timber elephants is needed to refine the estimate of the birth rate that would make the timber elephants a self-sustaining population. It was calculated as 8 births per 100 females of breeding age per year, only a small increase over the prevailing rate of about 5 births per 100 females. But the figure of 8 depends for its accuracy on a mortality rate calculated by approximation from U Toke Gale's figures which, although they give frequency of mortality by age, they do not give the equivalent age distribution of the living elephants needed to complete a valid analysis.

If the calculated replacement birth rate is about right it implies that for little extra trouble or effort the timber elephants could be converted into a self-sustaining population. Only a small change in birth rate is needed and no attempt need be made to lower the prevailing death rate. The Burmese Veterinary Officers are better qualified than the writer to decide how this might be done. Slight changes in the management of resting elephants might be sufficient, or artificial insemination might be considered.

### *Wild Elephants*

The other side of the problem is the trend of the wild elephant population. Unlike the timber elephants, where all the necessary data are already available in the detailed records of the Forest Department, little information is available on the wild elephants.

The priority requirement is for an estimate of numbers in each Forest Division, particularly for those Divisions in which elephants are captured, and a re-survey in three years time to estimate trend. An appropriate first approximation can be obtained by a questionnaire survey of each Division. The writer was impressed by the amount and consistency of local knowledge on wild elephants and considers that a gathering of this

local knowledge would provide a reasonably accurate estimate of wild elephants in each Division.

An initial idea of trend can be gained from a questionnaire survey by asking the respondents whether there are more, fewer or about the same numbers now as three years ago. If the population is declining, the rate of decline, population size and offtake can be analysed to discover whether legal catching alone is responsible. Should this show that other factors are involved there would need to be a survey and upgrading of the wildlife sanctuary system to protect the wild elephants and their habitat.

### *Capture*

U Toke Gale reports a loss rate of around 13% for *kheddah* and *melashikar* operations. It is remarkably low and reflects the expertise of the personnel. Since 1969 an immobilising technique using the drug M99 has been used as well. The writer has no information on the loss rate from this drug in Burma, but his experience of its use in Africa suggests that it would be much higher than 13% even when administered by experts. If this is so the Forest Department might consider using one of the drugs that take longer to act but cause fewer deaths than does M99. Most of these safe drugs take 30-40 minutes to immobilise, and they were not popular because the animal can move far enough away in that time to be lost. That problem has now been solved with radiodarts produced in New Zealand. They contain a small transmitter that can be located with an ordinary transistor radio and loop aerial.

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# THE SUMATRAN ELEPHANT *(Elephas maximus sumatranus)*: ITS POPULATION STRUCTURE AND IMPACT ON WOODY VEGETATION IN THE WAY KAMBAS NATIONAL PARK, SUMATRA, INDONESIA

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## ABSTRACT

*The subspecies Elephas maximus sumatranus, endemic to Sumatra, occurs in discrete populations across much of the island. Its range in Sumatra has declined as a result of deforestation and increase in human population growth. A study of the population of elephants in Way Kambas National Park (1,300 km²) was carried out between 1984 and 1986 to determine the population structure, composition, sex ratio, number, density, biomass and impact on woody vegetation. Group size of the family units ranged from 4-8 animals while, larger aggregations up to 45 animals were not uncommon. The most frequently observed category was that of the adult bull elephant which accounted for 34% of all observations. In addition, there were also bull groups whose size ranged from 2-9 (average 4.4). Mean group size tends to be smaller during the dry season and larger during the rainy season. Population structure is biased in favour of the adults and subadults. Sex ratio appears to be 1:5 in favour of the females. The proportion of tuskers among the adult bulls is about 28% - much higher than what is seen in Sri Lanka where it is less than 10%. Logging in the past has created secondary vegetation capable of supporting elephants at higher densities than primary rain forest habitats. Much of the elephant damage to the vegetation consisted of main-stem breaking. The incidence of bark peeling was low given the abundance of alternative food available. It is estimated that between 250 and 350 elephants may occur in Way Kambas, giving a crude density of between 0.19 and 0.27 per km2. The biomass may range between 344 kg/km2 and 488 kg/km2. Elephants appear to prefer woody vegetation with a stem girth between 1-32 cm dbh. Trees above 32 cm dbh appear to have some immunity from elephant damage. It is doubtful if elephants and economic timber production can be compatible. Way Kambas needs to be better managed to improve the grazing/browsing opportunities for the elephants.*

## INTRODUCTION

Of the three extant subspecies of the Asian elephant (*Elephas maximus* L.), the subspecies *Elephas maximus sumatranus*, is endemic to the island of Sumatra in the Indonesian archipelago. It is primarily an inhabitant of the moist tropical rainforest, where browse is scattered and herbaceous growth occurs only in cleared areas and along the river banks, where the canopy is broken.

Prior to about 1900, when agricultural settlement in Sumatra first led to substantial degree of deforestation, most of the island was covered with primary forest. In such circumstances, the somewhat smaller body size of the Sumatran subspecies would have been an advantage. Presumably, up to that time, although its population density would have been low, the effective use of the closed canopy habitat might have favoured the Sumatran elephant to be distributed widely across its habitat, in small social units. Less than a century later, it has almost disappeared from two provinces: North and West Sumatra (Fig. 1). The conversion of primary forest to agricultural holdings, some of which have proved ephemeral and been abandoned, is a particularly serious cause of conservation problems in Sumatra, and the elephant has been among the species of large mammals most seriously affected by it. It is estimated that between 65 and 80% of the forests in the lowlands of Sumatra (Fig. 2) have already been lost (Whitten *et al.* 1984). The mountain areas to date have been less seriously affected, but the disruption of continuous cover is already substantial in some cases, and perhaps 15% of their total area may tentatively be estimated as already removed (Santiapillai & Ashby, 1988). The altitude range of the mountains of Sumatra is such that most of their area is rich habitat in their undisturbed state. Unless much firmer conservation and management policies are adopted in forest areas than have been followed hitherto, and badly planned changes of land use curtailed, the Sumatran subspecies of the Asian elephant will be at severe risk in the wild within a few decades excepting perhaps in some of the large protected areas. It is already listed as endangered (IUCN, 1990) and has been protected since 1931. Legal protection alone however cannot save the Sumatran elephant if its habitat is lost. Such protection similarly failed to save the tiger from Java and Bali.

## STUDY AREA

Way Kambas National Park with an area of 1,300 km$^2$, lies at the extreme southern end of the eastern coastal plain of Sumatra, in Lampung province. It was first established as a complex of Protection forests in 1924 and upgraded to the status of a Game reserve in 1937. It was declared a National Park in 1990. Natural boundaries exist on all sides except along a distance of 28 km in the south-east (Fig. 3). The eastern part of the park where the freshwater swamp forests are, is flat but towards the west, on the drier ground, the terrain is gently undulating. The altitude ranges from sea level to 16 m. The commonest soil type found in the park is the red-yellow podsol which is characteristic of the well drained areas. The Krakatau eruption in 1883, deposited a layer of fertile volcanic ash over the southern part of the park.

Drainage consists of a network of rivers and streams, of which the Way Kambas and Way Wako rivers, together with their tributaries drain approximately 68% of the reserve toward the coast (Wind *et al.* 1979). Seasonal inundation of brackish water may occur up to 2 km inland during abnormally dry periods owing to the low-lying nature of the land. The park receives on an average about 2000 mm of rain per year, much of it falling in December and January (Wind *et al.* 1979). There is a single, pronounced dry season that may last from July to October.

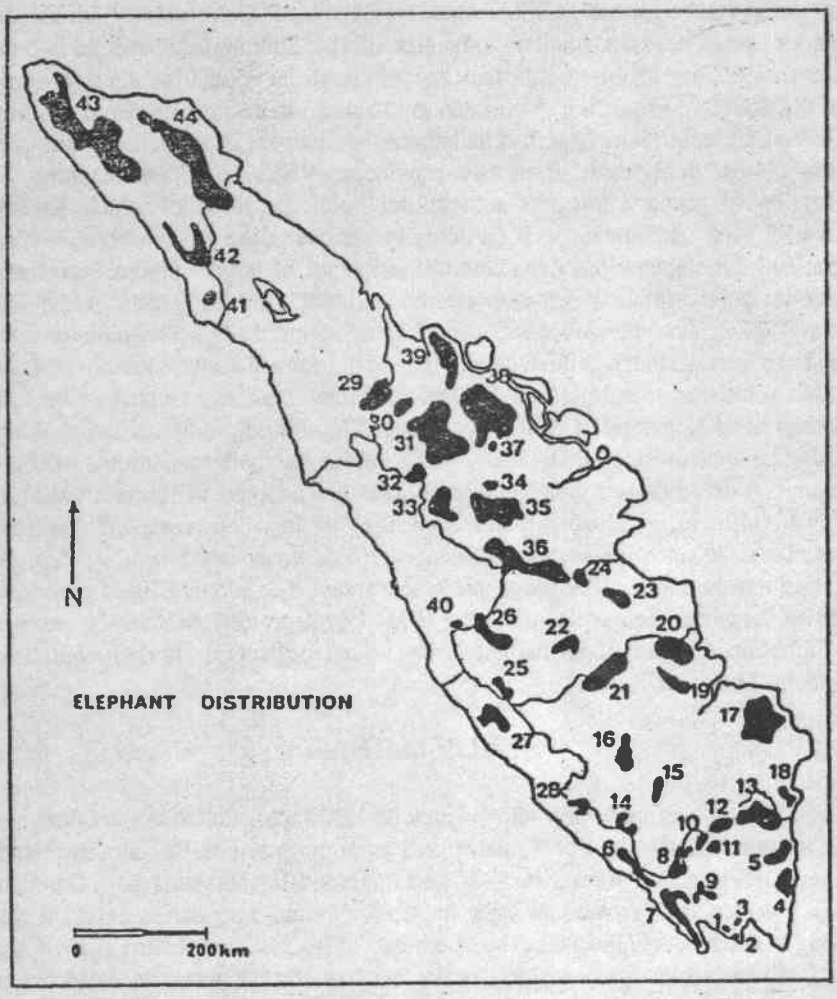



Fig. 1 The distribution of forty-four known populations of elephants in Sumatra. Number 4 represents the elephant population in the Way Kambas National Park, in Lampung province.

The original vegetation in the park was predominantly lowland dipterocarp forest. Today however, only about 5-10% of the park can be described as being "less disturbed" forest. Logging began in 1969 and by 1974, about 50,000 ha of the dipterocarp forest were selectively logged out (UNDP/FAO, 1977). Forest fires in 1972, 1974 and 1976 drastically altered the composition of the vegetation. The combined effect of logging and forest fires has led to the spread of grasslands composed predominantly of *Imperata cylindrica* locally known as alang-alang, which cover almost 70% of the park. Alang-alang is an aggressive weed, difficult to eradicate and thrives well in degraded areas. Despite the loss of up to 75% of the primary forest, Way Kambas still contains one of the largest areas of freshwater (non-peat) swamp forest of any reserve in Sumatra (McCarthy, 1991).

The mammalian fauna is diverse and consists of such threatened species as the Sumatran Tiger *(Panthera tigris sumatrae)*, Clouded Leopard *(Neofelis nebulosa)*, Malayan Sun Bear *(Helarctos malayanus)*, Red Dog *(Cuon alpinus)*, Asiatic Golden Cat *(Felis temmincki)*, Marbled Cat *(Felis marmorata)*, Oriental Small-clawed Otter *(Aonyx cinerea)*, Eurasian Otter *(Lutra lutra)*, Hairy-nosed Otter *(Lutra sumatrana)* and Malayan Tapir *(Tapirus indicus)*. There are six species of primates including the siamang *(Hylobates syndactylus)*. There is also recent evidence for the continued survival of a small population of Sumatran Rhino *(Dicerorhinus sumatrensis)* (Mr Widodo S. Ramono, pers. comm.). There are some 270 species of birds including white-winged wood duck *(Cairina scutulata)* and milky stork *(Mycteria cinerea)*. Reptiles include the estuarine crocodile *(Crocodylus porosus)* and the false gharial *(Tomistoma schlegelli)*.

## METHODS

The dense and tangled nature of the vegetation in the park makes the observation of even the largest terrestrial mammal such as the elephant difficult. Observations of elephants were carried out between June 1984 and January 1986, during which time a total of 85 days was spent in the park, spread over 14 visits. Classification of the groups was often difficult and in most instances, only a total count of the elephants could be taken. Much of the data on elephants was obtained on foot, in areas south of the Way Kam bas river, along the network of trails. The riparian vegetation and grasslands along the Way Kambas river were regularly surveyed from a boat and at every sighting of elephants, the location, time, number, composition and activity were recorded. The term "group" refers to any aggregation of two or more animals (Kurt, 1974). Five categories (adult male, adult female, subadult, juvenile and calf) were used in the study of population structure.

The effect of elephants on the woody-vegetation in the park was determined from a study of six categories of elephant-induced damage signs such as (i) branch breaking, (ii) main stem breaking, (iii) stem twisting, (iv) bark peeling, (v) pushing over, and (vi) tusk marking (Wing & Buss, 1970; Vancuylenberg, 1974; Ishwaran, 1983, 1984). These damage signs were scored along five trails randomly selected (each 0.5 km long) on either

side up to 2 m, on trees that were over 1.5 m height. Broken branches with leaves that could be attributed with certainty to elephants were collected for identifcation.

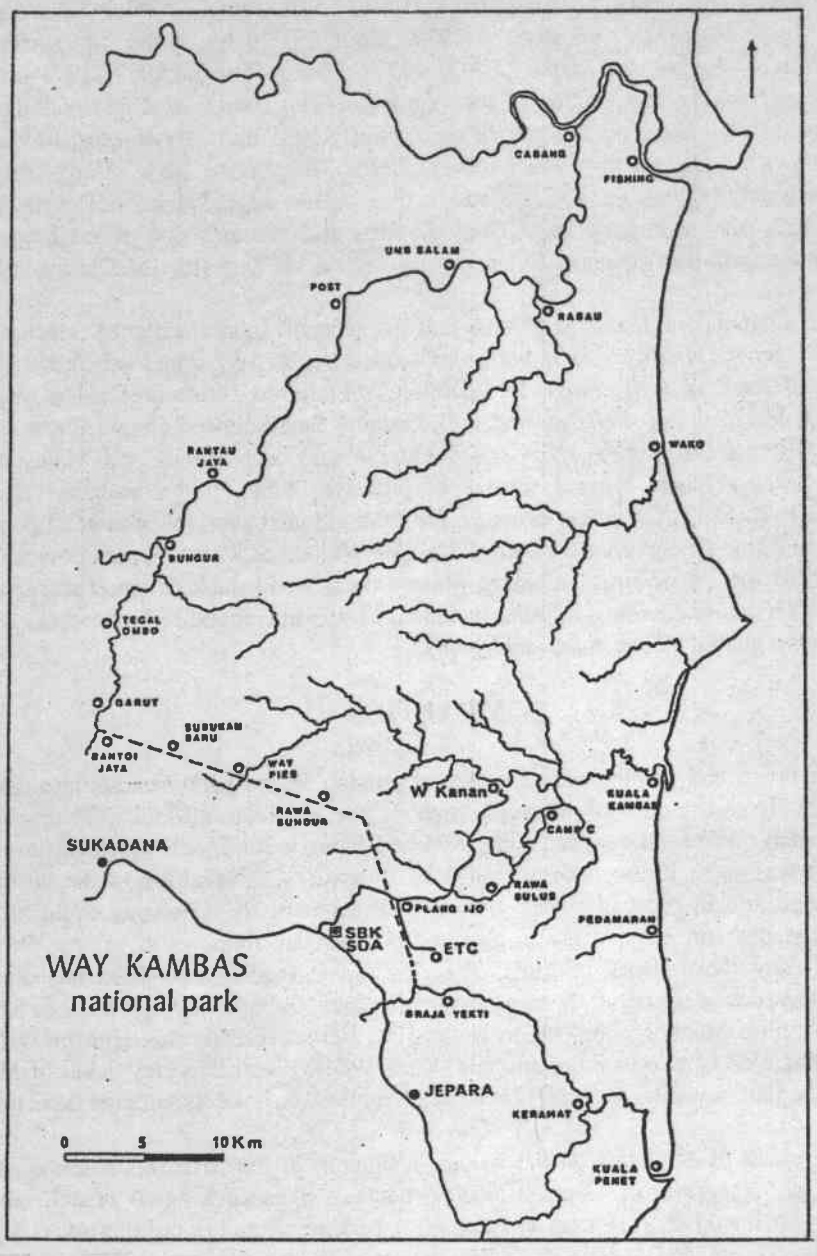



Fig. 2. Map of the Way Kambas National Park, situated in the southern province of Lampung in Sumatra, Indonesia.

Table 1. Number of elephants recorded in Way Kambas National Park, Sumatra.

| Date | Days | No: | Location | Composition | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | | am | af | sa | ju | cl | |
| Jun. 84 | (8) | 1 | Karangsari | 1 | 1 | - | - | - | 2 |
| | | 2 | Camp D2 | | | | | | (30) |
| | | 3 | Camp D2 | 1 | 2 | - | - | - | 3 |
| Jul. 84 | (8) | 4 | Karangsari | | | | | | (23) |
| | | 5 | Karangsari | 1 | - | - | - | - | 1 |
| | | 6 | Post 1 | 1 | - | - | - | - | 1 |
| Aug. 84 | (10) | 7 | Pancasila | | | | | | (32) |
| | | 8 | Post 1 | | | | | | (12) |
| | | 9 | Camp D2 | 1 | - | - | - | - | 1 |
| | | 10 | Negarabatin | 1 | - | - | - | - | 1 |
| | | 11 | Post 1 | 2 | - | - | - | - | 2 |
| | | 12 | Post 1 | 1 | - | - | - | - | 1 |
| Sep. 84 | (10) | 13 | Wako | | | | | | (45) |
| | | 14 | Post 1 | 2 | - | - | - | - | 2 |
| | | 15 | Karangsari | - | 4 | - | - | 1 | 5 |
| | | 16 | Pancasila | | | | | | (16) |
| | | 17 | Post1 | 1 | - | - | - | - | 1 |
| | | 18 | Camp D2 | - | 2 | 1 | - | - | 3 |
| | | 19 | Camp D2 | 1 | 19 | 11 | - | 4 | 35 |
| | | 20 | Camp D2 | - | 12 | 9 | 5 | 2 | 28 |
| Nov. 84 | (4) | 21 | Jepara | | | | | | (20) |
| Jan. 85 | (4) | 22 | Wak Kanan | 1 | - | - | - | - | 1 |
| Apr. 85 | (7) | 23 | Camp D2 | | | | | | (32) |
| | | 24 | Way Kanan | 1 | - | - | - | - | 1 |
| | | 25 | Way Kanan | 1 | - | - | - | - | 1 |
| | | 26 | Rasau East | 7 | 12 | 16 | 3 | 2 | 40 |
| May. 85 | (6) | 27 | Post 1 | | | | | | (12) |
| | | 28 | Post 1 | | | | | | (6) |
| Jun. 85 | (3) | 29 | Way Kanan | 1 | - | - | - | - | 1 |
| Jul. 85 | (6) | 30 | Post 1 | 1 | 1 | - | - | - | 2 |
| | | 31 | Post 1 | 1 | - | - | - | - | 1 |
| | | 32 | Post 1 | - | 3 | - | 1 | - | 4 |
| Sep. 85 | (8) | 33 | Boundary | 1 | - | - | - | - | 1 |
| | | 34 | Pancasila | | | | | | (9) |
| | | 35 | Negarabatin | 5 | - | - | - | - | 5 |
| | | 36 | Karangsari | | | | | | (23) |
| | | 37 | Karangsari | | | | | | (30) |
| Oct. 85 | (3) | 38 | Post 1 | 1 | - | - | - | - | 1 |
| Dec. 85 | (5) | 39 | Boundary | 9 | - | - | - | - | 9 |
| | | 40 | Boundary | 4 | - | - | - | - | 4 |
| Jan. 86 | (3) | 41 | Boundary | 1 | - | - | - | - | 1 |
| Total | 85 | | | 47 | 56 | 37 | 9 | 9 = 158+(313) = 471 | |

am (adult males), af (adult females), sa (subadults), ju (juveniles), cl (calves)
Totals within brackets refer to unclassified animals.

Table 2. Composition of the groups (excluding bull groups) classified

| Ad. males | Ad. female | Subadults | Juveniles | Calves | Total |
|---|---|---|---|---|---|
| 1 | 1 | - | - | - | 2 |
| 1 | 2 | - | - | - | 3 |
| - | 4 | - | - | 1 | 5 |
| - | 2 | 1 | - | - | 3 |
| 1(1t) | 19 | 11 | - | 4 | 35 |
| - | 12 | 9 | 5 | 2 | 28 |
| 7(1t) | 12 | 16 | 3 | 2 | 40 |
| 1 | 1 | - | - | - | 2 |
| - | 3 | - | 1 | - | 4 |
| 11(2t) | 56 | 37 | 9 | 9 | 122 |
| % 9 | 45.9 | 30.3 | 7.3 | 7.3 | 100 |

t = tusker

## RESULTS AND DISCUSSION

### *Group size*

The basic population unit among elephants is the family unit, consisting of an integrated group of closely related animals of all classes, excluding adult males (Buss 1961, Laws & Parker 1968, Laws 1970, Douglas-Hamilton 1972, Moss & Poole 1983, Moss 1988). In Way Kambas National Park, of the total 471 animals recorded in 41 sightings, (Table 1) such family units comprised between 4-8 animals (Fig. 3) and accounted for 12.2% of the observations. White *et al.* (1993) in a study of the African forest elephant, *Loxodonta africana cyclotis* found the mean group size to be 3.3. Olivier (1978) gave a figure of 5-6 for the family unit of the Asian elephant in the rain forests of Malaysia. The majority of the observations (34.1%) were of solitary individuals (14), all of which were adult bulls. Family units are stable, but aggregate to form "kin" or bond groups, clans, subpopulations and populations (Douglas-Hamilton 1972, Moss & Poole 1983). In Way Kambas, the remaining sightings were for the most part larger groupings or clans of up to 45 individuals, formed by the temporary merger of a number of family units (Eisenberg, 1981). Such larger aggregations in general, split into smaller foraging groups, which move in a coordinated manner (Owen-Smith, 1988).

The other small population unit is the loose group of mature bulls, the bull herd, averaging 4.4 animals. There were five bull groups that ranged in size from 2 to 9. Bull groups are characterized by ever-changing composition (Croze, 1974). Bull groups accounted for 12.2% of the observations. Laws (1974) has postulated that group size is a measure

of the ecological health of elephant populations, since aggregation of family units and bull herds is the result of stressful conditions. This was borne out by 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. In Way Kambas, the higher group size of the bull group (9) is indicative of the scale of the human-elephant conflicts that exist along the periphery of the park. Similar high group size of bull elephants was observed in Sri Lanka in the Handapanagala area where elephants are in conflict with man (Hendavitharana *et al.* 1994).

The extent to which elephants aggregate in a particular area is relevant to their management as regards habitat utilization. Group size of elephants in Way Kambas National Park showed variation in time and space, ranging from 2 individuals to a maximum of 45 in the grasslands of Wako (Table 1). Western & Lindsay (1984) discuss the reasons for large group formation. Large aggregations formed in response to heavy human predation (Laws *et al.* 1975). The higher group sizes may indicate a high level of disturbance due to social factors in the park. In Uganda, higher group sizes were observed among elephants inhabiting areas where poaching was prevalent, while those areas that were most secure from poaching had the lowest group sizes (Eltringham, 1977).

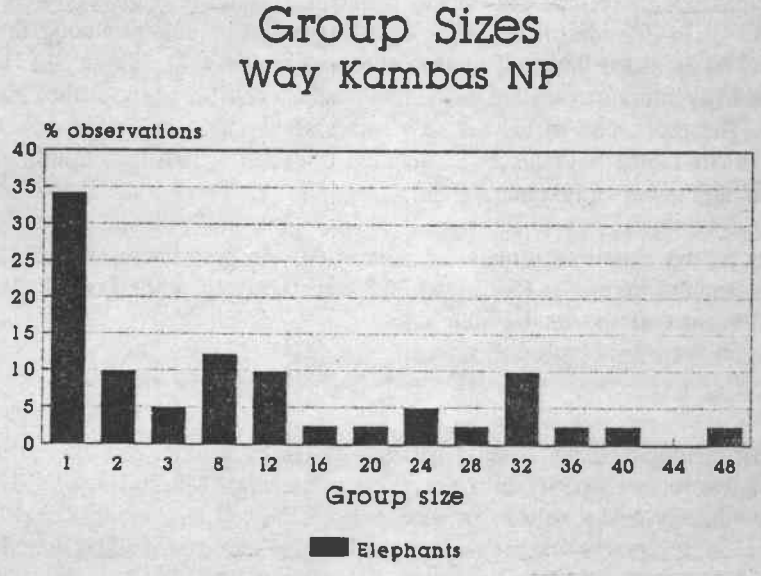



**Fig. 3** Frequency of sightings for elephant groupings of various sizes.

Social factors such as territoriality, average group size, seasonality of breeding etc. have a profound influence on the population dynamics of many large mammals and are also important in their management (Caughley & Walker, 1983). Elephants being social animals, live in groups. The basis of their social organization is matriarchy. The groups

are led by the oldest reproducing cow. As in man, the grandmother is an integral part of the group and has important leadership and/or infant care function (Laws *et al.* 1975). The extensive generation overlap leads to the establishment of linear dominance hierarchy among the females, and the leadership often falls on the oldest female in the group. Such female leadership is also known in the water buffalo (Tulloch, 1967) and in the gaur (Schaller, 1967; Ulrich, 1968).

## *Population structure*

The population structure of elephants in Way Kambas National Park appears to be biased towards adults and subadults. Of the 158 animals that were classified, 103 (or 65%) were adult males and females. This was similar to what was observed in the Ruhuna National Park, Sri Lanka (Santiapillai *et al.* 1984). Subadults in Way Kambas accounted for 23% (37 out of 158) of the classified total, while the proportions of the juveniles and calves were 6% (9 out of 158) each. The proportion of tuskers among the bull elephants in Way Kambas appears to be high, given that 13 out of the 47 bulls classified (or 28%) were tuskers. This is less than what was reported by Deraniyagala (1955) who found 98% of a sample of 29 bull elephants from Sumatra to be tuskers. The lower incidence of tuskers in Way Kambas could well be due to the fact that a number of tuskers were poached for their tusks or in defence of the crops. The proportion of tuskers among the bulls in captivity (72.2%) is much higher than that observed in the wild. (Table 3). These bulls were captured in operations to resolve the human-elephant conflict and to reduce the elephant depredations. The proportion of tuskers varies enormously in Asia. While, less than 10% of the bulls in Sri Lanka have tusks (Santiapillai & Jackson, 1990), in South India, over 90% of them are tuskers (Sukumar, 1989).

As far as the classified groups are concerned, the proportions of the adult bulls, adult cows, subadults were 9%, 45.9% and 30.3% respectively, while juveniles and calves made up 7.3% each of the total (Table 2).

## *Sex-ratio*

In most mammals, there is parity between the sexes at birth. But the "natural" adult sex-ratio is unlikely to be parity in a polygynous mammal (Mitchell *et al.* 1977). Adult bull elephants usually lead a solitary or semi-solitary life and rejoin matriarchal units only during the period of reproduction. Therefore, the "natural" sex-ratio will be biased in favour of the adult females (Kurt, 1969; Eisenberg & Lockhart, 1972; Santiapillai *et al.* 1984). In Way Kambas, the adult sex-ratio was 1:5 biased in favour of the females (Table 2). This reflects the selective mortality of the bulls, especially the tuskers as a result of escalating human elephant conflicts.

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. 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 (Sukumar, 1989). From Table 2, it appears that the inter-calving interval is about 6 years, which is somewhat longer than the average of 4 years. In view of the wide range of adjustment possible in mean calving interval (3 to 9 years), and in the attainment of maturity (9 to 20 years), reproduction might be the actual regulatory process (Laws, 1981).

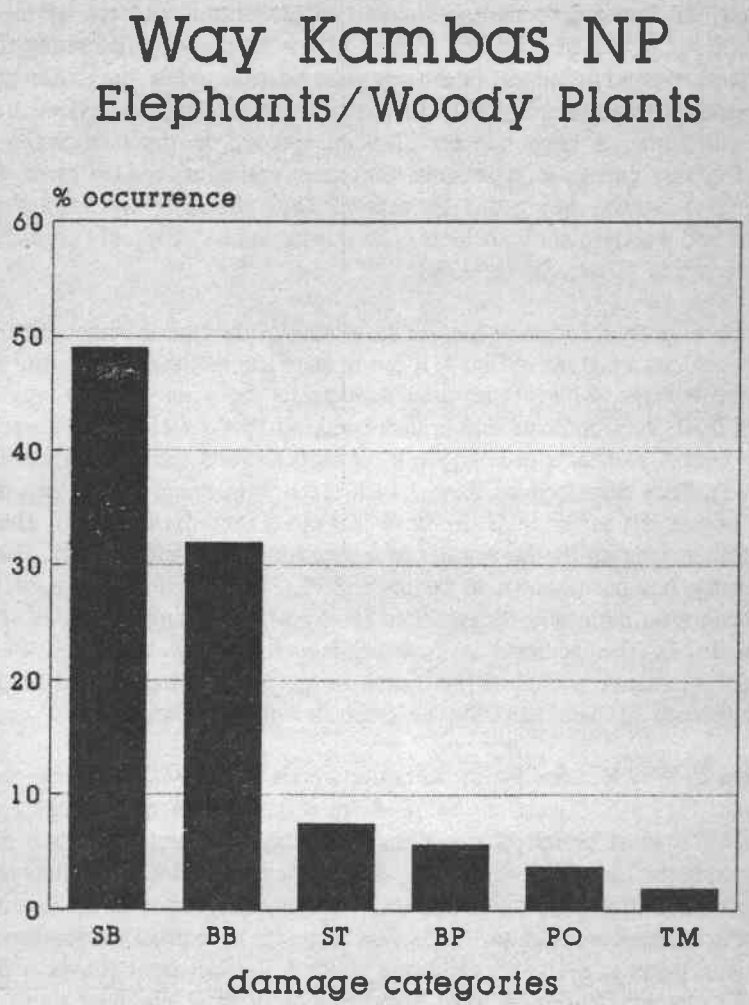



Fig. 4 - Impact of elephants on woody vegetation in Way Kambas National Park, Sumatra. (SB = main stem breaking; BB = Branch breaking; ST = Stem Twisting; BP = Bark Peeling; PO = Push Over; TM = Tusk Marking)

## *Impact on woody-vegetation*

Way Kambas National Park was subject to intensive logging for almost three decades. Much of the original lowland dipterocarp forest has disappeared and what is left today are large areas of secondary scrub and extensive grasslands dominated by *Imperata cylindrica*. The much valued hardwood timber species have been largely extracted and now, a large proportion of the woody vegetation is made up of trees with less than 20 cm diameter at breast height (dbh). But for the elephants and other herbivores, there are sufficient resources in the park, since secondary deciduous forests provide the greatest potential carrying capacity as standard foods can become superabundant and are of high quality (Olivier, 1980). Logging has also created a much higher diversity by increasing the "edge" habitats. Elephants respond to "edges" or the transition zones between forests and grasslands, in a positive manner (Seidensticker, 1984). Elephants being generalized feeders, are catholic in their diet, consuming a large number of plant species. In most environments food abundance and quality change with seasons. Elephants prefer to feed on grass when it is green, switching to browse during the dry season. Thus elephants are adapted as mixed grazer-browsers and woody plant branchlets offer a suitable mix of rapidly digestible leaves and indigestible stems (Owen-Smith, 1988).

The percentage frequencies of the six categories of damage inflected on the woody vegetation by elephants are given in Fig. 4. It can be seen that main-stem breaking accounted for much of the damage. 81% of the total damage to the woody plants was due to a combination of main stem breaking and branch breaking by the elephants. When browsing during the dry season, elephants usually break off branches and feed on the terminal twigs (Ishwaran, 1983). They also feed on bark, which are rich in minerals and sap. In Africa, bark stripping occurs just before trees flower or leaf out (Owen-Smith, 1988). The elephant is a wasteful feeder, judging by the amount of vegetation that is left uneaten. The animal's foraging efficiency has been shown to be high (80%) when feeding on grass, low (20-25%) when feeding on bark, and intermediate (50%) when feeding on leaves, stems and twigs (McKay, 1973). The incidence of bark peeling observed was low (5.7%). Perhaps, an abundance of alternative source of food, such as regenerating trees could be the reason for the low incidence of bark stripping by elephants in Way Kambas.

Elephants in Way Kambas appear to prefer woody plants with a stem girth between 1 to 32 cm dbh (Fig. 5). Size classes below 8 cm dbh were the most prone to elephant damage (81%). The most preferred size class of woody vegetation was between 2 and 4 cm dbh (or saplings). Small woody plants are commonly eaten whole. Elephants prefer feeding on most quick growing pioneer species, while rejecting most of the dominant trees of the Dipterocarpaceae (Owen-Smith, 1988). Forest studies have shown that when abundant young woody vegetation is available, elephants prefer it to older trees (Laws *et al.*, 1975). Trees above 32 cm dbh appear to have some immunity from elephant damage. These observations in Way Kambas National Park where the vegetation is secondary, are in agreement with those of Wing & Buss (1970), Laws *et al.* (1975) and Ishwaran (1983).

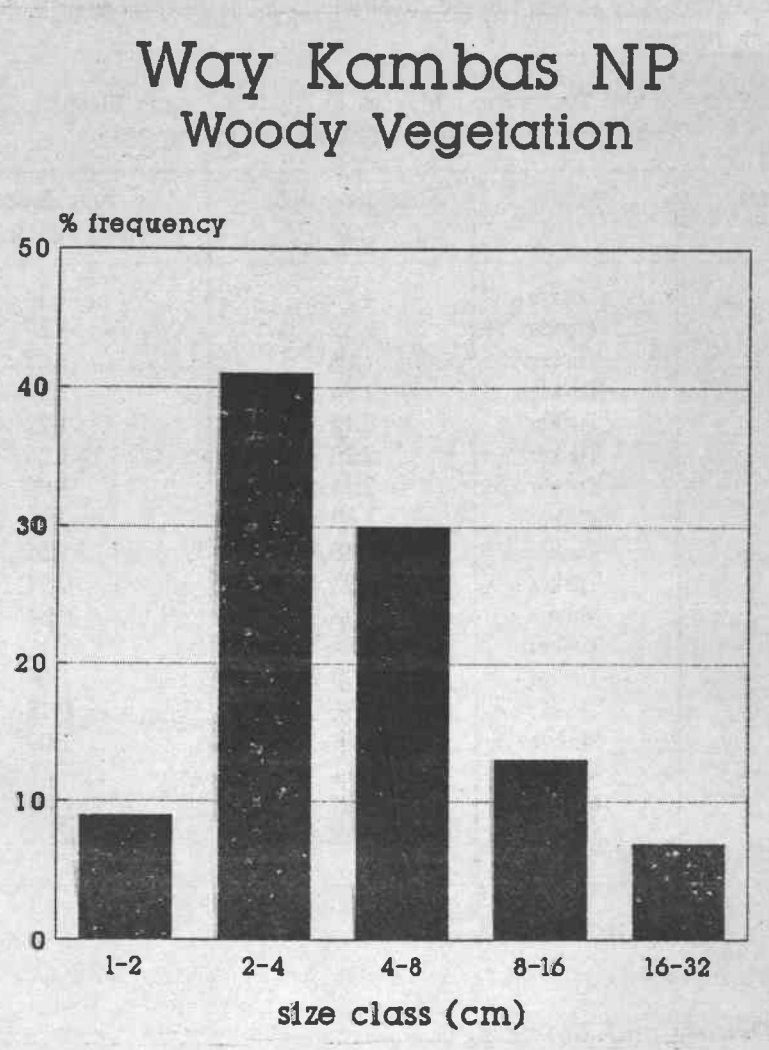



Fig. 5 - Size of woody vegetation preferred by elephants in Way Kambas National Park, Sumatra.

There is currently evidence to show that the tree species eaten by elephants are also fast growing and short-lived (Laws *et al.* 1975). Such fast growing species are characteristic of the secondary forests and production forests in Sumatra. Moreover, elephants not only selectively damage the smaller size classes of woody vegetation, they are also species selective and therefore in the long term, can alter the composition of the forest. If this is so, then elephants and economic timber production may not be compatible

(Laws *et al.* 1975). These observations therefore have serious implications for the management of production forests situated either within an elephant range or in the vicinity of an elephant reserve.

Table 3. Record of the Tuskers and Maknas in captivity at the Elephant Training Centre, near Way Kambas National Park, Sumatra.

| Age (yrs) | Status | Shoulder height (m) | circumference of right fore foot (m) |
|---|---|---|---|
| 18 | Tusker | 1.99 | 1.14 |
| 15 | Tusker | 2.32 | 1.34 |
| 15 | Tusker | 1.96 | 1.07 |
| 8 | Tusker | 1.94 | 1.06 |
| 15 | Tusker | 2.13 | 1.22 |
| 16 | Tusker | 2.29 | 1.25 |
| 12 | Tusker | 2.11 | 1.09 |
| 6 | Tusker | 1.63 | 0.89 |
| 12 | Tusker | 2.16 | 1.25 |
| 8 | Tusker | 1.98 | 0.99 |
| 3 | Makna | 1.48 | 0.84 |
| 6 | Tusker | 1.84 | 1.13 |
| 5 | Tusker | 1.73 | 1.09 |
| 2 | Tusker | 1.31 | 0.78 |
| 7 | Makna | 1.89 | 1.09 |
| 6 | Makna | 1.71 | - |
| 4 | Makna | 1.65 | - |
| 5 | Makna | 1.58 | - |

% of tusker = 13/18 x 100 = 72.2%

## *Number, Density and Biomass*

The number of animals and their occupance are of fundamental importance to wildlife management (Jachman & Bell, 1979). However, in the dense and tangled vegetation of the humid tropics, it is not often easy to arrive at accurate estimates of population size of even elephants. Any assessment of elephant number will therefore be prone to underestimate the actual total. This was very clearly demonstrated in 1982 during the elephant drive code-named, *"Operation Ganesha"* in South Sumatra province when a total of 232 animals were flushed out of a patch of forest in Air Sugihan transmigration settlement which was long thought to have had only about 80 elephants (Blouch & Haryanto 1984).

An alternative approach would be as recommended by Laws *et al.* (1975) to estimate the area available to the elephants and then apply hypothetical elephant densities to this area and thereby estimate the total number of elephants. In suitable South east Asian habitats, crude density of elephants can range from 0.1 to 1.0/km² (Eisenberg, 1981; Eisenberg & Seidensticker, 1976). In general, elephants are known to live at a higher density in secondary forests than in primary forests. Based on the number of separate groups of elephants actually recorded in the park in 1984 (minimum number of about 140 from three separate groups of 65 animals from Camp D2; 45 animals from Wako and 30 animals along the southern boundary) and the subsequent number of elephants translocated into the park from outside in two elephant drives (72 and 40 elephants totalling 112 animals), the minimum estimate of the total population of elephants in Way Kambas National Park by the end of 1987 was 252, giving a minimum crude density of 0.19 per km². The actual number could be anything between a minimum of 250 and a maximum of 350 animals. Despite its limitations, this is a more realistic estimate of elephant number than what was previously estimated; 30 by Wind (1978) and 40 by Olivier (1981) for the entire park.

In calculating the biomass of elephants in Way Kambas, an average value of 1,810 kg was used as the elephant's weight (adjusted with respect to percentage of age and sex classes) as recommended by Eisenberg & Lockhart (1972). This would mean a biomass of 344 kg/km2 at the minimum crude density of 0.19 per km². The biomass could be as high as 488 kg/km² at a maximum crude density of 0.27 per km², which is typical for most of the secondary forest habitats in the Indomalayan region. Even though elephants are not numerically the most dominant species in Way Kambas, they still remain ecologically the most important in terms of biomass and cycling of plant material.

## CONCLUSION

The elephants in Way Kamabs National Park represent an important lowland population, whose prospects for long term survival appear to be good provided efforts are made to minimize the human-elephant conflicts. The agency responsible for the conservation and management of elephants in Indonesia, the Directorate General of Forest Protection and Nature Conservation (PHPA) have taken a number of measures that range from translocation of problem elephants, establishment of electric fences, to capture and domestication of chronic crop raiders so that they could be gainfully employed in forestry, agriculture and nature tourism.

Some of the common management problems associated with elephants in the park are the inevitable consequences of their large body size and intemperate appetite. Land adjoining the park was once part of the elephant's range and today it is being intensively cultivated, which attracts the elephants even though there is plenty of food within the park (Santiapillai & Widodo, 1993). Sumatra is rapidly approaching a stage when all the remnant of natural environment will be contained in a patchwork of parks and reserves. Containing elephants within protected areas surrounded by dense human settlements will inevitably lead to an escalation of conflicts between man and elephant. Therefore elephant habitats

within the protected areas must be properly managed to improve the grazing/browsing opportunities for the elephants, given that the elephant's digestive physiology is adapted to a bulky, high fibre diet (Janis, 1976; Olivier, 1978).

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# HISTORY OF ELEPHANTS IN CAPTIVITY IN INDIA AND THEIR USE: AN OVERVIEW

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This is a story of captive elephants in India and their use - a period stretching over 5000 years, may be even upto 8000 years or so. As background information one should have an idea of the political geography of ancient India and the generally accepted period - divisions of India's history.

The period divisions are given in the most simplified and broader possible outline, with all their accompanying pitfalls. For example, none of the ancient and medieval empires mentioned covered the entire geographical extent of the sub-continent, but frequently extended to large areas in what is now Afganistan and Central Asia; the Islamic rules never extended over the whole of peninsular India; the British did not become rulers of India all at once in 1757 after the Battle of Plassey; the Mughal emperors continued to be the titular heads in Delhi right upto 1857.

The received view is that the earliest evidence of elephants in captivity comes from the Harappan seals which show elephants with ropes on them. As I see it, these only prove that elephants were captive, but not necessarily domesticated or trained; for no seal shows an elephant with a proper harness or a rider, and this is also true of artifacts of late Harappan culture which the Vedic period overlaps. It is well to remember that speaking of Harappan culture, we are only referring to one corner of India, the riverine tracts of north-western India, the Indus-Saraswati valley. When we speak of Harappan culture we do not speak of the entire subcontinent.

If we look at evidence of cave paintings from other parts of India, we can perhaps push back the history of elephants in domesticity in India by another 400 years or more - to around 6000 B.C. A word of caution: I am making these observations here tentatively, as I am yet to solve the problems of dating the relevant drawing / paintings to my entire satisfaction. Some of these paintings very possibly pre-date Harappan culture and may show positive evidence of elephants under human control.

The Aryans or Aryan-speaking people probably came into India from the Central Asia region around 1500 B. C. The Vedas of the Aryans are a series of compositions - hymns, prayers, poems, rituals, incantations - compiled over a period of a thousand years. The nomadic Aryans brought with them a horse-culture. Even in the *Rig Veda Samhita* (C. 1500 B. C.) we find evidence of elephants being in domesticity, and references to gifts of elephants, richly caparisoned elephants, elephants responding to commands, and even

to villages of elephant keepers, showing that elephants had already become a part of the life of the Rig Vedic Aryans, though I have not come across any reference to use of elephants in war.

We can now offer a model of this development. Aryans came into India from the temperate north-west, and learnt the art of domesticating elephants from the people they subjugated, and in turn used this newly acquired expertise to penetrate and conquer hilly, forest-clad, and frequently swampy tracts further east and toward the south, terrains unsuited to cavalry manoeuvre.

The importance of the domestication of the horse in the spread of neolithic revolution, especially among people of the temperate region, has been the subject of specialist studies. It seems elephants instead of horses played a similar role in the tropical climate of south and south-east Asia - hypothesis on which some of us are now working.

With the establishment of the Kingdom of Magadha (c. 600 B. C.), a new centre of power emerges in the east, in the heart of elephant country and the concept of the four-armed host-chariotry imported from Persia and the dry highlands, cavalry, elephantry and infantry - become firmly established. Alexander fought this four-armed fighting forces of King Poros in 326 B. C. Alexander nearly lost the day to Poros because of the latter's elephant power - the nearest he had ever come to defeat during his campaigns. It was again the story of the elephant power of the King of Magadha that, according to some historians, caused a near-revolt among the forces of Alexander and prevented him from moving further east. This was the West's first serious encounter with elephants in war which led to the introduction of elephants in Indo-Bactrian and Roman armies, and the first western account of the natural history of elephants in Aristotle. With the extension of Aryan power from the Sind valley in the west to the Ganga valley in the east, the real elephant territory, as Alexander notes in 4th century B. C., elephants started playing an increasingly important part in the army as well as in myths and religious rites, the beginning of the real or high elephant culture of India. The consequence of this shift to the east with its softer riverine soil and denser vegetation was that the chariot arm of the four-arm host withered away by approximately 1st century A.D. and elephants started to take an increasingly important part in the army. The king is entitled *Gajapati* or Master of Elephants. The cult of *Ganesha*, the elephant-headed God, is introduced, and various myths are created around elephants. Sculptures from the temple of Konarak in Orissa (13th century A. D.) demonstrate how elephants were used to demolish the native tribal elements as the main arm of the fighting forces of the Aryans pushing into the forested areas, the stronghold of the aborigines.

When the Islamic invasions came, the swift-moving iron-clad cavalry and superior archery won the day against the Hindu deployment of elephants. At the Battle of Khanua (1527) the founder of the Mughal empire in India, Babu, routed the army of Rana Sanga which included 500 war elephants. But the importance of elephants continued, these occasional debacles notwithstanding. The Mughals, once they consolidated their position, became great patrons of elephants. Throughout this period one reads of accounts of war

with more than a thousand elephants employed by a side. The imperial stables under Akbar in his far-flung territory reportedly had 32,000 elephants, and during the reign of his son Emperor Jehangir, 113,000.

Table 1 - Periods of Indian History

| | | |
|---|---|---|
| Before | c. 2500 B. C. | - Prehistory - overlaps with the Harappan period in many areas. |
| | c. 2500 - 1500 B. C. | - Harappan Civilization in western India - prehistory. |
| | c. 1500 - 600 B. C. | - Aryans into India - the Vedic period. |
| | c. 600 - 321 A. D. | - The rise of the kingdom of Magadha (c. 600 B. C.); Buddha and the rise of Buddhism; Maurya Empire founded (c. 321 B. C.); Satavahan Empire: the age of the final form of the epics, the *Ramayana* and the *Mahabharata*. |
| | 321 - 1192 A. D. | - The Classical period of the Imperial Guptas; Harshavardhana of Kanauj in northern India (606-47); the southern kingdoms of the Pallavas, Chalukyas, and Cholas. |
| | 1129 - 1757 A. D. | - The Islamic period: Turkish empire, Afghan rulers, Mughal empire. |
| | 1757 - 1947 A. D. | - British rule. |
| | 1947 - | - The present day. |

But slowly and inexorably, increased efficiency and accuracy of musketry and the introduction of mobile canons pushed the elephants back from the front-line to the commissariat. In the Battle of Plassey in 1757 where Clive came out victorious against the Nawab of Bengal and thus laid the foundation of the British Empire in India, elephants were used by the Nawab only in the commissariat and to give occasional push to mobile canons in difficult terrain. Thus a two thousand five hundred year old tradition of using elephants as a fighting force gradually petered out.

We see a new kind of large-scale deployment of elephants from around the 2nd quarter of the 19th century: in *shikar* or big-game hunting. Elephants have been used to hunt game since the time of Emperor Chandragupta Maurya in the 4th century B. C., as Megasthenes (315 B. C.) informs us. Mughal miniatures show emperors hunting from the back of elephants. In the 19th century apparently a new technique emerges: employment of elephants in huge numbers to beat out a cover, particularly the grassy tracts. Maharaja Jung Bahadur Rana (1946) of Nepal employed upto 700 elephants in his famous, or infamous depending on one's way of looking at it, "ring method" of hunting in the grassy tracts of sub-himalayan Nepal or Nepal Terai, at it is known to us. The idea is to completely encircle located tigers with a ring of elephants to prevent their breaking out and allow selected *shikaris* to get in on elephant back, flush out the animals, and deliver the *coup de grace* - altogether a frightening exercise guaranteed to produce charges from cornered tigers in dense, impenetrable cover. The *shikar* party which Sir George Trevelyan joined in 1863 had 48 elephants. Sir Samuel Baker used a very large number of elephants in the "char" or grassy riverine islands of the Brahmaputra river in eastern India in 1885. The Maharaja of Coochbehar's *shikar* party frequently used nearly hundred elephants or more to beat out game and carry the guns. This, in addition to regular employment in administration, communication in accessible areas, state pomp, and religious ceremonies. Lord Curzon, Viceroy of India, made his state entry into Delhi on the occasion in Delhi Durbar (1903) on the back of an elephant leading a procession of elephants. Modern bulk users of elephants are Forest and Tourism Departments of the government, circus parties, loggers, and religious endowments.

# HABITAT ENRICHMENT IN BLOCKS III & IV OF THE RUHUNA NATIONAL PARK, SRI LANKA

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## INTRODUCTION

Blocks III & IV (Fig. 1) were incorporated into the complex of Ruhuna National Park in 1967 and 1969 respectively with the view to enlarging the habitat then available for wildlife in general and the elephants in particular. These two administrative Blocks are 67,192 ha in extent and they account for 53% of the total area of Ruhuna National Park (126,782 ha). The Buttala-Kataragama road forms the western border of these two blocks, while the Kumbukkan Oya runs along much of the north and north-eastern border. The elephant population of Ruhuna National Park is estimated to be between 350 and 400 animals, many of which through seasonal movement, maintain a substantial amount of gene exchange with other elephant herds, thereby blurring the boundaries between populations.

### *Ruhuna National Park*

Much of the area of Ruhuna National Park consists of the flat coastal plains, which however show a number of scattered "inselbergs", which are the erosion remnants of quartzofeldspathic gneisses that appear as smooth, usually unvegetated rock mounds reaching in height up to 90 m above the plains (Katz & Comanor, 1969). Two rivers, the Menik ganga and Kumbukkan oya and a number of seasonal streams drain the area and discharge into the sea through a shifting system of sand dunes and brackish lagoons (Woodford, 1979). The main rainy season occurs from mid-October to January, when the park receives rain from the NE monsoon. A short rainy season occurs in March and April from convectional rains, and the rest of the year is characterised by a distinct drought season

(Mueller-Dombois, 1968). The mean rainfall is about 1,100 mm but it can vary from year to year.

## *Vegetation*

The main vegetation cover is woody, mostly scrub, with canopy below 5-m height (Mueller-Dombois, 1972). The secondary vegetation can be characterised as "thorn-scrub" with such species of woody plants as *Manilkara hexandra, Drypetes sepiaria, Bauhenia racemosa, Salvadora persica, Feronia limonia and Cassia fistuala* (Balasubramaniam *et al.* 1980). Shrub vegetation consists of *Dichrostachys cinerea, Randia dumentorum, Cassia spinarum* etc. (IUCN, 1990). Near the coast, the scrub is frequently interrupted by grass covered areas of various sizes, dominated by species such as *Eragrostris viscosa, Dactylotaenium aegyptium, Sporobolous diandrus, Echinochloa colonum, Setiaria pallidifusca and Alloteropsis cimicina* (Balasubramaniam *et al.* 1980).

## *Human-Elephant problems*

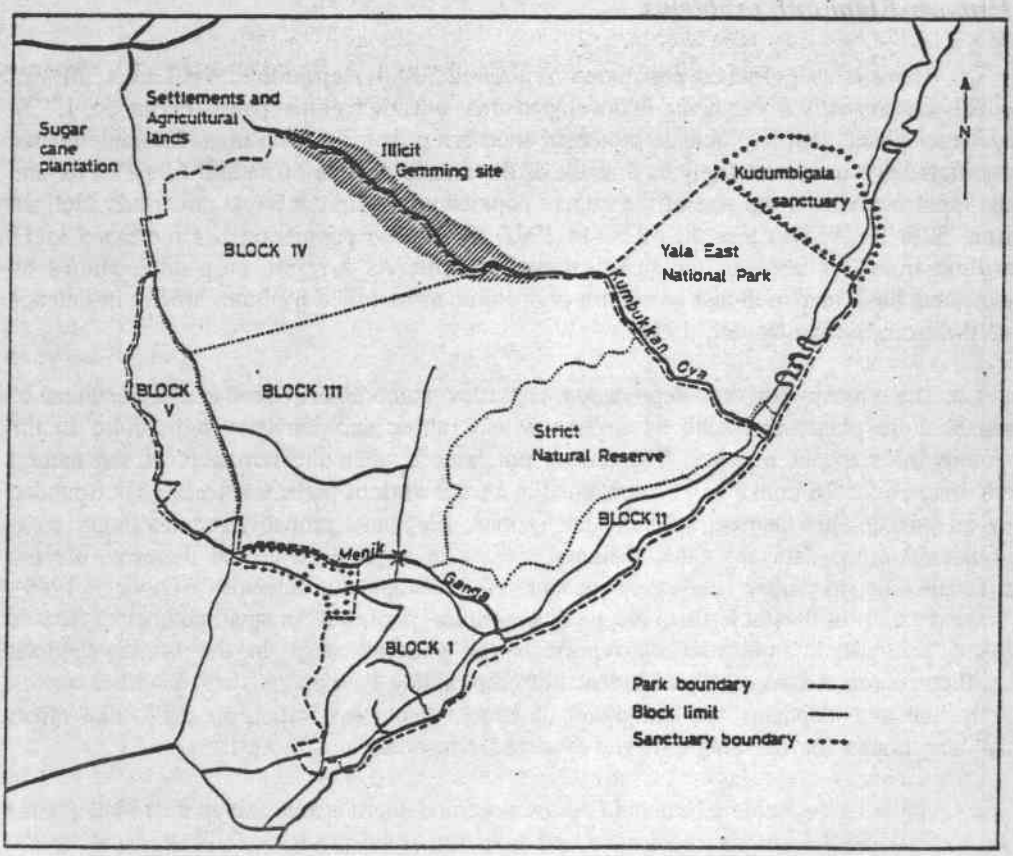
There is an estimated population of about 2,500 + elephants in Sri Lanka, 70% of which are presently free-ranging in developed areas outside national parks (Fernando, 1993). These elephants that live outside protected areas are in conflict with man. Human-elephant conflicts have increased lately as a result of the drastic decline of natural forest cover and the rapid increase in the size of the human population. While the forest cover has declined from 52% in 1952 to less than 22% in 1992, the human population has increased to 17 million from 7 million in the same interval of time. As a result, crop depredations by elephants have increased and so elephants continue to be killed by irate farmers in defence of their crops (Santiapillai, 1994).

The problem of crop-depredation is further compounded by the establishment of monoculture plantations such as sugarcane and rubber and intensive agriculture in the vicinity of elephant reserves. The day is not far off when the remnants of the natural environment of Sri Lanka will be contained in a patchwork of parks and reserves surrounded by an inhospitable landscape dominated by man. Elephants probably require larger areas of natural range than any other mammal species in tropical Asia, and therefore are the first animals to suffer the consequences of development activities (Olivier, 1980). Fragmentation of habitat leads to elephants becoming "pocketed" in small patches of forests. Such "pocket-herd" phenomenon represents the extreme stage in the human-elephant conflicts, characterised by high incidence of crop-raiding by elephants and fatalities among both man and elephant. The mitigation of human-elephant conflicts in Sri Lanka offers the best hopes for the long-term survival and conservation of elephants.

As far as the Ruhuna National Park is concerned, there are at least about 150 elephants west of Blocks III and IV moving to and from the Handapanagala tank attracted by the year long availability of water and grazing areas. Unfortunately, this area borders the sugarcane plantations, which act as "supermarkets" for elephants, given their high palatability

and nutritional value. These elephants have been the centre of conflict in this area and have attracted substantial media attention and public concern. The population of elephants in the Handapanagala area represents one of the few populations left in Sri Lanka having a number of tuskers. Tuskers account for 10.2% of the adult bulls in the Southern region (Hendavitharana *et al.* 1994). The Handapanagala elephants with their high percentage of tuskers, therefore represent a very valuable population that needs to be protected. Left where they are, surrounded by sugarcane, it is inevitable that conflicts with man and elephant will escalate in the years to come. Therefore the long-term survival prospects of these elephants in this area appear grim unless they are relocated to the Ruhuna National Park, which the elephants seasonally utilize and so is a part of their annual home range. The Department of Wildlife Conservation has identified Blocks III and IV as the target areas for these elephants in the event of their relocation.

Fig. 1. Map of Ruhuna National Park, Sri Lanka, showing Blocks I - V.



## *Cautionary note on Translocation*

However, it must be strongly emphasized that before such a translocation is even envisaged, the habitat in these two Blocks must be enriched in such a way as to support, maintain and contain the elephants. Many translocations in the past did not achieve the desired level of success because well meaning conservationists did not give much thought to how the animals will fare in their new habitat after they were translocated.

A Committee in 1984, headed by Mr D. B. I. P. S. Siriwardhana, Secretary to the Minister of Public Administration at that time, and consisting of Mrs Iranganie Serasinghe, Mr D. C. W. Kannangara, Prof. B. M. O. A. Perera and Dr Ranjan Fernando concluded that *"the preferred method, wherever possible, of translocation to be adopted should be the Elephant drive"*,.....*"Driving the elephant is the most practical method of dealing with large numbers"*..... and sensibly added that, *"Bringing the elephants to the new location is not the end of the problem and the essence of translocation lies in the extent to which we can keep the elephants in the new habitat"* (Anon, 1984).

It is to address this last recommendation of the Committee that this report was prepared with the view to improving and enriching the habitat in Blocks III and IV as a prelude to elephant translocation in the future if and when such an operation takes place. Unless the habitat in the target areas (Blocks III & IV) can provide the required food, water and cover to elephants throughout the year, the translocated elephants will return to their original feeding grounds and the translocation would be a failure. So the principal management concern must be in improving the carrying capacity of the target areas for elephants. This should be done before any elephants are moved from outside. Even with improved habitat in the new areas, it would be difficult to ensure that the translocated elephants remain where they are if suitable barriers such as electric fences are not erected simultaneously along the western border of Blocks III & IV. Elephants with their strong sense of attachment to their traditional feeding grounds are likely to return in the absence of safeguards such as electric fences or other forms of barriers to their movement.

## *Habitat enrichment in Blocks III & IV*

The Block IV has been identified for development with NORAD aid. However, as Fernando (1993) cautions, development of Block IV without first developing Block III, which is bordered by Block IV and V on the north and west respectively will attract elephants from the core areas to the edges and to the adjoining cultivations and settlements, and will only help escalate the human-elephant conflicts.

Elephant habitats can be enriched through activities such as restoration of tanks and pasture lands to improve the grazing opportunities for elephants. But such activities must be carried out first in Block III and only then, in Block IV. In considering elephant problems in Sri Lanka, it is important to realize that wide variations in environments exist, even in areas geographically close to one another, and hence in different environments different

problems exist. The passing of time can allow new factors to develop, old ones to diminish or disappear and this in turn may be reflected in changing attitudes towards animal problems (Riney, 1982).

The maintenance of appropriate habitat for elephants can only be done if one knows what is appropriate. If we wish to maintain the habitat for the elephants, we need to have a knowledge of the habitat needs of elephants. Riney (1982) suggests a number of questions that need to be asked before habitat enrichment can be done.

1. What elements of the habitat are required to maintain the desired number of animals, and how are they best interspersed.

2. What is the present status of the vegetation?

3. In what direction is the vegetation changing?

4. Is the habitat changing as a result of an ecological succession? What agency has set this succession in motion?

5. Is the habitat changing as a result of pressure by domestic or wild animals? Which animals?

Fortunately, much information on the habitat preferences of elephants in Sri Lanka exists as a result of the previous investigations of Wickremasinghe (in de Alwis, 1970), Eisenberg & Lockhart (1972), McKay (1973), Nettasinghe (1973), Vancuylendberg (1977), Olivier (1978), Ishwaran (1979), Santiapillai *et al.* (1984), and Dissanayake *et al.* (1992). Three factors appear to have limited elephant populations to their vegetation types: (1) the need for water, (2) the need for shade, and (3) the preference for grass as forage.

## *Water requirements:*

Asian elephants drink once or twice a day when water is readily available. The availability of surface water restricts the dry season distribution of elephants (Owen-Smith, 1988). During drought, elephants are known to make extensive journeys in search of water. Elephants seem able to smell water and move towards a large body or an area receiving rain (Allaway, 1979). The unpredictable availability of water in semi-arid areas in Africa may contribute to relatively large home ranges. Home ranges of over 2,000 km$^2$ have been reported during the dry season in the Tsavo region of Kenya (Leuthold, 1977). In Sri Lanka, even much smaller home ranges of about 40-50 km$^2$ would mean the movement of elephants out of the protected areas since they are small. Some old bulls are able to exist away from water for quite long periods, but the daily cycle of the family unit is closely tied to water (Laws, 1970). The trunk makes it possible for elephants to dig down to water under the dry river beds. Besides drinking, elephants need water for wash and wallow.

In terms of the number of water holes in Ruhuna National Park, there is some variation. Much of the coastal area of Block I is dotted with numerous water holes of various sizes. However, the number of water holes in Blocks III and IV are few in comparison to their areas. Ruhuna National Park in the distant past was a heavily cultivated area and hence there are numerous abandoned tanks or water holes dotted throughout the entire area. A vast majority of them in Blocks III and IV need extensive resteration if they are to regain their water holding capacity.

However, the improvement of water holes should not be done with religious zeal, as in Block I, where there are in fact too many of them today, leading to other problems of over grazing of grasslands by buffalo and the spread of distasteful annuals particularly near these water holes. In Block I, there has been one continuing exception to a policy of non-intervention in the functioning of the ecosystem, which is the digging of additional water holes with the object of attracting game for viewing by visitors to the park. Given their wallowing habit, the water buffalo *(Bubalus bubalis)* have been particularly attracted and favoured by this development (Ashby & Santiapillai, 1984). The number of water holes the buffalo can use there in the dry season appears to have doubled (Cooray, 1968). There is evidence of overgrazing since the programme of construction began.

Water hole development in Blocks III and IV must avoid such proliferation of small tanks. Instead, much attention must be directed towards the construction of a few water holes that are large and deep enough to retain water even at the peak of the drought. What must be kept in mind is that additional water would be particularly liable to cause overcrowding of a gregarious, non migratory herbivore such as the buffalo, with no serious predators which is strongly attracted to water irrespective of the need to drink (Ashby & Santiapillai, 1984).

Given the size of Block III, construction or renovation of four large water holes the size of either Heenwewa or Buttuwa wewa in Block I is recommended. Block IV must have at least three large water holes. In addition to these large water holes, a few shallow wells (not deeper than 4 m) could be dug in areas where water tables are high. Such wells are mainly to provide clean drinking water to elephants and hence must be protected against buffalo by log barriers. Hardwood tree trunks must be used to construct such barriers around the wells. If the hardwood trees are toppled along the periphery of the wells, with their roots still jutting out, there is little danger of elephants dragging them off.

Elephants need not just food but also water in large quantities. Elephants are known to be prone to sodium deficiency (Benedict, 1936), and to prefer water and soils rich in sodium (Weir, 1973). Their movement would also be governed by the spatio-temporal availability of water (Sukumar, 1989a). Studies on the seasonal distribution of elephants in Africa have shown high density strata along water sources during the dry spell and a dispersal after the rains (Allaway, 1979; Leuthold, 1977). This is precisely what is happening to the elephants in the Handapanagala area in Sri Lanka: concentration during the dry season and dispersal during the rainy season.

## *Food requirements*

An animal's range of movement can increase with greater body size and energy requirement (McNab, 1963). Even if water is not a limiting resource, the availability of food and the diversity of habitat types may determine the size of the home ranges in elephants. The more diverse an area, the smaller would be the home range since elephants would be able to meet their varied seasonal requirements within a relatively restricted area (Sukumar, 1989a).

Elephants in Sri Lanka are known to spend 89% of their foraging time in grassland, and in Gal Oya grass formed just over 50% of the diet (McKay, 1973). In Ruhuna National Park Block I, elephants forage preferentially in the open scrub and make little use of the evergreen vegetation along the river. Wickremasinghe (in de Alwis, 1970) provides a comprehensive list of all grasses and shrubs eaten by elephants in and around the Lahugala tank (see Appendix 1). Two species namely, *Cynodon dactylon and Sacciolepis interrupta* are known to be preferred by elephants and therefore would be worth considering for use in the enrichment of Blocks III and IV of Ruhuna National Park.

*Brachiaria sp.* is particularly suitable as a tough grass to be propagated in Blocks III & IV to improve the grazing areas for elephants. *Brachiaria sp.* can be grown in dry areas as it does not need much water to survive. It can also be grown in marshy areas. *Brachiaria sp.* is eaten by elephants in Ruhuna and Lahugala National Parks. It is recommended that *Brachiaria sp.* be grown in the vicinity of the water holes that are planned for restoration. Before the grass is planted, the area must be ploughed with a tractor. The planting must be done soon after the rains. Once the grass is established, it can withstand heavy grazing by elephants and so needs minimum management (Vasantha Nugegoda, *pers. comm*).

Although grass forms the bulk of elephant's daily diet in Sri Lanka, during the dry season in particular, browse plants may become more important as they have a higher crude protein content than grasses. While crude protein in browse is about 6-18% of the dry weight, it is much lower, between 1.5-2.5% in the grasses (Sukumar, 1989a).

It appears therefore that over browsing may be a far more serious management problem than over grazing. Here the crucial factor is that these food resources (browse plants) are *k*-selected (relative to grass) and their replacement is slow, even in the absence of browsers. Adult elephants may continue to maintain feeding pressures of bushes and trees for years. This effect is enhanced in drier areas, in dry seasons and in drought years. The proportion of browse required in the diet is greater in the dry season when the grass is low in nutrition. African elephants in semi-arid environments may be totally dependent on browse for their food for several months of the year. Thus there can be a situation where elephant population may be declining say at 2% annually, while the standing stock of trees may be declining more rapidly at 6% per annum.

Although elephants obtain much of their sodium requirements from the water they drink, some of it may come from the vegetation. However, all the wild plants analyzed by Sukumar (1989b) in southern India had a relatively low sodium content, while certain cultivated crops had significantly higher amounts of sodium. This may partly explain the preference of elephants to some of the cultivated crops.

The degree of interspersion of edges (the transition zone between forests and grasslands) and the density and richness of habitat food patches are important determinates of habitat suitability, and thus density of elephants.

### *Fire management*

Although fire has been used as a management tool in several African and Asian counties to improve the grazing opportunities for grazers, it is not recommended in the case of Blocks III and IV in Ruhuna National Park, given the nature of the grasslands. Fire is usually effective in tall grass situations which offer very poor dry season grazing to herbivorous mammals. An early season fire in such areas will remove the coarse, dry grass and stimulate a flush of green growth that is rich in crude protein and palatable to grazing animals (Rodgers, 1979). Burning of indigenous grasslands in Blocks III & IV may lead to the elimination of many saplings. Besides, the short grass community in these areas do not respond well to a fire regime.

## CONCLUSION

It is recommended that habitat enrichment activities be carried out from the core area (Block III) outwards, to minimize contact between man and wildlife. A few large water holes need to be restored in both Blocks to assure year round availability of water to elephants and other wildlife. Establishment of too many smaller water holes would only help build up buffalo numbers and thus lead to overgrazing. *Brachiarai sp.* can be used to establish grazing grounds in the vicinity of water holes that are restored. Some other species of plants preferred by elephants (given in Appendix I) can also be propagated. Fire management is not recommended for the area as it is not appropriate for the types of short grass available. In the absence of permanent supply of water and fodder in Blocks III & IV, it would be unwise to translocate large number of elephants from outside. Even with an assured supply of water and fodder, many elephants will certainly try to return to their former range.

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## *Appendix 1; List of plants consumed by elephants in Lahugala.*

*Alloteropsis simicina*
*Axonopus affinis*
*Brachiaria distachya*
*Brachiaria remota*
*Brachiaria reptans*
*Cynodon dactylon*
*Chloris barbata*
*Dactylotaenium aegyptium*
*Digitaria stricta*
*Digitaria adsendens*
*Digitaria longiflora*
*Echinochloa colonum*
*Eriochloa porcera*
*Eleusine indica*
*Eragrostis diplachnoides*
*Fimbristylis argentea*
*Fimbristylis falacata*
*Hymenachne pseudo-interrupta*
*Leersia hexandra*
*Panicum repens*
*Panicum trypheron*
*Panicum psilopodium*
*Paspaladium flavidum*
*Paspaladium punctatum*
*Paspalum metzii*
*Paspalum scrobiculatum*
*Perotis indica*
*Oplismenus compositus*
*Stenotaphrum dimidiatum*
*Sacciolepis interrupta*
*Oryza rufipogon*
*Oryza perennis*
*Cyperus pygmaeus*
*Cyperus brevifolius*
*Cyperus exaltatus*
*Cyperus compressus*
*Cyperus distans*
*Desmodium triflorum*
*Commelina diffusa*
*Murdannis spirata*
*Molochia corcherifolia*
*Berreria hispida*
*Alternanthera sessilis*
*Mulluge oppositifolia*
*Urena lobate*
*Hydrocera triflora*

# ELEPHANT TRANSLOCATION: THE MALAYSIAN APPROACH

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## INTRODUCTION

In Malaysia, the conflict between man and the elephant is primarily due to the rapid development in agriculture and infrastructure. Each year thousands of hectares of prime elephant habitat are being taken up by oil palm and rubber plantations and other forms of infrastructural development such as building of dams and highways. Soon after independence, the clearing of forests for development was done in isolated patches. This created a mosaic of forest islands. Despite the more systematic clearing of land since then, there has resulted a phenomenon called *'pocketed elephant herds'*, trapped in the tiny islands of isolated forests which are usually the hilly or swampy leftovers of development. These areas are generally not conducive to long term elephant viability.

The conflict between man and the beast arises mainly because they both require the same land for existence. Limited home range, low food density and unfavourable habitat conditions force the elephants to encroach onto the surrounding agricultural areas. There are no corridors along which the elephants can retreat into larger, permanent forest reserves. There are heavy economic losses running into millions of dollars annually, resulting from elephant depredation. There is a corresponding increase in human population and the conflicts between man and elephant. Development is for the economic stability of a country like Malaysia. There is, therefore, a heavy price developing countries must pay for progress: the depletion of wildlife habitat.

The mitigation of the conflict must be a national concern. The solution seems to lie in the translocation of the trapped elephant herds to larger and safer permanent forests and the proper management of development by the authorities in the future. Therefore this paper will only discuss translocation as a means to managing elephant populations in the wild.

In peninsular Malaysia, all the elephant problems are handled by a specially set up Elephant Management Unit of the Department of Wildlife and National Parks. This Unit was established in 1974 in the light of increasing elephant problems associated with the increased rate of development. This Unit has been specially trained in the techniques of catching and translocating wild elephants. Over the years this Unit has evolved into

a highly specialized one with improved and perfected methods to ensure safe and successful elephant translocation.

In pre - capture preparation, a study of the elephant herds in the country is done and the status of the problematic herds is determined. These problematic herds are further divided into three broad categories, (1) pocketed herds, (2) peripheral herds adjacent to large permanent forest, and (3) inland herds within large permanent forests. Each category is approached differently. Translocation is carried out as the best solution for pocketed herds. Electric fencing is used effectively for the second category of peripheral herds. The third category requires no immediate attention as it does not often come into contact with man.

Translocation is a very complex procedure which requires careful planning and consideration. Reconnaissance of the pocketed area from which translocation is to be carried out is done. The herd size, sex ratio, etc. are determined. A few suitable release areas are also determined. An Elephant Trust Fund (ETF) is set up, normally funded by the Department of Wildlife and National Parks, the relevant state Government and agricultural estate facing problems from that particular herd.

## THE TRANSLOCATION TECHNIQUE

### *Materials and Methods*

Before commencing work, the capture team must first conduct a field survey to familiarize itself with the forest, know the number of animals involved and ranging pattern of the herds in the area. The capture team comprises 15 personnel: the team leader, who is responsible for the running of the whole capture operation; a veterinarian for administering the drugs used and post capture care; two well trained trackers; two backup rifle men armed with .458 rifles; and nine rangers in shackling (using high tensile steel chains) techniques. These rangers are also responsible for the captured animals. The trackers begin tracking at about 0730 hrs. They look out for fresh elephant tracks or damaged crops before tracking the animals. The team is likely to encounter the elephants at about 1000 or 1100 hrs. This is when the elephants slow down and rest as the day becomes hot.

The dosage of *immobilon* used is based on the diameter of the front foot print of the elephant to be tranquillized. This is because it is difficult to estimate the body weight of the elephant due to poor visibility in the dense forest. Previous use of a combination of *etorphine hydrochloride* and *acepromazine maleate* in Asian elephants never exceeded 3.5 ml. Present studies indicate that a dose of 9.8 - 11.0 mg. of *etorphine hydrochloride* and 40 - 45 mg. of *acepromazine maleate* can be used safely for the free ranging adult elephants.

A major problem with tranquillization of free ranging elephants is mortality associated

with abnormal posture during induction. This problem is further complicated when the animal is under-dosed and subsequently allowed to travel a longer distance before being immobilized. In this instance the capture team will take a longer time to locate the immobilized animal. As a result the animal could be dead from suffocation or respiratory failure. In Malaysia a higher dose is administered in order to shorten the induction period. The drugs are prepared into the darts as soon as there is a good indication of the animals' presence within 100 - 300 metres. Noise from breaking of branches, ear flapping and squeaking calls are some of the clues indicative of the proximity of the elephants.

It is very essential that the elephants must not be alerted so that darter would be able to get close, within a shooting distance of about 30 metres. The darter must ensure a clear flight path for the dart. All elephants are immobilized using a long range *Palmer Cap Chur* rifle and a 5 ml. capacity aluminium syringe - barrel with a 7.5 cm. collared needle. (Palmer Chemical and Equipment Co., Inc., U.S.A.)

After the elephant has been darted, it would normally run for a short distance before succumbing to the effects of the drugs. If disturbed at this stage, the elephant would run even further. This would make it all the more difficult for the captured team to locate the immobilized animal. It would thus be absolutely imperative for the capture team to wait at least five minutes before approaching the darted animal. This is a crucial period as the unfavourable field conditions could easily result in the death of the animal. The drugged animal may fall into a swamp, ravine or just remain in a position of sternal recumbency causing death within 30 minutes. It is necessary for the team to locate the drugged animal within this period of time. Should the animal be found in an unfavourable position, it would be revived immediately and efforts to capture the animal at this juncture should be abandoned.

After the animal has been located, the respiration and rectal temperatures are regularly monitored at 15 minute interval. A conventional mercury glass thermometer is placed against the rectal mucosa for about one minute. The pulse rate is taken by palpating the ear vein conspicuously seen beneath the skin of the under-ear. Respiration rate is determined by placing the hand against the nostril and observing the chest movement.

A blood sample is collected in a vacuum tube from the marginal ear vein. It is also at this time that body measurements are taken for record purpose. The animal is tattooed on the inner-lower lip or on the upper ear as an identification to enable systematic monitoring after translocation. A few selected elephants in a herd are fitted with radio transmitter collars for follow up studies. A separate unit, the Elephant Research Unit (ERU), handles all research work on the released animals.

The animal is restrained using the shackling technique: the double front leg shackle; the single front leg shackle; or the double front and hind leg shackle. The choice of the shackling technique depends on the terrain and situation in each case. Restraining an animal can take up to 30 minutes. The animal is then anchored to a big tree using a 6 metre

chain. It is advisable to revive the animal as soon as possible after the animal has been restrained. This would reduce the possibility of any danger to the animal from over exposure to the drug used. *Revivon (Diprenorphine hydrochloride)* is used to revive the immobilized animal. In normal circumstances, the animal takes about 5 minutes to recover and get back on its feet. The animal will continue to hobble around, still shackled and anchored, until the animal is ready to be transported out. The captured animal is fed with banana stems soaked in water.

### *Transportation*

A path of about 5 metre-wide is cleared to make the captured animal accessible to the transportation lorry. A loading bay is constructed by cutting into a hillock. A ten-wheeler truck is used to transport the captured elephant. Two trained working elephants are used to guide the captured elephant to the loading bay. *Rompun (Xylazine)* is use to sedate the elephant during transportation. It may be necessary to administer a second dose of *Rompun* before the animal reaches its destination because the release area might be a considerable distance away (about 300 - 400 km). *Yohimbine hydrochloride* is used effectively as a stimulant if it is required to revive the animal during transportation.

The animal is usually transported to the release area after 1700 hrs, to avoid heavy traffic and heat. The destination is reached by day break the next day. The animal is usually released on the other side of a water body, be it a river or a dam found within the proximity of a National Park or a large permanent forest reserve. A raft is normally used to transport the elephant across thee water.

There are at present 6 release sites in use for translocation purpose in Peninsular Malaysia: at Taman Negara (Pahang), at Taman Negara (Trengganu), Ulu Belum permanent forest reserve, and at Endau - Rompin National Park (Johor).

## DISCUSSION

Translocation is done as a last resort in management. This is because it means uprooting the elephant or entire herds of elephants from their traditional home range to one unfamiliar to them. Fortunately, there is negligible difference in the type of habitats found in the different areas in Malaysia. This facilitates better adaptation of the elephants to their new habitat. Continuing research reflects this success in translocating elephants in Malaysia.

The uniqueness of the elephant situation in Malaysia where most of the elephant herds have been left stranded in the remaining pocketed forests has left the Wildlife Department no choice but to translocate the animals. This seems to be the best alternative to culling. Electric fencing as a method of elephant control would not be effective nor economical as the forest pockets are too small to provide a home range to the trapped elephant herd (Khan *et al.*, 1992). These forests are isolated with great distances in between them. Furthermore, they do not have forest corridors along which these elephants can be

driven to larger permanent forests. The number of successfully translocated elephants stands at 285 animals since the establishment of the Unit in 1974. This figure includes elephants from 7 out of the 11 states in Peninsular Malaysia.

Since the inception of the translocation operations, about 109 agricultural schemes and villages have been freed from problems of elephant attack. The crop depredation has been estimated to be over 300 million Ringgit since 1969. The Department of Wildlife & National Parks and other relevant agencies have spent up to 4 million Ringgit to finance the various translocation operations that were carried out. In comparison the amount spent on elephant translocation is much less than the amount lost in crop depredations due to elephant attacks.

Through such successful translocations, one aspect of the elephant conservation has been achieved and the nation can surge forwards in its economic development. The success of translocation operations is also seen in the continuing financial support provided by the Federal Government for future elephant conservation and management programmes.

The Federal Government is aware of the tremendous damage that can be caused by elephants. There is increasing awareness of the damage to the environment associated with all the new development projects carried out by the public as well as the private sectors in the country.

Comparative studies have been done in Sri Lanka and Singapore, where translocation operations were carried out by the Malaysian Elephant Capture Unit, at the invitation of the respective governments (Daim *et al.*, 1991; Abdulla *et al.*, 1992). The nature of translocation was very similar to that adopted in Malaysia. There was no difference in the dosage of drugs used and the general elephant condition remained stable as has always been the case in Malaysia. The difference lay only in the means of tethering the animal in Sri Lanka. The easily available ropes were more widely used than the padded chains used in Malaysia and Singapore. However, this did not have any effect on the actual translocation work.

At the invitation of the Government of Vietnam funded by WWF International, a study was carried out on of the problem elephant herds in the provinces of Dong Nai, Bien Thuan and Baria Vung Tau (Daim, 1992). The situation in Vietnam was found to be similar to that in Malaysia. There are also several pocketed elephant herds which constantly trouble the villages and agricultural areas. There is also a lack of forest corridors linking the isolated forests to the larger permanent forests. Translocation seemed to be the best solution to their elephant problems. The only drawback was the need for substantial funds to finance the translocation programme. There is also the need to train Wildlife officers for this type of work.

In Malaysia there has been no known incidence of translocated elephant herds returning to their original habitats. This is based on the total absence of complaints from

the areas where the operations were carried out. There has also been no further damage caused by elephants in these areas.. The Malaysian technique is a combination of various experiences developed and adopted for the purpose of translocation. The Assamese technique of tethering and training the animal has been adopted as it has been proven effective. The Thai technique of the use of an elephant harness and chains for pulling logs is used in Malaysia to pull the captured elephants from the capture area to the loading bay. The use of chemicals to capture and transport of the animal is a modern practice that is widely used in Africa. The technique of using ropes to shackle the animal was changed to using padded chains. This proved to be more effective economically. Using chains is also safer when it comes to handling bigger and stronger animals. It is easier to buy chains as jute ropes are not easily obtained. Furthermore, making jute ropes takes too much time and man power.

There is no significant difference in the extent of injury to the captured animal when either ropes or padded chains are used. When chains are used for shackling the elephants, the time taken is only about 30 minutes compared to using ropes which takes about an hour to secure the animal. The time factor is vital when dealing with a fully sedated animal. This has greatly helped in reducing the mortality rate in translocating elephants. Even with the success we are experiencing at the present, we are constantly trying to learn and improve the method used for the safety of the elephants.

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