

RANGING BEHAVIOUR OF THE ASIAN ELEPHANT (*Elephas maximus*) IN THE NILGIRI BIOSPHERE RESERVE, SOUTH INDIA

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INTRODUCTION

The Asian elephant (*Elephas maximus*), on account of its large size and intemperate appetite, needs large areas to forage. Bull elephants are known to take greater risks in moving out of their habitat in search of palatable, highly nutritious plants and also females in oestrus. An understanding of the home range of elephant in Asia is invaluable for its conservation and management. The home range of elephants has been extensively studied in Africa, covering habitats ranging from deserts to tropical forests. In Asia, home range has been studied in the Malaysian deciduous rain forest (Olivier, 1978). However, detailed studies on the ranging pattern of Asian elephant have been lacking. Home range sizes depend on the habitat types. This paper summarises the results of a long-term study that was carried out in the Nilgiri Biosphere Reserve in South India under the auspices of the Bombay Natural History Society.

STUDY AREA

Much of the observations on the movement and ranging behaviour of the Asian elephant was made in the Mudmalai Wildlife Sanctuary located in the Nilgiris district of Tamil Nadu, South India. The Nilgiris Biosphere Reserve covers an area of 700 km². Mudumalai is a part of a complex of four sanctuaries, the others being Bandipur Tiger Reserve (Karnataka), Nagarhole National Park (Karnataka), and Wynnad Wildlife Sanctuary (Kerala). The four areas and adjoining forest reserves cover over 3,300 km² of forest land and are known to support an estimated population of 1,800 to 2,300 elephants. Together, they form one of the largest single protected elephant populations and ranges in Asia. The terrain is undulating, with an average elevation of 1,000 m. The rainfall varies from 600 mm to 2,000 mm per annum.

MATERIALS AND METHODS

Ranging Behaviour

Data on ranging behaviour was collected from the three radio collared elephants (Priyanka, Harini and Wendy). The details of number of locations collected from these collared elephants are given in the Table 1.

Table 1. Data on radio-collared elephants

#	Name of elephant	# of locations
1.	PRIYANKA	23
2.	HARINI	30
3.	WENDY	6

The objective was to collect a minimum of four locations per month (i.e. 24 locations in 6 months) for clans Priyanka and Harini and two locations per month for clan Wendy. A total of twenty three locations was collected from Priyanka and thirty locations from Harini. Though efforts were made to collect the required data every month, lack of funds made it impossible to locate the elephants when they were far away from the Mudumalai field station. Additionally, the strength of the signal from Priyanka's transmitter became very weak as the transmitter had been functioning for more than three and half years. Therefore the number of locations in different months was not even, especially in the case of Priyanka. The collared elephant Wendy was operating at Coimbatore division during the study period and therefore a total of six locations (one location per month) was collected on this animal. It was not possible to travel to this area and locate the elephant more than once given the financial and transport constraints. But efforts were made to collect information on its past movements from the local staff and people. This was possible as this clan raids crops frequently and the collared female is known in the area.

Feeding and habitat utilization

The collared elephants Priyanka and Harini were observed and data on feeding, major-habitat, micro-habitat dispersion, etc. were collected. A total of 100 hours of observations on the feeding of clans Priyanka and Harini were made. The data on habitat utilization was collected from all three collared elephants (Priyanka 23 records, Harini 30 records and Wendy 6 records) and non collared elephants (20 records).

Social organization

The data on the group size was recorded at every sighting of the collared and non collared elephants. Interaction between clans and between clans and bulls were also recorded to study spacing behaviour and reproductive behaviour. The dispersal of the identified sub adult males from the radio-collared clans was also recorded during the period.

Ranging behaviour

- The collected data on ranging behaviour from the radio-collared elephants (from April to September 1994) were plotted on the map.
- The plotted locations (from September 1993 to September 1994) were digitized in the computer. These data were later segregated into year and season and analyzed for annual, seasonal, daily and overall home range. The data was also analyzed to determine the spacing pattern of different clans.
- The use of corridors by these collared elephants was also analyzed.
- Analysis of ecological and administrative boundaries was also carried out.

Crop raiding

The crop raiding data collected from six villages during 1993-1994 was analyzed and lodged in the computer. The combined data on crop raiding was entered and analysed.

Feeding data

A total of 115 hrs of feeding data was collected on the collared elephants, Priyanka and Harini between October and December 1993, and from July to October 1992.

Habitat utilization

Data on habitat utilization and micro habitat use of the three radio collared elephants Priyanka, $n = 308$; Harini, $n = 335$; and Wendy, $n = 45$) were entered. The non-collared elephant groups ($n = 216$) recorded in the study area and the radio-collared males data are yet to be entered.

Social organization

The group size of the three collared females (Priyanka, $n = 236$; Harini, $n = 251$; and Wendy, $n = 45$) and the males (Salim Ali and Admiral) and the non-collared elephant groups ($n = 197$) were entered in the computer and analysed.

RESULTS AND DISCUSSION

Home Range Size

The home range of all three clans reached an asymptotic value in the second year and there was only a marginal increase in the third year which can be expected due to minor changes in the ranging pattern due to variation between years in the habitat quality. In Fig. 1 the cumulative home range size in relation to time has been plotted for clans Priyanka and Harini. Wendy shows a similar trend but has not been plotted as it has shifted its home range.

The two bulls provided data for 15 and 22 months. We have been unable to locate Salim Ali after the 15th month. The elephant itself has not been re-sighted by anyone in its former range, whereas earlier it was regularly sighted by others. It could be that its collar had stopped functioning and it had moved to another area or that it had been poached. The male Admiral was shot dead in September 1993. Figure 2 shows the area-time curve for the two male elephants. Samil Ali was a young male in the process of establishing its own home range and there had been a gradual shift in its ranging pattern. It is certain that its home range size will increase further and the size defined in the present study is not the final size. In the case of Admiral, though the home range size shows an asymptotic value, the actual home range size has not been defined. This bull has not come into musth during the entire period due to gunshot injury resulting in the loss of body condition during the first year and it was killed in the second year. Home range sizes of males during their musth period are several times larger than the size of their non-musth period home ranges.

The overall home ranges defined for three years for the three clans Priyanka, Harini and Wendy was 670 km², 562 km² and 799 km² respectively. The basic information is given in Table 2. The home ranges for the three years are given in Fig. 3. The mean home range size or the range will have little or no significance for actual management (design of elephant reserves as they represent the area used in any one year under certain climatic (therefore habitat) conditions. The clans in reality require the upper home range size defined by the cumulative figure for three years as this is the area that will support them under different climatic conditions.

Table 2. Basic data on home range of the three elephant clans.

clan	sample size (locations)	home range cumulative km ²	mean home range size km ²	range km ²	SD
Priyanka	564	670	464.6	395 - 555	81.8
Harini	539	562	382.6	261 - 530	136.7
Wendy *	127	799**	288.8	19 - 799	442.7

* This lann had shifted its home range and its range should not be taken as representative of clan home range sizes in the study area.

** The actual size is 1665.3 km² but the area with actual forest cover and accessible to the clan is 799 km².

It can be seen that home ranges are much larger than those defined in the earlier studies on Asian elephants (Desai, 1991; Easa, 1987; Olivier, 1978; Sukumar, 1985, 1989.) For elephant conservation, areas larger than 600 to 700 km² will be required in deciduous forest areas. This would be the minimum area for a single clan. The overlap between two clans can be between 0 and 80% and even assuming that two clans overlap to the extent of 50%, we would require at least 900 km² of area. In the absence of such large areas, it is likely that the clans that do not have adequate habitat will start moving into agricultural areas on the periphery for their resource (food) requirements and thus the level of human-elephant conflict will increase. Small areas of 300 km² or less are likely to be too small for long term conservation, as they are too small while the level of conflict being too high.

The home range size of males though not fully defined in this study is still larger than those defined as non-musth ranges in earlier studies. This means that the actual home range sizes are likely to be bigger or equal to those of the clans. The same problems of conflict with humans are likely in the male situation also. This too has to be taken into account when designing conservation areas for elephants. Areas of high males or bull areas as defined by Moss and Poole (1983) should get special attention when designing elephant reserves. In the low male areas (due to poaching) as in south India, new males (maturing) coming into the population will automatically adjust their new (establishing) home ranges to the available forest areas and do not pose a real problem.

Fidelity to Home Range

The annual home range for three years of clans Priyanka and Harini (Figs. 4 & 5) overlapped to a large extent with only minor shifts in the home range between years. This indicates a strong fidelity to the home range under natural conditions. Both clans tended to use the same areas consistently year after year. This is the only study other than that of Desai (1991) that has looked at home range fidelity.

The home range of Wendy shows a major shift (Fig. 6) from northern part of Nilgiri Biosphere Reserve (NBR) to the southern part. This clan operates primarily in the thorn forests and most of its southern range has been degraded and also access to the river Bhavani has been cut off due to cultivation. As such we feel that this clan could have shifted its range due to the poor quality of its present range. This is the first recorded case of home range shift in a large forested tract. The present range it is operating in is of poor quality when compared to the areas in NBR north. This strongly suggests that clans within poor habitats or those whose home ranges are lost or degraded cannot simply move into better areas within the remaining elephant range. This could be due to competition between clans.

The above findings are vital for elephant management as they show that elephants (clans) have specific home ranges and that they do not freely use all the available habitat (possibly due to competition) and as such when a part or whole of the home range is lost or degraded the affected clan cannot move into the remaining elephant habitat (if it isn't a part of its range) due to competition. It may have to move into agricultural areas (fewer elephants or lower competition) or into agricultural areas. Those that move into agricultural areas end up as wandering herds that cause enormous loss in crops and human lives. That habitat loss could be related to increased incidence of crop raiding.

The home range of Admiral did overlap almost totally between the two years of study showing that males also show strong fidelity to their non-musth home range (Fig. 7). The reaction to loss of habitat of males with established home ranges will be similar to that of females i.e. they will come into greater conflict with humans. Sub-adult males in the process of establishing new ranges are likely to be more flexible and therefore likely to shift into the forest (but we do not yet know anything about competition between males for resources). We can safely assume that loss or degradation will lead to greater conflict with humans and also result in greater stress for the elephants. Both these situations are not good for the population and as such efforts should be made to reduce them.

Administrative Areas

Analysis on the legal status of home ranges of the collared animals showed that elephants move irrespective of administrative zones. Figs. 8 & 9 show the details of

percentage of home ranges that lie in different administrative zones. Though the clans Priyanka and Harini have very little part their home ranges (16.1% and 12.1% respectively outside the protected areas) they spent nearly 30% of their time in these areas. Since these two clans operate in the central areas of PAs (TR, MWS and WWS) spending over 60% of their time there and together represent over 120 elephants (6% of the NBR population), the unprotected part of their home range should be included into protected areas (PAs). The home range of other male Admiral had an even larger part of its range (22.5%) outside the PAs than the other two clans Priyanka and Harini.

Clan Wendy has only 4.3% of its home with in the PAs while 92.1% of its home range lies within the Reserve Forest (Fig. 9). Trying to include all these areas into PA network will be very difficult as inclusion of all home ranges basically means that the entire population range will have to be converted to PAs. Socio-economic considerations generally do not permit such an action. In such cases, the Reserve Forest area outside PAs which form a part the elephant range should be managed as elephant conservation areas. Management in these areas should take into account the requirement of elephants before embarking on any forestry operations.

Corridors

The clans and the adult bull (Figs. 10-13) all used corridors identified by earlier studies (Desai, 1991). The study shows that elephants show strong fidelity to the routes used during their seasonal movement. In species that show such fidelity to the home range and the routes for movement between seasonal ranges, creation of corridors in directions other than the established movement would be futile. Corridors between and within elephant habitat should be designed and created only after confirming that there is a movement in that direction otherwise the entire effort will be wasted.

Crop raiding

The findings clearly show that only specific clans and males raid crops. Where management option also includes capture of elephants for reducing conflict it should be kept in mind that only identified raiders should be caught. Random capture will result in some non-raiding elephants being caught and as such it will harm the population that is non-raiding and most suitable for long term conservation. The finding is that clans are also responsible for serious damage and their capture should also be considered where capture is an option. This will have a dual benefit, namely reducing the growth rate of elephant populations in already confined ranges and reducing crop damage. This may be the only option in areas like south India where male removal is not an option due to the skewed sex ratios. The data on elephant crop raiding was collected from six villages (Masinagudy, Moyar, Bokkapuram, Mavinhallah, Vazhithottam and Anaikatti) situated in and around of MWS between 1993 & 1994. Ten fields were selected from each village and monitored once in a month to record the elephant damage. The major crops damaged by elephants

were Green fodder (25.80%), Ragi (3.53%) and Paddy (3.41%) (Table 3). Total area of crops damaged by elephants indicates that Ragi, Paddy and others together contribute 11.6% of damage while the green fodder alone contributes 88.4% of the total area damaged. The major crop raided was green fodder and the high damage inflicted could be due to poor maintenance of electric fencing. Both males and females raided the crops but the males raided more frequently (8 times) than the females (3 times). However the total area of crops damaged by females was greater (65.2%) than that by the males (34.8%). As the rain fall was low, a considerable number of fields were abandoned by the farmers during the study period.

Table 3. Details of crops damaged by elephants.

Crops	Area cultivated (in sq.m)	% of damage
Ragi	36100	3.53
Horse gram	6750	0.00
Paddy	2200	3.41
Maize	1500	0.00
Cotton	350	0.00
Others	64375	0.44
Green fodder *	48000	25.80

* A hybrid species of Sorghum raised for cattle by the Dairy Department

Social Organization

The data has to be analyzed but preliminary analysis shows that there are differences between dry season and the first wet season group sizes (Fig. 14). For clan Priyanka, the mean group size during the dry season was significantly smaller than the 1st wet season group size. This indicates that elephants within the clan are likely to aggregate more during the wet season than during the dry season. Group sizes in relation to seasons and habitat are to be analyzed and interactions between clans and also between clans and males have been entered and preliminary analysis shows that clans avoid each other i.e. that there is competition between clans. The male Admiral did not associate with females on any appreciable level. This could be due to the fact that it was injured and did not come into musth

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Fig.1 Cumulative monthly increase in home range size

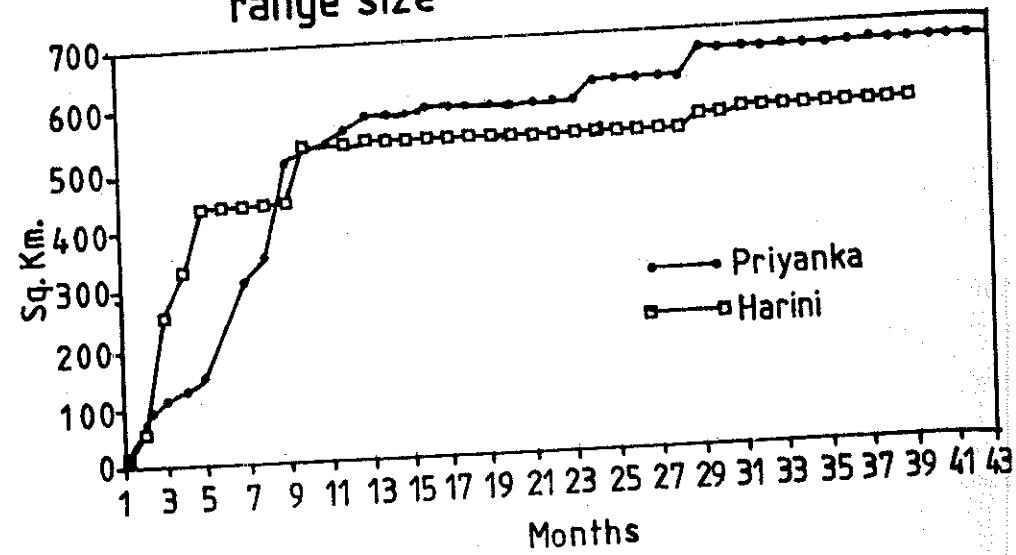
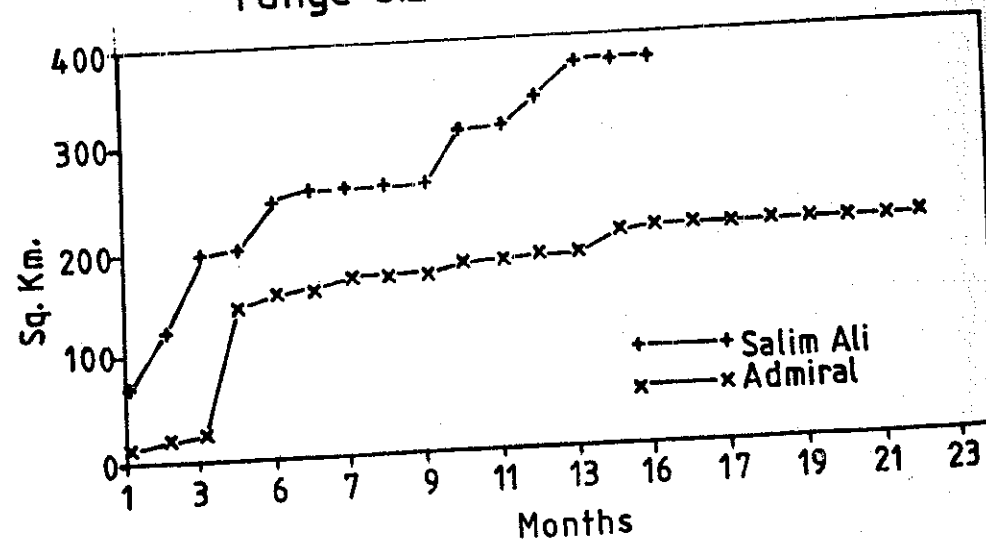
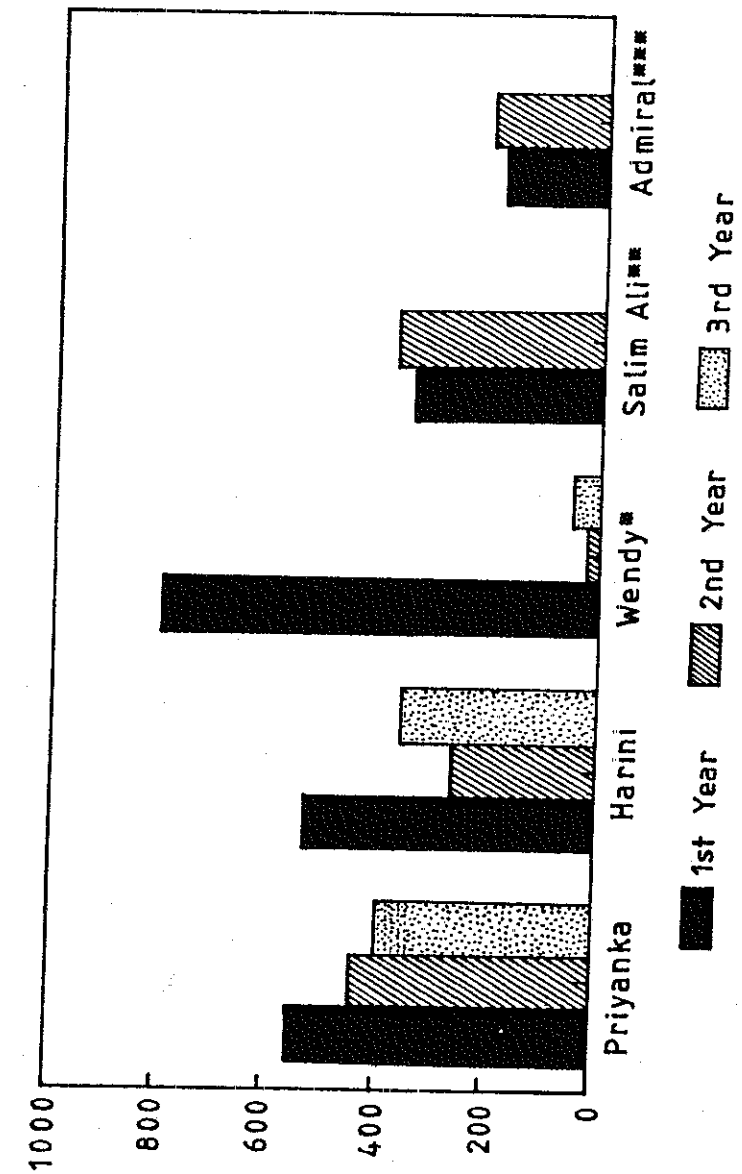


Fig.2 Cumulative monthly increase in home range size



Inter-annual differences in home range size



* shifted its home range to new area
 ■ 2nd year represents 22 months data
 ■ 2nd year represents 22 months data

Fig. 4 Home range of clan 'Priyanka' for the period March 1991 to March 1994

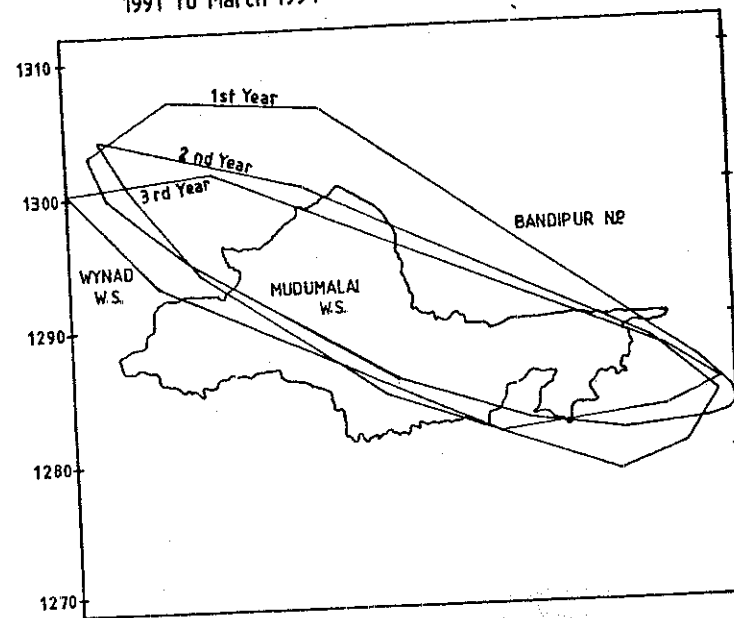


Fig 5 Home range of clan Harini for the period July 1991 to July 1994

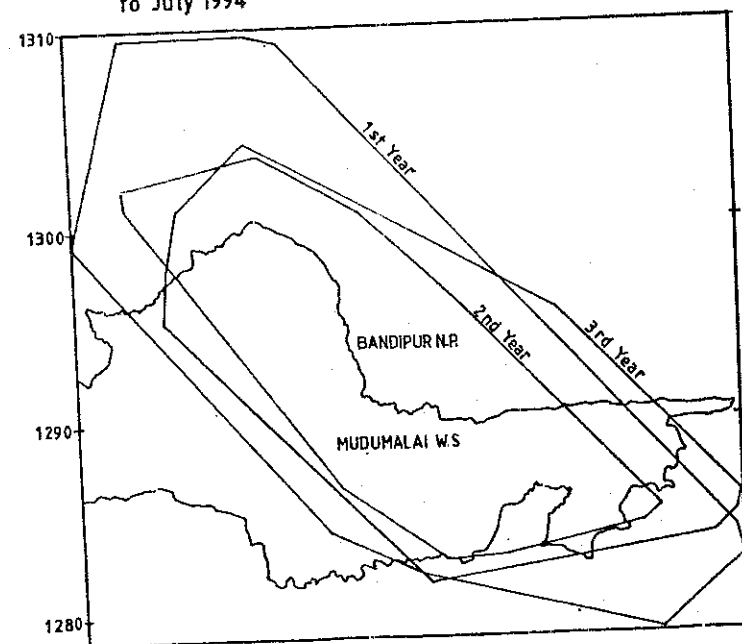


Fig. 6 Home range of clan Wendy for the period June 1991 to May 1994

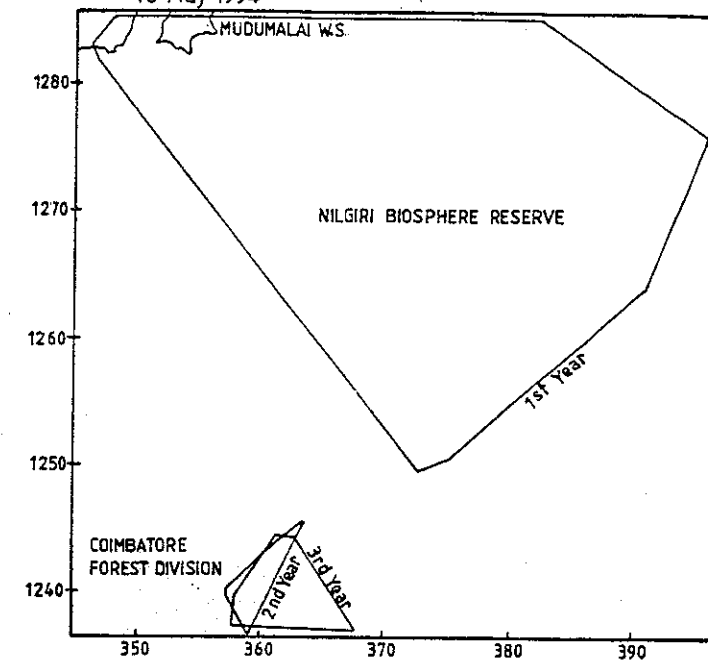
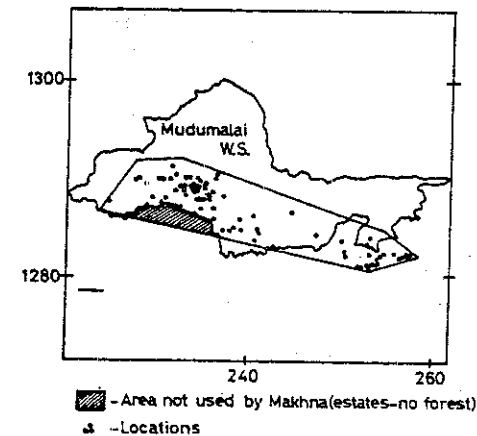


Fig 7

Home range of radio collared Makhna "Admiral" from Nov. 1991 to Oct. 1992



Home range of radio collared Makhna "Admiral" from Nov. 1992 to Sept. 1993

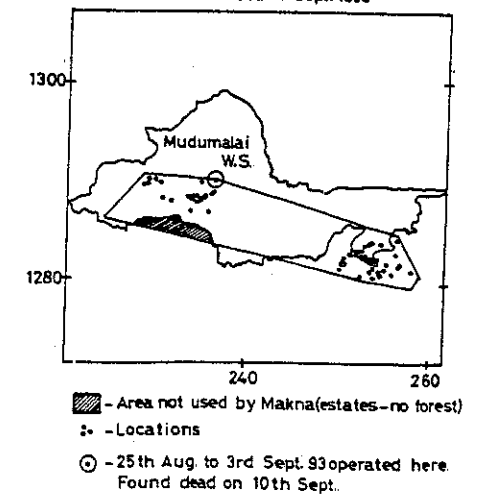


Fig. 8 Percent area of home ranges of elephants under different administrative zones

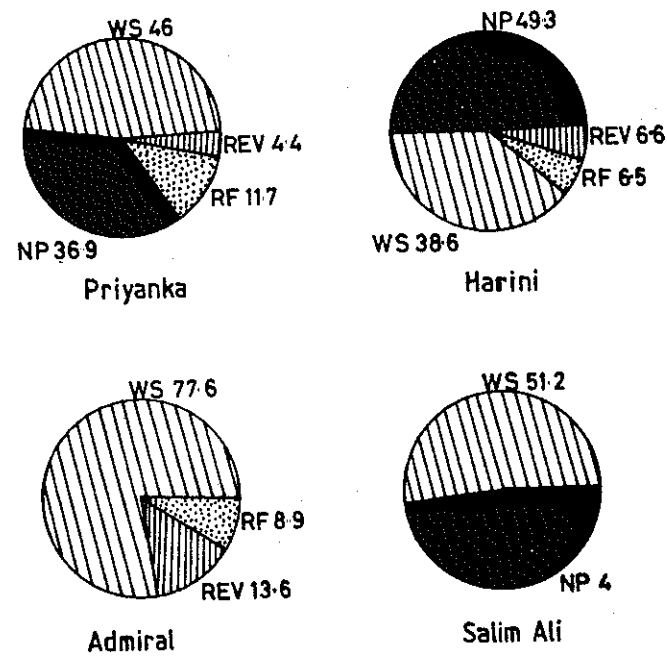


Fig. 9 Percent area of home range of Wendy under different administrative zones

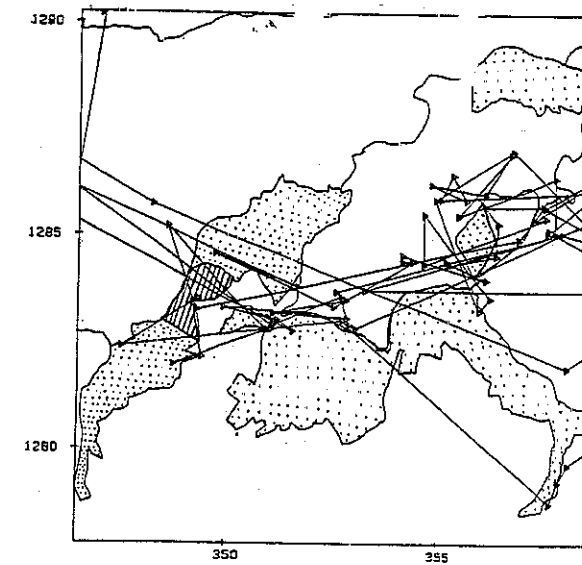
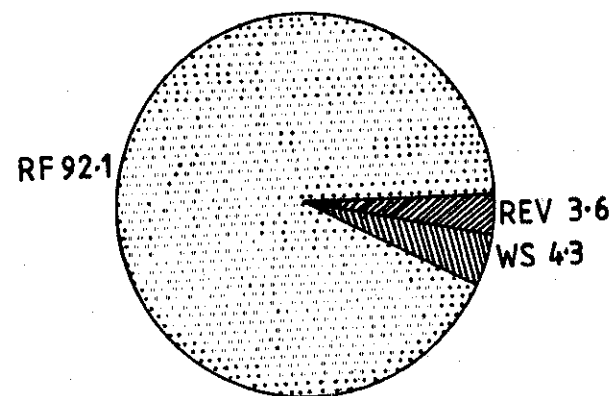


Fig 10. Corridors used by clan # 525

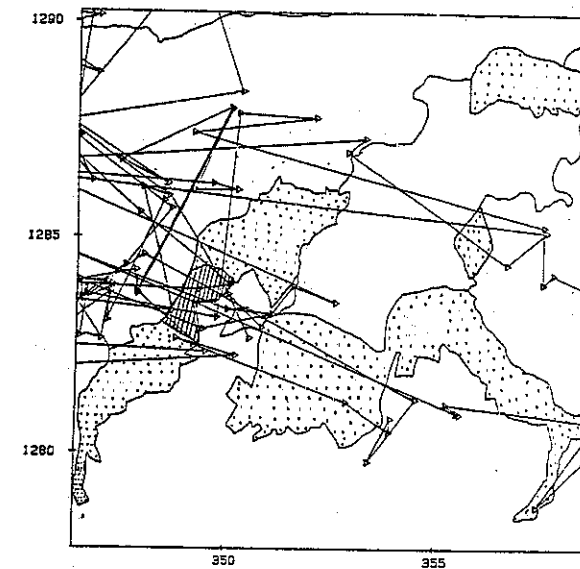


Fig 11. Corridors used by clan # 462

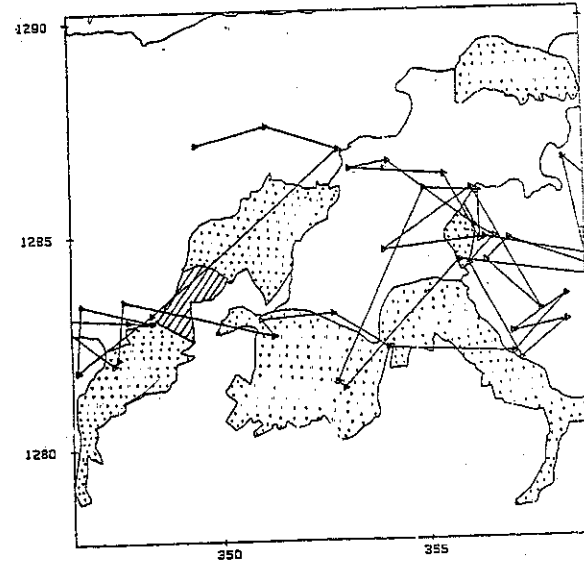


Fig 12. Corridors used by clan # 522

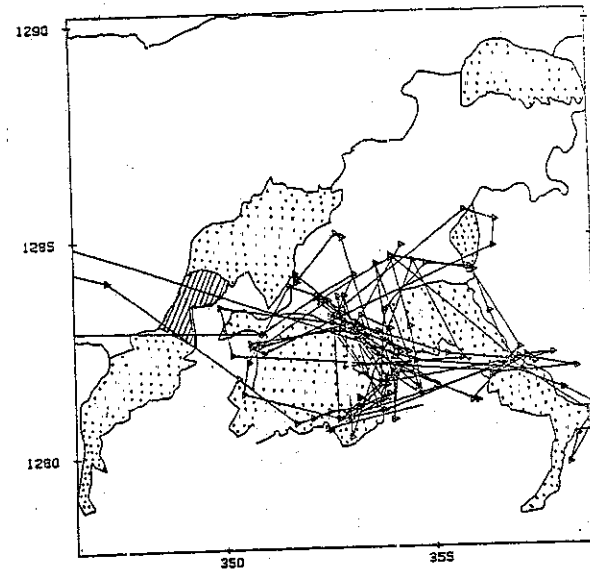


Fig 13. Corridors used by bull # 464

Fig.14 Group size differences between dry and 1st wet season (Priyanka)

