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# STUDY ON MAN – WILDLIFE INTERACTION IN WAYANAD WILDLIFE SANCTUARY, KERALA

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## SUMMARY

A study was carried out in Wayanad Wildlife Sanctuary and adjacent areas in Kerala during 1994-1997 to collect information on crop raiding in relation to animal abundance and distribution. Wayanad, consisting of the forests under the administrative control of North Wayanad, South Wayanad and Wayanad wildlife forest divisions constitute a major portion of Nilgiri Biosphere Reserve. This also forms part of the Elephant Reserve No.7 comprising elephant habitats in Kerala, Tamil Nadu and Karnataka. The area has southern moist mixed deciduous; west cost semi evergreen and southern dry mixed deciduous forests. A portion of the natural forests is converted to plantations of teak and eucalypts. The area could he divided into three regions based on contiguity. The area is rich in fauna with representation of all Peninsular Indian mammals. The characteristic feature of the study area is the large number of settlements scattered in the form of a mosaic where cultivation is practiced.

A population of more than 25,000 people live in and around the forest. The main occupants of the settlements in the study area are the Wayanadan Chetties and the Gowdas. The principal tribes living in the forest plateau are the Mullakurumas; Paniyas, Kattunaikkans and Uralis.

Dry deciduous forests dominate in Southern region, moist deciduous in Central and teak plantations in Northern region. All these regions have plantations of teak. Twenty seven species of trees were recorded in Southern regions of which *Terminalia tomentosa* was the most dominant. Forty five species were recorded in Central region. *T. tomentosa* was the most dominant tree. *Tectona grandis* was the most dominant among the twenty eight species recorded from Northern Ranges.

The forest cover has been reduced by 1086 $km^2$ during thirty year period of 1950-82 with a corresponding increase in the area under plantation and cultivation.

The intact and continuous vegetation cover has been fragmented almost throughout having bearing on the movement of the larger mammals.

Household survey was conducted in 2174 houses to collect information on forest dependence, social and cultural activities and peoples' attitudes towards the management of forest and wildlife. Mullakuruman, Kattunaikkan, Adiyan, Urali and Kurichiyans are the main tribal communities in 69 enclosures. About 48 % of the people within the enclosure have title deeds for their lands. Others are in forest lease and revenue lands. Seventy five percent of the inhabitants acquired the land by deforestation. The main source of income for the people living in and around the forests was the daily wage labour followed by agriculture. Nearly 5% of the peoples in enclosures depend on the forest for NWFP collection. Ninety nine percentage of the settlers collect construction materials from the forest. The people of Wayanad are predominantly agriculturist and cultivation is one of the major source of income. Crop damage is a severe problems in most of the settlements. Elephant and wildboar topped among the most damaging ones. Cattle lifting were more in enclosures (68.50%) than periphery and away from the forest. About 73% of the human death reported were inside the forest, 36% near the forest and 9% on roads. House damage in enclosure (91.66%) were higher than periphery and away from the forest. Only 27.27% of the affected were compensated.

Fire wood was collected both for own use (98%) and sale *(2%).* The dependence of the tribals are higher than the non tribals. NWFP is the main source of income for the tribals. Only a small proportion of the population in Southern and Central regions are involved in NWFP collection compared to Northern region. An estimated 3500 livestock graze in the forest of Wayanad The dependence of the tribals on forest for cattle grazing was comparatively higher.

About 48.32% of the respondents in Wayanad are willing to be resettled out side. Nearly 75% of the people in the enclosure, 66.56% in periphery and 91.81%

along the transect are of the opinion that forest and wildlife should be protected without affecting the people. About 87% of the people in enclosures, 81% in periphery and 78% along the transect are aware of the need to conserve wildlife.

Information on group size, composition and structure of animals were collected through direct observations. The individuals were classified into different age-sex categories. Transects were laid in the study area in proportion to habitat size. Line transect method was followed to collect information on dung/ pellet density There was a fluctuation in the annual density of elephants which ranged from 0.85 to 2.04 /$km^2$ in Southern, 0.59 to 1.36/$km^2$ in Northern and 0.63 to 1.53 /$km^2$ in Central region.

Herd size of elephants was found to range from 1-38 in Southern region and 1-33 in Northern region. Adult females formed a major portion of the population in Southern (42.31%) and Northern regions (46.17%). Overall male to female sex ratio in the population was I: 3.50 in Southern and 1:3.59 in Northern regions. However, an adult male to female sex ratio of 1:40 in Southern and 1:3.59 in Northern regions were observed.

Herd size of gaur ranged from 1 to 26 in Southern region and 1 to 30 in Northern region. Adult females formed a major portion of the population in both the regions. The overall male to female sex ratio in the population was 1:3.31 in Southern region and 1:4.24 in Northern region.

Herds size of sambar deer ranged from 1 to 11 in Southern, Northern regions and 1 to 13 in central region. Adult females formed major portion of the population in all the regions. The overall male - female sex ratio varied in different regions

Herd size of spotted deer ranged from 1 to 26 in Southern region, 1 to 38 Northern and Ito 12 in the Central region. Adult females formed a major portion of population in all the regions. The male - female sex ratio in the population varied from region to region.

Elephants in the study area were observed to feed on 97 plant species belonging to 34 families. The members of Poaceae and Cypraceae were dominant among the food species. Sambar in the study area were observed to feed on 92 plant species and spotted deer on 93 plant species.

The data from transects were pooled to estimate the animal density in different habitats. Seasonal food availability in different habitat were estimated through clip and weigh method. There were seasonal differences in the density of elephants, gaur, sambar and spotted deer in different habitat.

Twenty nine settlements were selected for crop raiding studies based on surrounding vegetation types, location of the settlements and type of protection methods employed. These settlements were visited twice in a month to collect information on crop damage. The extent of damage due to feeding and trampling was estimated by laying plots. Economic loss due to crop damage was quantified and converted into per unit area. Elephants were responsible for most of the damage in the study area Paddy was the most affected crop. Trenches was most effective compared to any other protection methods. Total economic loss due to crop damage by animals was Rs.42,43,203.47. There was a positive correlation between the frequency of raiding and size of the settlement.

A number of factors including the food and water availability, higher seasonal density distribution of animals and management of forest areas in the adjacent states contribute to the crop raiding problem in Wayanad.

# CHAPTER 1

# INTRODUCTION

India has an extensive network of about 500 National Parks and Wildlife Sanctuaries. These are the home of representative natural habitats and wildlife as well as the traditional communities. These are also repositories of natural resources. The industrial economy also looks forward to these areas for exploitation. Protected Areas thus mean different things to different people. Restrictions and denial of access to the resources and the competition by wildlife and human beings for the same resources lead to the conflict between the two. Kothari *et al*., (1995) have discussed various aspects of conservation problems in India. A survey in the late 1980s by Indian Institute of Public Administration revealed that 69% of the surveyed Protected Areas had human population living inside and 64% had community rights, leases or concessions (Kothari *et al*., 1989). The authors, through extrapolation estimate about 3 million people inside the Protected Areas. The conflict arising out of various factors have been evident in some of the Protected Areas in India (Kothari *et al*., 1995). The conflict could be due to forced displacement of people while declaring the area Protected, the curtailment of access or rights of the people to the resources which they had been enjoying for a long time or could be due to the increase in the animal population resulting in crop damage, livestock lifting and human death. The pressure on the natural resources from the industries competing with the resource demand of the local people along with the fragmentation and degradation of the existing habitat worsen the issue of human animal conflict in most of the Protected Areas.

The once contiguous and diverse forest ecosystem in Western Ghats deteriorated due to deforestation leading to fragmentation of habitat, forming 'islands' affecting the wildlife in general and the larger mammals in particular. These islands are further fragmented/degraded by encroachments, developmental programmes and the

unscientific land use patterns. Recent reports indicate increase in crop damage incidences by wild animals in different parts of Kerala (Easa, 1994; Veeramani *et al.*, 1996).

Crop raiding and manslaughter by elephants have been reported from different parts of its distribution ranges where elephants have been pushed to the fragments. Depredation is a major problem in parts of Malaysia (Blair *et al.*, 1979; Seidensticker, 1984), Sumatra (Santiapillai and Suprahman, 1984; Blouch and Simbolon, 1985), Sri Lanka (McKay, 1973; Santiapillai, 1987), China (Xiang and Santiapillai, 1995), Laos (Venevongphet, 1995) and India (Mishra, 1971; Lahiri Choudhary, 1980; Sukumar, 1985; Appayya, 1992; Murthy, 1994; Naik, 1994; Reddy, 1994; Yadav, 1994; Datye and Bhagavath, 1995a; Balasubramanian *et al*., 1995; Veeramani *et al*., 1996).

Information on man-elephant conflict and effectiveness of different kinds of protection methods to deter elephants were well documented in Africa (Thouless 1994 & 1995; Thouless and Sakwa, 1995). Apart from these, numerous reports on crop depredation, livestock death and injuries and damage to properties due to elephants have also been made in African elephant ranges (Kiiru, 1995; Ngure, 1995; Tchamba, 1995; Barnes, *et al*., 1995). Smith *et al*. (1995) identified the factors influencing the elephant distribution with a focus on human-elephant conflict in Zaire. Hoare (1995) suggested options for control of elephants in conflict with people. Recent research carried out by Osborn and Rasmussen (1995) indicate that *Capsicum oleo-resin* spray could be used as a short term repellent against African elephants. Similar research is being carried out in Sengwa Wildlife Research Area of Zimbabwe (Osborn, 1996).

Crop raiding by elephants has been reported from almost all elephant ranges in Asia where elephants survive in fragmented and disturbed habitats. Quantification of the crop damage in terms of economic losses have been made in Palamau National Park

(Mishra, 1971). McKay (1973) and Olivier (1978a) gave a brief account on the problem of crop raiding by elephant in Sri Lanka and in Malaysia respectively. Blair *et al*. (1979) estimated the economic losses due to the oil palm and rubber plantation damages and manslaughter by elephants in Malaysia. Blair and Noor (1981) reported elephant damage to oil palm and rubber plantations in South East Asia, which run into million dollars in economic loss. Caufield (1984), Santiapillai and Ramono (1993) and Santiapillai and DeSilva (1994) concluded that the elephants are forced to raid crop as their habitat was degraded and lost. Punchihewa (as quoted by Santiapillai, 1994) correlated the attitude of the present-day people with man-elephant conflict and remarked that the settlers who came from towns do not have the tolerance of elephants. Devaraj (1994) reported the socio-economic aspects of elephant damage and problems posed in Andaman Islands.

Allaway (1979), Fernando (1990) and Desai and Krishnamurthy (1992) identified the problem of crop raiding elephants. Studies by Seidensticker (1984), Sukumar (1985 & 1990), Kumar and Desai (1992), Bist (1996), Santiapillai (1996) and Sale (1997) suggested control measures to overcome the problem of crop raiding.

Thousands of families were adversely affected due to crop damage by elephants in Uttar Pradesh (Singh, 1978). Lahiri-Choudhury (1975) and Dey (1991) reported the problem of elephant depredation in North Bengal. Datye and Bhagwat (1995b) studied the crop damage by elephants and its economic implication in Dalma Wildlife Sanctuary in Bihar. Yadav (1994) documented the crop raiding by elephants in North Bengal and suggested mitigation measures. The problem has been highlighted by Reddy (1994) in Pakhui Wildlife Sanctuary in Arunachal Pradesh, Naik (1994) in Mollen Wildlife Sanctuary in Goa, Murthy (1994) in Madhya Pradesh and Easa and Basha (1994) in Kerala. This has spurred several studies in Tamil Nadu, Karnataka and Kerala (Kumar 1995, Balasubramanian *et al*., 1995). The menace due to crop depredation by

elephants in Karnataka was identified by Nair and Gadgil (1978) and 900 Km. of elephant trench at a cost of Rs.300 lakhs had been proposed to mitigate the problem (Appayya, 1992). Veeramani and Jayson (1995) and Veeramani *et al.* (1996) documented the wildlife damage and man wildlife conflict in Kerala using the secondary data collected from Forest Department.

Apart from these, there are several reports available on manslaughter by elephants in India. Sukumar (1989) reported the manslaughter in Southern Eastern Ghats. Datye and Bhagwat (1995c) reported a total of 134 human deaths caused by elephants in South Bihar and 74 deaths in Southwest Bengal between 1980 and 1991. About 500 people have been killed by the elephants in Assam in the past decade and one makhna killed about 50 people in Assam during 1993 (Hussain, 1993).

Rhinoceros has been reported to cause crop damage in Royal Chitwan National Park in Nepal (Mishra, 1982) and Jaldapara Sanctuary in India (Ghosh, 1994 & 1996). Crop damages by deer (Dennett, 1965; Moore and Folk, 1978; Onoyama *et al*., 1990; Ratcliffe 1991; Vecellio *et al*., 1994), wild boar (Bratton, 1975; Genov, 1984; Kristiansson, 1985; Vassant *et al*., 1987; Mussa and Debernardi, 1990; Labudzki, 1991; Labudzki and Wiazelko, 1991; Macchi *et al*., 1992; Brownlow, 1994) and bison (Meagher, 1989) have also been reported from different parts of the world.

Singh and Shrivastava (1994) reported crop damage by nilgai, spotted deer, sambar and wildboar in Madhya Pradesh. Crop depredation by black buck have been reported to be a serious issue in various parts of India (Chauhan and Sawarkar, 1989; Dubey and Rahmani, 1994; Indurkar *et al*., 1994; Kotwal 1994; Kumar *et al*., 1994; Manakadan, 1994; Prakash and Bohra, 1994; Rao and Rao, 1994; Sharma, 1994). Crop damage problem in Haryana due to nilgai and black buck (Singh and Chauhan

1991 a & b) in Rajasthan due to chinkara (Bohra and Goyal, 1991), in Gir due to sambar (Khan *et al*., 1994) and in Rajasthan due to macaques (Malik, 1994) have also been reported. Singh and Dixit (1994) reported crop-raiding problem in Dudwa National Park and Siktel (1994) in Sikkim.

Ramachandran (1990) and Gopinathan (1990a) have mentioned the migration and crop-raiding problem, due to elephants in Wayanad Wildlife Sanctuary. The Management Plan for Elephant Reserves in Kerala has highlighted the incidences of loss of life and crop depredation due to wild animals in general and elephants in particular (Easa, 1994). A total of Rs. 2,40,505 has been paid as compensation for crop damage and Rs. 1,25,150 for death and injury to human in Wayanad during the period between 1985 and 1993 (Veeramani and Jayson, 1995; Veeramani *et al.*, 1996). This was registered as the highest amount paid compared to the other Forest Divisions in Kerala. The compensation is on the increase since 1986 even after providing live wire fencing in some of the areas in Wayanad (Easa, 1994). These reports indicate the severity of the problem in Kerala especially in Wayanad.

**Hence the present study was taken up in Wayanad**

**to estimate the population and assess the distribution of animals in relation to season, habitat, water availability and crop pattern**

**to assess the pattern of crop damage by elephants and other wild animals**

**to assess the current status in different land use/vegetation types**

**and**

**to study the socio-economic structure of the settlement in study area to assess their dependence on forest products.**

## CHAPTER 2

## STUDY AREA

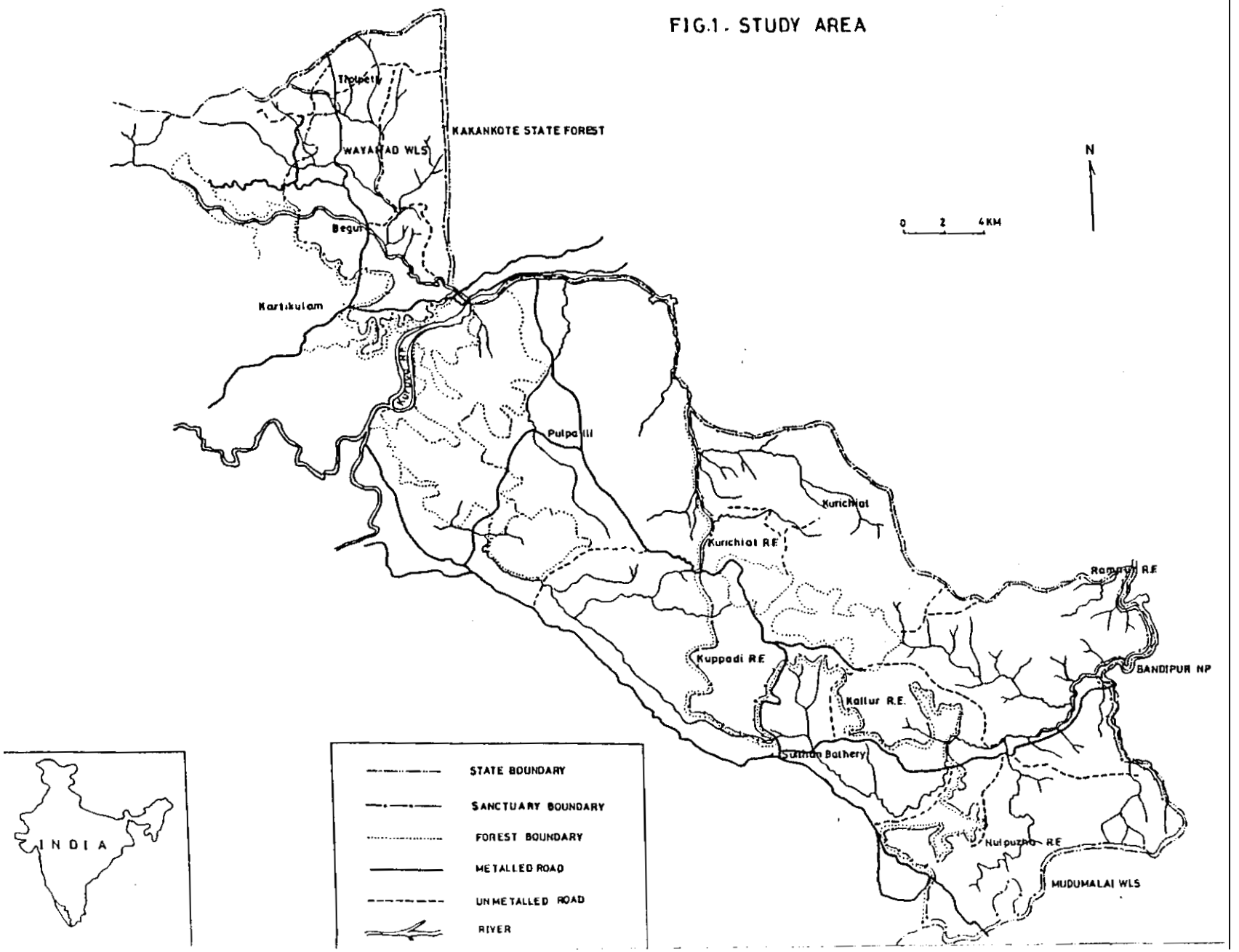
Wayanad, consisting of the forests under the administration of North Wayanad, South Wayanad and Wayanad Wildlife Sanctuary Divisions form a major portion of Nilgiri Biosphere Reserve. This also forms a part of the Elephant Reserve No. 7 comprising elephant habitats in Kerala, Tamil Nadu and Karnataka. Wayanad is contiguous with Bandipur Tiger Reserve and Mudumalai Wildlife Sanctuary in the South and Southeast and Rajiv Gandhi National Park in the North and Northeast (between $11^0$ 20' and $12^0$ 7' N latitude and between $75^0$ 28' and $76^0$ 36' E longitude). The total extent of area is about 520.78 $km^2$, of which 344.44 $km^2$ forms the Wayanad Wildlife Sanctuary (Fig 1).

### A brief history

'Wayanad' derives its name from the numerous swamps (locally called as *vayals*). Francis (1994) described the political history, forest, agriculture and wildlife in Wayanad in earlier days. The forests of Wayanad were "being almost interminable subtropical jungle in which grow trees and plants unknown to the higher levels and its animal, bird and insect life (not forgetting its leeches) being more in evidence and more varied. It is in short a botanist's paradise and a naturalist's El Dorado".

Paddy was the commonest crop and was cultivated in the swamps. The dry higher grounds were cultivated with crops such as ragi and chama. These were often grown on the shifting system. Wildlife was so numerous that crop raiding was frequent. Fencing or continuous watching was necessary to prevent wild animals from damaging the crop. According to Francis (1994) "One of the characteristics of Wayanad fields is the large number of watchers or raised platforms (*machans*) which are dotted about them".

FIG.1. STUDY AREA



Coffee was probably the first plantation crop to be introduced into Wayanad in 1828 and by 1839, its cultivation became an enterprise. This triggered a series of monoculture plantations such as tea and then extensive deforestation for raising teak. The plantations actually signalled the start of deterioration of the habitat.

The human populations were so low that labour was a real problem and the Britishers once even thought of encouraging or forcing the Badagas of Nilgiris to migrate to Wayanad to make agriculture extensive and profitable. The tract was feared for its malarial fever that people were reluctant to move to the area. But in the fifties, after the state reorganization, there was a mass invasion of the forests of Wayanad by the settlers.

Commercial plantations increased the requirement of labour. The 'Kurumban' tribals were replaced with coolie labourers brought from elsewhere and the number of settlements increased. The commercial activities and the increased settlements had its effects on the once continuous stretch of thick forests. As the population increased, the settlements began to intrude the neighbouring forests thus fragmenting the wildlife habitat. The developmental programmes that followed contributed further to the deterioration of the remaining forest areas.

During the dawn of the century, the area was protected as Reserved Forests under the jurisdiction of Chedleth Range. Subsequently, Sulthan Battery Range was formed in 1924. After 1958, South Wayanad was managed under Kozhikode Forest Division and North Wayanad under Wayanad Forest Division. The area was declared a Sanctuary in 1973 and brought under the Wildlife Division in 1985. Gopinathan (1990b) has given a detailed description and history of the Sanctuary.

The forest of Wayanad could be considered as three Regions based on the contiguity of forests.

**Southern Ranges**- comprises the forests of Muthanga, Sulthan Bathery and Kurichiat forest ranges. The range starting from Nulpuzha reserve extends through Kerala, Karnataka and Tamil Nadu trijunction to the Kabini riverbank. Its contiguity with the Padiri reserve of Chedleth Range is lost due to the encroachment in Pulpally forest areas. However, contiguity is maintained through the forest of Padri reserve and a narrow strip in Karnataka side. A major portion of this range is boardered by Kabini river, both sides of which are under cultivation. A major portion of the segment is boardered by the forests of Mudumalai Wildlife Sanctuary and Bandipur Tiger Reserve of Karnataka. There are about 29 enclosures in the Southern Ranges.

The forests in this range represent one of the best examples of dry deciduous forests in the state. Presence of extensive bamboo break is one of the most important characteristics of the area.

**Northern Ranges**- The northern ranges in Wayanad extends from the Shanamangalam, Kartikulam reserve forests boardering North Padri reserves through the highly fragmented patches of Begur and Tholpetty Ranges of North Wayanad and Wayanad Wildlife Sanctuary division respectively. This has contiguity with Periya, Kottiyur and Mananthavady of North Wayanad and Kannur Forest divisions. Rajiv Ghandi National Park of Karnataka is located on the East. The fragile, unique ecosystem of Kuruva islands falls between these ranges and the Central ranges. There are about 26 enclosures in the northern ranges. The vegetation types in the ranges vary from evergreen to deciduous types.

**Central Range**- The central range comprises the forest of Padri reserve under the administrative control of Chedleth Range of South Wayanad Forest Division. A

narrow strip of forest along the Kabini river is bordered by Kabini river. Both sides of Kabini are under cultivation. Electric fencing leaving a gap for elephant movement protects the cultivated areas along the Kabini on one side. A large part of the forest falls under the moist deciduous forest with bamboo break. There are 14 enclosures of which two occupy a vast expanse.

**Precipitation**

The annual rainfall in Southern Ranges varies from 1200-1700 mm, 1760 mm in Central Range and 1360 mm in Northern Ranges. Maximum precipitation is from June to September. The South West monsoon brings the greater part of the total rainfall bursts normally by first week of June proceeded by a few showers in April and May. Northeast monsoon brings some rain in October and November. Breaks in the monsoon are not uncommon. Based on the rainfall pattern, three seasons *viz*. dry (January-April), first wet (May-August) and second wet (September-December) could be identified. The moist deciduous forests received more rainfall compared to the dry deciduous forests (Balasubramanian, 1998).

**Temperature and humidity**

The temperature and humidity data for the Southern Ranges were collected from the Agricultural Farm at Ambalavayal adjacent to Wayanad Wildlife Sanctuary. Mean atmospheric temperature in Southern Ranges varied from a monthly maximum of 31°C in March to 24°C in July and monthly minimum of 19°C in May to 14°C in December. The average relative humidity ranged between 60.4% in January and 87.6% in June (Fig 2).

The mean atmospheric temperature varied from a monthly maximum of $34^0$ C in March to $24^0$ C in August and December and from monthly minimum of $22^0$ C in February to $17^0$ C in November in Central Range (Fig 3). In Northern range, the mean atmospheric temperature varied from a monthly maximum of $36^0$

C in March to $27^0$ C in July and from a monthly minimum of $19.4^0$ C in June to $12.9^0$ C in December (Fig 4).

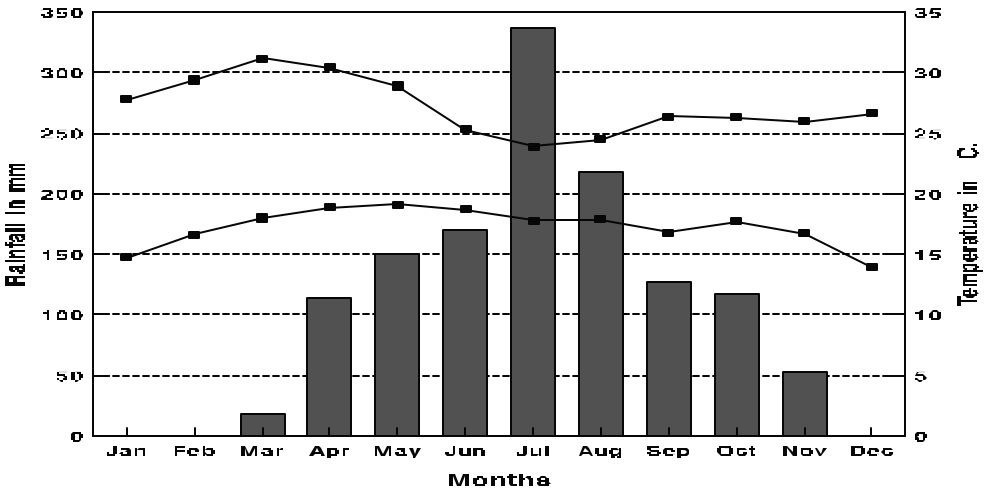



**Fig 2. Monthly distribution of rainfall and temperature in Southern Ranges during 1993 - 1994**

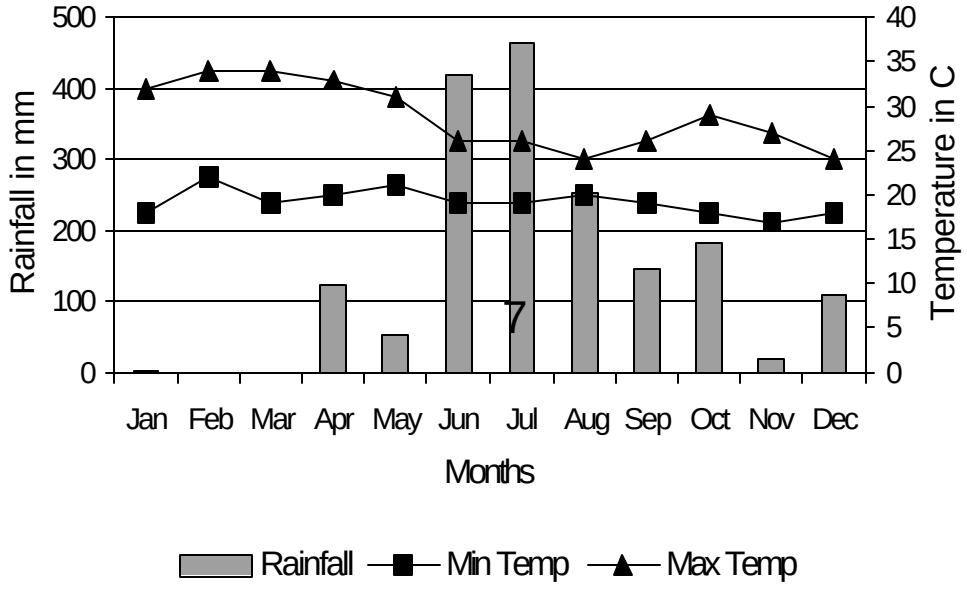



**Fig 3. Monthly distribution of rainfall and temperature in Central Range during -1996**

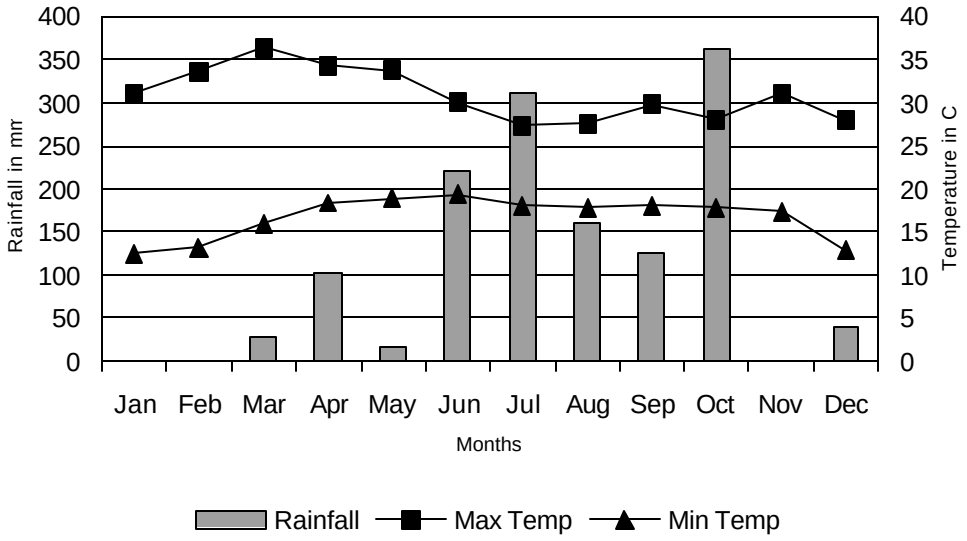



**Fig 4.Monthly distribution of rainfall and temperature in Northern Ranges during –1996**

## Terrain and soil

This range is a part of the Mysore plateau. The terrain is almost flat (less than 5°) to gentle slope (varies from 5° to 10°) in the western part. The altitude varies between 850 m and 1147 m. The broad type of soil is Ferrolite and sub type is Ustic Altisol.

## Water sources

Wayanad forms a significant part of the catchment area of Kabani river which flows into Karnataka. Begur and Tholpetty Ranges are drained by Baveli puzha and Panamaram puzha and join the Kabani river. Northern portion of Kurichiat Range is drained by Kannarampuzha and Kurichiat Thodu flowing northward and joining Kabini river. Towards the southeast, Manjal Thodu and other streamlets join Nuguhole river to flow further north east to Karnataka. Southern portion of the sanctuary is drained by Nulpuzha and Mavinahalla Thodu

which combine to form Nuguhole river. Manjal Thodu and other small streams in the sanctuary become dry during peak summer season.

**Vegetation Types**

The forest types in the area are mostly moist deciduous (MDF) with a few scattered patches of evergreen and riverine forests. A long belt of dry deciduous forests (DDF) exists in the areas bordering Tamil Nadu and Karnataka. About one third of the sanctuary is covered by plantations of teak, eucalypts and mixed species interspersed with bamboo. The forest types could be broadly classified into the following categories (Champion and Seth, 1968).

1. Southern Moist Mixed Deciduous Forests
2. West Coast Semi-evergreen Forests
3. Southern Dry Mixed Deciduous Forests

**Southern Moist Mixed Deciduous Forests**

A major portion of the area falls under this category. Moist deciduous forests are interspersed with seasonally waterlogged areas in the depressions known as *vayals* (marshy/wet lands). *Vayals* are dominated by grass and are devoid of tree cover. The moist deciduous forest has a moderate canopy cover (50-70%) during the wet seasons. During the dry season, most of the trees shed leaves and canopy cover is comparatively less (10-20%). Bamboo brakes (*Bambusa arundinacea)* are distributed sporadically all over the habitat. It is also found all along the perennial streams and in the wet areas. The upper canopy consists of *Terminalia tomentosa, Terminalia bellirica, Terminalia paniculata, Pterocarpus marsupium, Tectona grandis, Grewia tiliaefolia, Adina cordifolia,* etc. The middle canopy comprises *Schleichera oleosa, Kydia calycina, Bridelia retusa, Acacia pinnata, Butea monosperma, Haldina cordifolia, Cinnamomum zeylanicum* etc. Main species of ground flora are *Helicteres isora, Lantana camera, Eupatorium odoratum, Hibiscus furcatus, Zizyphus xylocarpus, Randia dumetorum*, etc. A few climbers like *Butea parviflora, Caesalpinia* sp.,

*Calycopteris floribunda* are also seen. *Xylia xylocarpa* is conspicuous by its absence. Grasses such as *Cyrtococcum patens, Apluda mutica* and *Oplismenus compositus* are thinly distributed with low productivity. Fire occurrence is comparatively less in this type of forests.

**West Coast Semi-evergreen forest**

This type of forest is found mostly in patches at few places. It is a heterogenous mixture of evergreen and deciduous species. The number of species is high but less than pure evergreen. Climbers are heavy and epiphytes abundant. The main species of top canopy *Terminalia bellirica, Olea dioica, Schleichera oleosa, Hydnocarpus pentandra, Aporusa lindleyana, Mallotus philippensis* and *Diospyros* sp. Ground flora consists of *Strobilanthus* sp., *Curcuma* sp., etc. Where the canopy is open *Eupatorium odoratum* is seen spreading.

**Southern Dry Mixed Deciduous Forests**

The dominant tree species are *Shorea roxburghii, Anogeissus latifolia, Terminalia alata, Terminalia chebula, Pterocarpus marsupium, Gmelina arborea, Schrebera sweitenioides, Diospyros montana, Schleichera oleosa, Grewia tiliaefolia, Dalbergia latifolia, Mitragyna parvifolia, Bauhinia racemosa, Xeromphis uliginosa* and *Tectona grandis*. The saplings of tree species are abundant along the nullahs where ground water is available. Grass species such as *Themeda cymbaria, Themeda triandra, Cymbopogon flexuosus* and *Imperata cylindrica* grow more than 200 cm in height and form a dominant ground cover. The canopy layer of the trees is broken due to the spatial distribution as well as comparatively low tree density. Canopy cover is less (10-20%) during dry season. Due to its deciduous nature, leaf fall is common even in the month of December and dry spell extends up to pre-monsoon showers beginning in May. The bamboo (*Bambusa arundinacea*) is less frequented compared to moist deciduous forest. In the dry deciduous forests, the *vayals* are comparatively less and are dominated by tall grass (*Themeda* sp. and *Pennisetum hohenackeri*).

**Plantations**

Total area of the plantation in the study area is about 163 $Km^2$, which includes pepper, eucalypts, teak and mixed softwood species. Eucalypts plantations do not have any other tree species except a few saplings of *Cassia fistula* and *Terminalia* sp. The whole plantation is occupied by *Lantana* sp. Tall grasses *viz.*, *Themeda cymbaria*, *Themeda triandra* and *Cymbopogan flexuosus* are found in open areas in the plantations. In Teak plantations, apart from a few deciduous tree species, *Helicteres isora* occupy a large proportion of the area.

**Fauna**

The area is rich in faunal in diversity and abundance. Almost all the large mammals of peninsular India are observed in the area. The area has a good population of elephant (*Elephas maximus*), gaur (*Bos gaurus*), sambar (*Cervus unicolor*), spotted deer (*Axis axis*), barking deer (*Muntiacus muntjac*), mouse deer (*Tragulus meminna*) and wild boar (*Sus scrofa).* Other animals such as bonnet macaque (*Macaca radiata*), common langur (*Presbytis entellus*), sloth bear (*Melursus ursinus*), tiger (*Panthera tigris*), wild dog (*Cuon alpinus*), panther (*Panthera pardus*), jungle cat (*Felis chaus*), Indian pangolin (*Manis crassicaudata*), porcupine (*Hystrix indica*), Malabar giant squirrel (*Ratufa indica*, and Indian hare (*Lepus nigricollis nigricollis*) are also seen in this area. Sighting of four horned antelope (*Tetracerus quadricornis*) is rare and are restricted to areas bordering Karnataka. A total of 44 species of reptiles (Thomas *et al*., 1997), 31 species of amphibians (Easa, 1998) and 54 species of fishes (Shaji and Easa, 1997) were identified from Wayanad.

**Human habitations and cultivation**

An interesting feature of the study area is the large number of settlements where cultivation is practised. A total of 69 enclosures are situated inside the study area. These settlements are confined to the moist deciduous forests and teak plantations. The people occupy almost all the vayals with perennial water sources.

A population of more than 25,000 people live in and around the Protected Area. Their main occupation is agriculture. They cultivate cash crops such as coffee, pepper and coconut followed by primary crops *viz.*, paddy, ginger, tapioca and plantains. Electric fencing, provided by the Forest Department protects a few of the settlements. A total of 166 Km. length of electric fencing has been erected in the study area.

Cattles and goats form the major livestock of the people. The people residing inside the sanctuary own a total population of 3500 cattles. These animals are mostly left to feed inside the Sanctuary. Cattle lifting by panther and tiger are also reported.

**The people**

The main occupants of the settlements in the study area are Wayanadan Chetties and Gowdas. The principal tribes living in the forest plateau are Mullukurumbas, Paniyans, Kattu Naikans, Uralis and a few Kurichiars (Thurston and Rangachari, 1909). Some of the settlements have also Hindus, Christians and Muslims. The chief occupation of Chetties is cultivation of paddy in the swamps. They also grow pepper, plantains and coffee in their homestead. *Lantana* bushes are found in abandoned shifting cultivation plots.

The Paniyans are an aboriginal race, owning no land, but cultivating paddy for the Chetties. They speak an aboriginal language and also a dialect of Malayalam. Among the Kurumbas, the Mullukurumbas are socially and economically advanced. They cultivate various crops in the adjoining wet lands. They also own cattle. They want little from the forests other than the land to cultivate. The Paniyans used to practice shifting cultivation in the virgin forest. At present, they live by extending labour to neighbouring estates as well as to the Forest Department. The Kattunaikans are considered as the least civilized among the jungle tribes and subsist on the forest by collecting non-wood forest produce such as honey, tubers, fruits, medicinal plants and others.

## CHAPTER 30

## VEGETATION ANALYSIS

### Introduction

The forest areas of Wayanad plateau have witnessed a variety of human activities in the past. Coupled with a rapidly changing rainfall gradient from West to East, different patterns of plant communities exist in the area. Varying degrees of anthropic pressures such as shifting cultivation, extensive grazing, selection felling and various other activities had resulted in formation of mosaic of forest patches. Plots taken along the transects covering the three regions were studied to throw light on the existing vegetation types in this area.

### Methods

A reconnaissance survey was conducted in the three Ranges with the objective of identifying different forest types. Transects were laid in the three regions, namely Southern Ranges, Northern Ranges and Central Range in the study area. Along the transect, plots of 10 x 10 m were laid in every 100 meter interval. All plants of girth 10 cms and above at breast height (1.3 m above ground level) were marked and identified. Girths at breast height (gbh) of all trees were measured individually for each species. For trees with large buttresses girth was measured at a height of 2-2.75 m to avoid buttressed part and height measurements were also taken.

Basal area was calculated from the gbh measurements and total basal area calculated for each plant species in each region.

### Results

Sampling of Southern Ranges covered two locations, Edavamp and Ponkuzhi dominated by dry deciduous vegetation types. Sampling of Central Range covered seven locations; Kottamala, Kuruva, Kuruva 1, Kurichipatta, Perikalloor, Vandikadavu and Chullikadu. All these locations had dominant moist deciduous vegetation except in Kurichipatta where teak plantation with miscellaneous growth of moist deciduous species was found. Sampling of Northern Ranges covered nine

locations; 1995 teak plantations, 2nd Gate, 4h mile, Alathur, Appapara, Bavali, Begur, Camp road and Puthukkal. All these locations have teak plantations except for Begur, which harbours natural forest with dominant moist deciduous vegetation type.

**Southern Ranges**

Dry deciduous forest was the dominant vegetation type in this region. Twenty seven species were recorded. *Terminalia tomentosa* was the most dominant tree with the highest total basal area of 20751.55. This was followed by *Pterocarpus marsupium* , *Anogeissus latifolia* , T*ectona grandis, Dalbergia latifolia*, T*erminalia paniculata* and *Kydia calycina* . Highest number of individuals were recorded for *Anogeissus latifolia* , *Terminalia tomentosa*, *Olea dioica* and *Kydia calycina* (Table 1).

**Table 1. Details of tree species in the Southern Ranges**

| Sl. No. | Species name | No. of individuals | Total Basal area |
|---|---|---|---|
| 1. | *Terminalia tomentosa* | 32 | 20751.55 |
| 2. | *Pterocarpus marsupium* | 5 | 12466.00 |
| 3. | *Anogeissus latifolia* | 32 | 9271.78 |
| 4. | *Tectona grandis* | 6 | 8593.27 |
| 5. | *Dalbergia latifolia* | 4 | 5018.79 |
| 6. | *Terminalia paniculata* | 7 | 4392.91 |
| 7. | *Kydia calycina* | 10 | 3808.92 |
| 8. | *Syzygium cumini* | 2 | 2375.80 |
| 9. | *Hopea ponga* | 4 | 1467.32 |
| 10. | *Olea dioica* | 18 | 1329.92 |
| 11. | *Bucharia recemosa* | 2 | 1029.30 |
| 12. | *Lagerstroemia parviflora* | 3 | 935.43 |
| 13. | *Grewia tillifolia* | 2 | 872.61 |
| 14. | *Buchana lanzan* | 1 | 828.34 |
| 15. | *Wrightia arborea* | 1 | 561.78 |
| 16. | *Gmelina arborea* | 1 | 459.87 |
| 17. | *Radermachera xylocarpa* | 2 | 360.31 |
| 18. | *Emblica officinalis* | 9 | 287.92 |
| 19. | *Schleichera oleosa* | 2 | 231.89 |

| | | | |
|---|---|---|---|
| 20. | *Randia gardneri* | 2 | 158.36 |
| 21. | *Terminalia bellirica* | 1 | 140.45 |
| 22. | *Casia fistula* | 4 | 120.80 |
| 23. | *Diosphyros cordifilia* | 1 | 76.51 |
| 24. | *Bucharia axillaris* | 1 | 66.96 |
| 25. | *Shorea sp.* | 2 | 46.16 |
| 26. | *Pavetta indica* | 2 | 38.30 |
| 27. | *Butea monosperma* | 1 | 15.61 |

**Central Range**

Moist deciduous forest is the dominant vegetation type in this region. Forty five species of trees were recorded. *Terminalia tomentosa* was the most dominant tree with a highest total basal area of 36219.03 followed by *Grewia tiliifolia* , *Stereospermum chelonoides* , *Dalbergia latifolia* , *Terminalia paniculata* , *Pterocarpus marsupium* , *etc*.(Table2) Highest number of individuals were recorded for *Alstonia scholaris,* followed by *Kydia calycina, Careya arborea* and *Grewia tiliifolia*. The details are summarised in Table 2. *Alstonia scholaris* and *Careya arborea* were the most regenerating species.

**Table 2. Details of tree species in the Central Range**

| Sl. No. | Species name | No. of individuals | Total Basal area |
|---|---|---|---|
| 1. | *Terminalia tomentosa* | 18 | 36219.03 |
| 2. | *Grewia tillifolia* | 45 | 31953.24 |
| 3. | *Stereospermum chelonoides* | 17 | 28692.44 |
| 4. | *Dalbergia latifolia* | 37 | 27785.47 |
| 5. | *Terminalia paniculata* | 30 | 26184.45 |
| 6. | *Pterocarpus marsupium* | 16 | 18967.16 |
| 7. | *Careya arborea* | 45 | 17438.85 |
| 8. | *Lagerstroemia microcarpa* | 13 | 14707.98 |
| 9. | *Ficus racemosa* | 1 | 12738.85 |
| 10. | *Alstonia scholaris* | 68 | 12408.44 |
| 11. | *Tectona grandis* | 24 | 11321.76 |
| 12. | *Terminalia bellirica* | 10 | 10524.60 |
| 13. | *Olea dioica* | 18 | 7505.43 |
| 14. | *Diospyros malabrica* | 3 | 7377.39 |

| | | | |
|---|---|---|---|
| 15. | *Haldina cordifolia* | 12 | 7364.33 |
| 16. | *Artocarpus hirsutus* | 5 | 5965.68 |
| 17. | *Erythrina indica* | 5 | 5956.53 |
| 18. | *Kydia calycina* | 51 | 4692.30 |
| 19. | *Wrightia tinctoria* | 5 | 4222.37 |
| 20. | *Spondias indica* | 10 | 3838.46 |
| 21. | *Neolamarckla cadamba* | 3 | 2845.70 |
| 22. | *Dalbergia lanceolata* | 4 | 2682.96 |
| 23. | *Randia longispina* | 9 | 2524.24 |
| 24. | *Casia fistula* | 9 | 2356.05 |
| 25. | *Butea monosperma* | 4 | 2275.32 |
| 26. | *Bombax ceiba* | 3 | 1920.22 |
| 27. | *Syzygium caryophyllaeu* | 3 | 1780.02 |
| 28. | *Bridelia crenulata* | 11 | 1774.22 |
| 29. | *Albizia lebbeck* | 3 | 1760.27 |
| 30. | *Gmelina arborea* | 1 | 1743.95 |
| 31. | *Artocarpus heterophyllus* | 8 | 1668.39 |
| 32. | *Mangifera indica* | 8 | 1468.09 |
| 33. | *Syzygium cumini* | 1 | 1408.38 |
| 34. | *Artocarpus ponga* | 3 | 1371.50 |
| 35. | *Hopea parviflora* | 2 | 1200.64 |
| 36. | *Randia gardneri* | 4 | 1174.60 |
| 37. | *Calophyllum inophyllum* | 1 | 1089.89 |
| 38. | *Anogeissus latifolia* | 1 | 379.06 |
| 39. | *Atalantia recemosa* | 3 | 330.10 |
| 40. | *Emblica officinalis* | 2 | 205.20 |
| 41. | *Michelia champaka* | 1 | 66.95 |
| 42. | *Holigarna arnottiana* | 1 | 31.85 |
| 43. | *Chukrasia tabularis* | 2 | 29.06 |
| 44. | *Buchanania axillaris* | 1 | 7.96 |
| 45. | *Cinnamomum malabatrum* | 1 | 1.27 |

**Northern Ranges**

The sampling locations in this region were dominated by teak plantations. Twenty eight plant species recorded from this region include the moist deciduous ones and the miscellaneous growth of moist deciduous species in the teak plantation. *Tectona grandis* was the most dominant tree species with highest total basal area of 125196.8 comprising 188 individuals (Table 3). This was followed by *Schliechera*

*oleosa*, *Terminalia bellirica*, *Grewia tiliifolia* and *Randia gardneri*. Tree species with highest number of individuals were *Dalbergia latifolia* (26) and *Cassia fistula* (25).

**Table 3. Details of tree species in the Northern Ranges**

| Sl. No. | Species name | No. of individuals | Total Basal area |
|---|---|---|---|
| 1. | *Tectona grandis* | 188 | 125196.80 |
| 2. | *Schieichera oleosa* | 9 | 68844.98 |
| 3. | *Terminalia bellirica* | 4 | 16987.14 |
| 4. | *Grewia tillifolia* | 5 | 13720.00 |
| 5. | *Randia gardne* | 12 | 12658.36 |
| 6. | *Dalbergia latifolia* | 26 | 11583.44 |
| 7. | *Pterocarpus marsupium* | 3 | 10352.07 |
| 8. | *Azadirachta indica* | 1 | 4102.63 |
| 9. | *Syzygium cumini* | 3 | 3726.35 |
| 10. | *Olea dioica* | 6 | 3687.26 |
| 11. | *Erythrina indica* | 6 | 3493.47 |
| 12. | *Terminalia tomentosa* | 1 | 3184.71 |
| 13. | *Adenanthera triphysa* | 6 | 2578.80 |
| 14. | *Anogeissus latifolia* | 4 | 2567.91 |
| 15. | *Terminalia crenulata* | 1 | 2115.37 |
| 16. | *Casia fistula* | 25 | 1912.82 |
| 17. | *Sterospermum chelonoid* | 3 | 1454.30 |
| 18. | *Lagerstroemia lanceolata* | 4 | 1175.96 |
| 19. | *Kydia calycina* | 2 | 1139.65 |
| 20. | *Haldina cordifolia* | 2 | 1059.87 |
| 21. | *Albizia odoratissima* | 2 | 905.89 |
| 22. | *Xylia xylocarpa* | 4 | 669.11 |
| 23. | *Butea monosperma* | 1 | 659.32 |
| 24. | *Terminalia paniculata* | 1 | 258.68 |
| 25. | *Garcinia gummi-gutta* | 1 | 240.84 |
| 26. | *Alstonia scholaris* | 2 | 118.79 |
| 27. | *Zizyphus xylophyrus* | 1 | 114.97 |
| 28. | *Aporusa acuminata* | 1 | 38.54 |

**Discussion**

Even though moist deciduous vegetation type was present in all the regions, the regeneration pattern was different in localities within the regions. The most regenerating species like *Alstonia scholaris, Careya arborea, Kydia calycina, Cassia fistula, Dalbergia latifolia, Randia* spp. were found to be confined to certain localities within the regions. Perikalloor locality of the Central Range had vast stands of profusely regenerating *Alstonia scholaris* where as in Kuruva and Kuruva -1 localities, the most regenerating tree species recorded was *Careya arborea*. Chullikad locality of Central Range had profusely regenerating *Kydia calycina*. The teak plantations of Northern Ranges had profuse regeneration of *Cassia fistula*.

Higher frequency of *Anogeissus latifolia* and *Terminalia tomentosa* indicate the dry conditions of the southern ranges. Upper canopy was mostly dominated by moist deciduous species and regenerating species are mostly of dry deciduous type. Certain localities of this region had vast patches of *Olea dioica,* which is a semi-evergreen species. *Kydia calycina* and *Emblica officinalis* were the other regenerating species found in this region. The structure and composition of this forest type indicate that the anthropic pressure coupled with adverse climatic conditions have brought about changes in the recent past.

## CHAPTER 4

## LANDUSE

The east sloping Wayanad plateau extends north west of the Nilgiris in between the main watershed line along the western edge of the ghats and the dry Deccan plateau. The plateau is more than 1500 $km^2$ at an elevation of 900-1000 msl., which is drained by Kabini extending partly into Tamil Nadu and Karnataka. The state boundaries do not correspond with any natural topographic sub division of the Wayanad. In the otherwise gently rolling plateau, a few hills rise up to 1400 m.

Wayanad could be divided into two distinct entities, the eastern drier tract along the state border and the western wetter tract along the western escarpments and borderline ridges of Wayanad hills continuing up to the Brahmagiris. In topography, bio-climate and biological diversity and also in conservation potential, the eastern and western forest belts in Wayanad are essentially different.

The Wayanad plateau forests are mostly restricted to the state border in an irregular strip starting from the Kerala-Tamil Nadu-Karnataka trijunction and it extends north east along the border to near Kabini. It is then broken by the Pulpalli encroachments and after a gap, a small strip of forests remain on the eastern bank of Kabini. On the left bank, through a number of unconnected pockets of forests, the eastern borderline forests of Wayanad can be considered to be in connection with the Brahmagiri slope forests. Across the border, the eastern borderline strip of forests in Kerala is continuous with the forests of Tamil Nadu and Karnataka.

The Reserved Forests in the eastern edge of Wayanad are less than 10 km. wide strip of moist and dry deciduous forests which have been heavily exploited and degraded and mostly converted to teak and eucalyptus plantations. The eastern most parts of Mavinhalla Reserve and Rampur Reserve are of very dry and open forests.

Although degraded and broken up as they are today, forests of Wayanad plateau must have been far denser and moist, a few centuries ago. The topography of the region with low hills and flat terrain has resulted in extensive slushy valleys. `Wayanad', the name itself is supposed to mean land of swamps. These forests were also part of a vast forest belt extending from Coorg and the edge of Mysore plateau all along the Western Ghat eastern slopes, skirting the Nilgiris and continuing along the Moyar Valley to the Eastern Ghats. The forests of Kerala Wayanad and the adjoining now destroyed forests of Gudalur as well as the Coorg forests along Kabini left bank form an extensive belt of forests. But almost a century of heavy forest exploitation, conversion of forests into teak plantations and, very large scale settlements of people during the last half a century in Wayanad have resulted in fragmentation and degradation of Kerala Wayanad. Extensive fragmentation and reduction of natural forest areas in the other states have also taken place.

Since Wayanad was a part of Malabar, most of the forests were privately owned and the government forests were only scattered islands. The only Reserved Forests in the wetter part of Wayanad were on the Brahmagiri slopes and on the north west corner.

Unlike in the Travancore and Cochin area, forest reservation in Malabar was slower and most of the existing Reserves were notified in the later part of 1930s and the early 1940s. Before the process could be completed, the Second World War intervened and the process was halted. Due to the prevailing scarcity of food material, the Government opened up many areas for settlement, in particular the entire Wayanad plateau where the terrain was safe and suitable for paddy cultivation. Thus an opportunity to protect the forests of Wayanad was lost forever.

The Reserved Forests existing in Wayanad today are unlike most of the other Reserved Forests in Mala bar or Travancore-Cochin. Instead of the extensive composite uninhabited areas constituting the Reserves elsewhere, the Wayanad forests are very irregularly shaped with enclosures and settlements scattered all over

inside with all the valleys and swamps under cultivation. A large tribal population depends on these forests for survival. As the total forest area rapidly shrunk in the Wayanad plateau, the pressure on the remaining forests from the people and their domestic animals increased. The very irregular boundaries of these Reserves made available more perimeter areas for degradative interactions. The availability of good quality teak had initially attracted Tipu Sultan and later the British to this plateau and as the technique for raising teak plantations were perfected in Malabar, more and more natural forests in Wayanad also got converted. The moist deciduous forests of Wayanad in general and in particular, those on the fringes of the swamps, which were open, had luxuriant growth of bamboos and hence the whole area got worked for bamboo for the Gwalior Rayons(***).

Beginning in the 1966-'67 period, the first large-scale encroachment of private forests in Wayanad resulted in the organised destruction of Pulpally forests. This disrupted the continuity of the forest belt along the eastern border of Wayanad with the Padiri, Begur and Kudrakod Reserves and the northern side was cut off from the southern Kurichiyat and Kuppady forests. Wayanad being a flat accessible area and the forests moist deciduous, conversion working was highest including extensive conversion to eucalyptus plantations in the 1970s. When private forests were nationalised, considerable areas in the northern and western parts of Wayanad became vested with the government. About 23,113 hectares were set apart for permanent reservation in the northern and western slopes of Wayanad and an additional 4445 ha. further north in the Brahmagiri slopes along Aralam and Kottiyar areas. Most of the vested areas are potentially wet evergreen habitats of considerable value for the conservation of biological diversity. Besides, these forests clothe the extremely steep precipitous slopes of the western edge of Wayanad and the Brahmagiris from which a large number of rivulets originate. But the act of vesting did not guarantee the protection of these forests. Extensive areas were lost and continue to be lost due to loopholes in the law. The fact that most of

these forest tracts are unsurveyed helps considerably the land grab operations. The grave inadequacy in the protection machinery for the vested forests in manpower, money and material resources further aids in its destruction.

The destruction of the Wayanad plateau forests resulted in the elimination of the wetter part of the habitat complex extending from the northern slopes of Nilgiris to Coorg Ghats. The buffer area of Nagarhole National Park, Bandipur National Park and the Mudumalai Wildlife Sanctuary in the adjoining states was lost. Elephant poaching and sandal smuggling from these adjoining areas mostly by operators based in Kerala Wayanad became a serious problem.

In the entire Wayanad Wildlife Sanctuary area, there is no intact or representative forest habitat except along the eastern edges of Rampur and Mavinhalla Reserves which may be considered examples of the dry deciduous forest type which occur elsewhere only in the Chinnar Reserve in Idukki district in Kerala. But as a wildlife habitat, Wayanad still remains a potential area.

The large-scale conversion of forests into plantations has caused depletion of the diversity of forest produce, which the tribal population used to collect and use regularly. Disruption of ecological processes as a consequence of widespread deforestation has also affected the people. All these have a negative feedback influence on the forests accelerating their degradation. Along with better protection, the management of these forests has also to be modified to cater to ecosystem needs as well as basic human needs..

**Growth and expansion of plantations**

As early as 1797, the East India Company started its own plantation with a view to experimental cultivation in pepper, cotton, coconut, betelnut, cassia, nutmeg, sandalwood, cinnamom and coffee in Anjarakandi of north Malabar and appointed one Murdock Brown as overseer and manager (Logan, 1951). Initially, though pepper was the largest export earner of Malabar, it started declining by the end of the 1830s and reached a low level of 1 per cent of world trade. This decline is

attributed to factors such as spread of `wilt' disease, fall in the price and high tax (Logan, 1930). Coconut and coconut products were also exported from Malabar during this period.

Though coffee emerged as a successor to pepper, the coffee industry, however, was not fairly established till about 1840, when several European planters opened up estates. The two principal species grown were *Coffea arabica* and *Coffea liberica*. In 1866, there were about 200 coffee estates in Wayanad covering 5,918 hectares of which 3,995 hectares belonged to the Europeans and 4,748 to the natives (Clement, 1866). In 1865, the borer, *Xyllotrechus quadrupas* destroyed whole estates. Soon after a remedy had been discovered, another fungoid leaf disease, *Hemelia vastratrix* devastated the entire coffee plantations in the district by 1875. The decline was further accelerated by fall in prices due to increased production in other countries. To this was added, the Brazilian competition at the end of the century, which drove prices further down. In the ten year period from 1893 to 1903, the area under coffee decreased from 8,139 hectares to 2,218 hectares (Logan, 1930).

Coffee was gradually supplanted by tea. The earliest tea plantations introduced in Wayanad by Ms Parry and Company was later on taken over by Harrison and Crossfield Company limited. Since 1892, numerous coffee estates were converted into tea gardens as tea did well in many parts of Wayanad. The tea planter required more capital than the coffee planter, since tea must be manufactured on or close to the estates where it is picked and a considerable outlay is necessary on machinery and buildings. Picking and manufacturing went on all the year round, whereas the coffee planter had only one crop to deal with. In 1904, there were 69 coffee plantations and 27 tea estates. In the same year the total output of coffee was 645 tons (Imperial Gazetteer, 1908).

Rubber began to attract attention in the early years of the 20$^{th}$ century. The principal rubber species were *Hevea braziliensis* (para), *Manihot gloziovii* (ceara)

and *Castilloa elastica*. In 1930, in Malabar, there were about 61 estates with 5,004 hectares under tea, 1,124 under coffee, 3,745 under rubber, 779 under pepper and 179 hectares under cardamom. In the ensuing year, the area under coffee showed an upward trend. In 1956, plantation cultivation in Malabar extended to an area of about 24,300 hectares consisting of about 12,150 hectares of coffee and the rest shared between tea and cardamom (Varghese, 1970). Almost all the plantations were concentrated in the Wayanad taluk of the district.

**Change in landuse (1950-1982).**

The amount and pace of forest conversion to other types of landuse during 1950-1982 have accelerated the man wildlife conflict in Wayanad Wildlife Sanctuary. The change in landuse was studied by analysing the toposheets of 1950 (SOI) and the vegetation map prepared by the French Institute, Pondicherry in 1982. The relevant maps are provided in Figs. 5 and 6. The area under different vegetation types was estimated using a digital planimeter and the figures are provided in Table 4.

**Table 4. Land cover of Wayanad District (area in km$^2$)**

| Land cover type | 1950 | 1982 | Difference |
|---|---|---|---|
| Forest | 1811.35 | 724.54 | -1086.81 |
| Agricultural plantation | 63.93 | 532.75 | 462.82 |
| Cultivation | 255.72 | 873.71 | 617.99 |
| **Total** | **2131.00** | **2131.00** | |

***Source: 1950-SOI topographical maps 49M 13 & 14***

***1982-Vegetation map prepared by French Institute of Pondicherry***

The forest cover has been reduced by 1086 km$^2$ during the thirty year period with the corresponding increase in area under plantations and cultivation. The intact and once continuous vegetation cover has been fragmented almost throughout having a bearing on the movement of large mammals.

Fig 5. LAND COVER MAP OF WAYANAD 1950

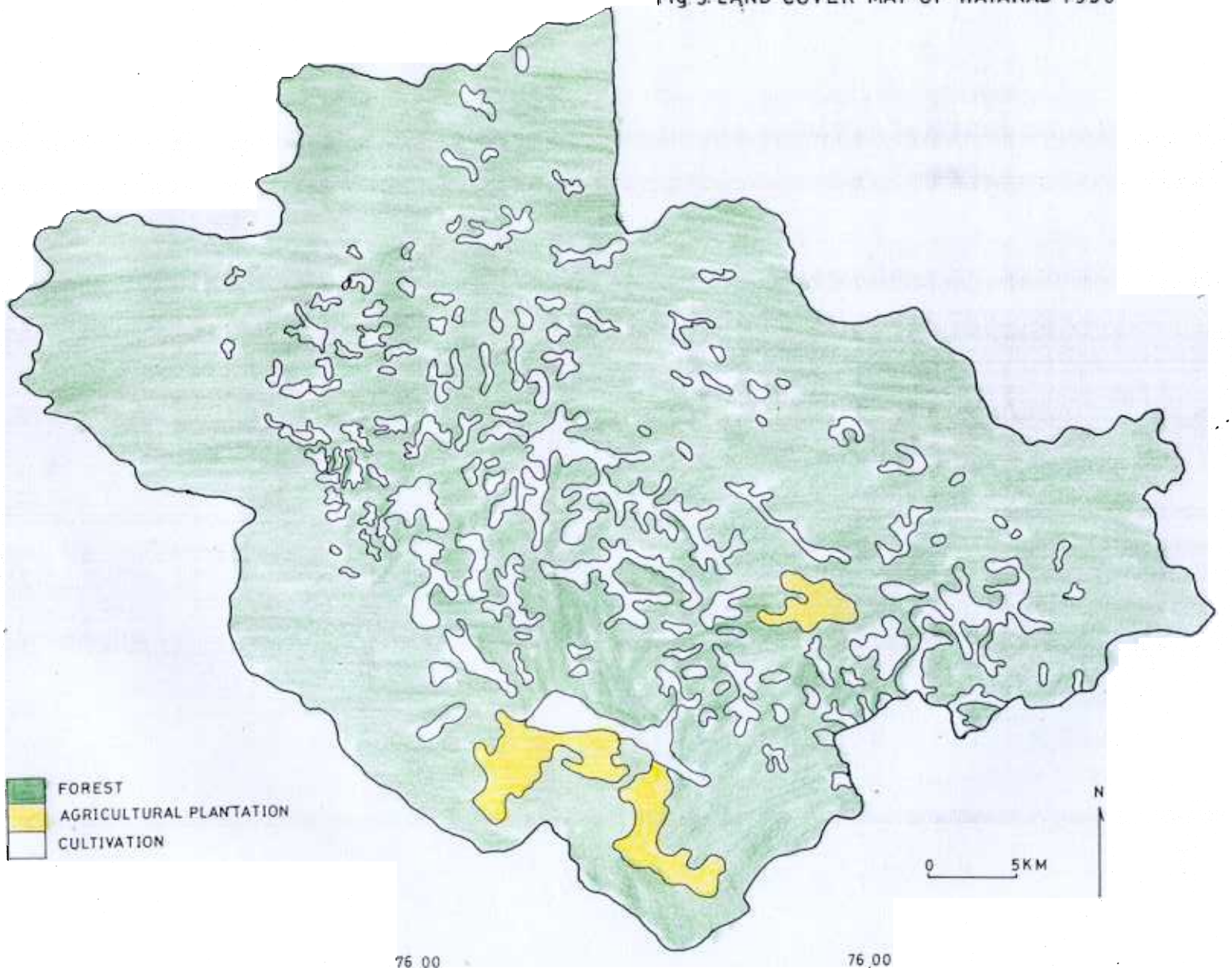
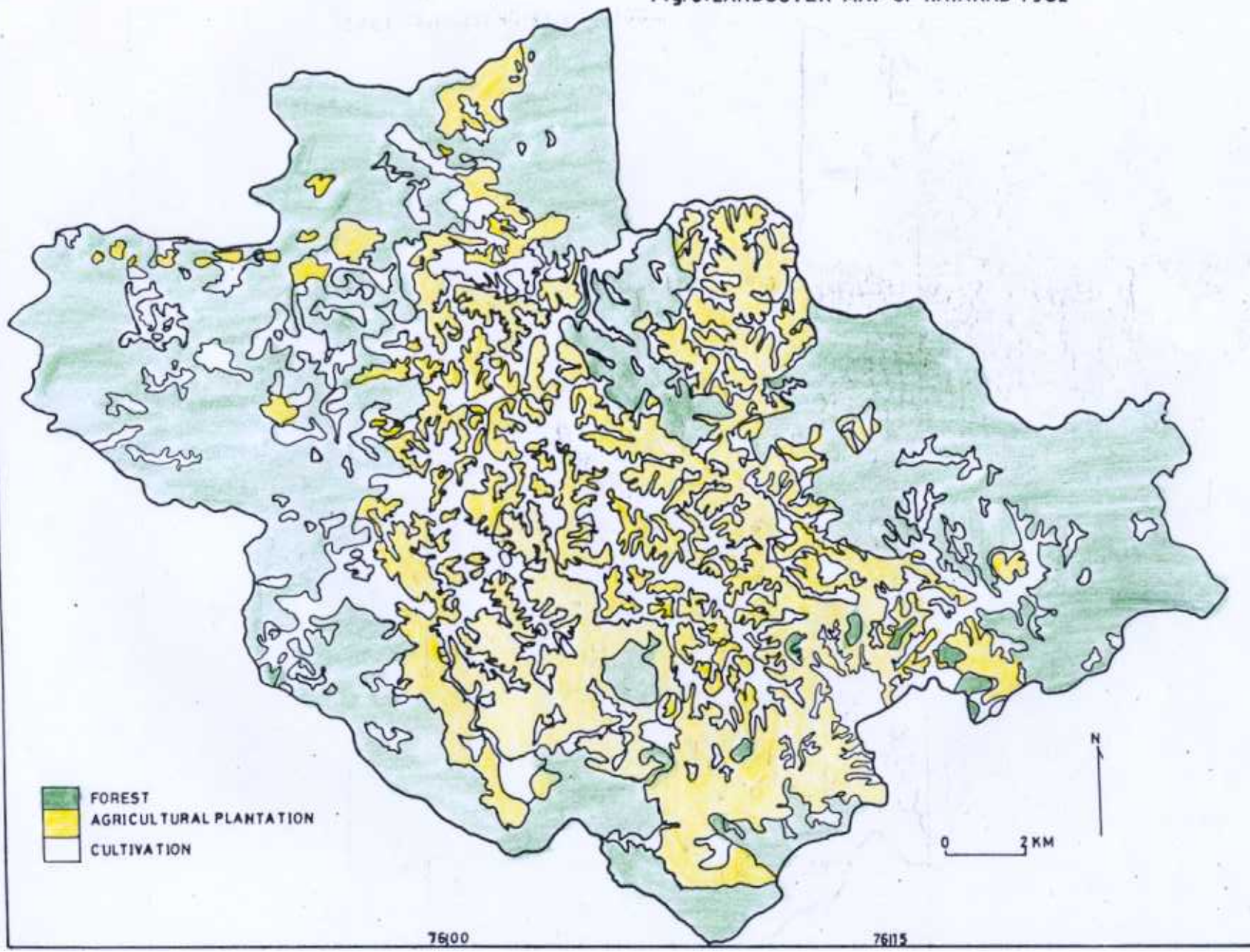


Fig. 6. LANDCOVER MAP OF WAYANAD 1982



# CHAPTER 5

# SOCIO ECONOMIC SURVEY

## Introduction

The socio-economic status of the people in the forests surrounding areas will have positive or negative impacts on the systems. Considering the importance of such information in assessing the crop raiding and related problems in Wayanad, a survey was conducted among the people in the enclosures and periphery in Wayanad.

## Methods

### Socio-economic survey

Socio-economic survey was conducted in Mananthavady and Begur Forest Ranges of North Wayanad, Chedleth of South Wayanad and all the Ranges of Wayanad Wildlife division. Large number of people live inside the revenue land, forest leases and reserve forests and these enclosures are scattered in the form of a mosaic. These are located in Nulpuzha, Kidanganadu, Pulpally and Thirunelli Panchayaths of Wayanad.

Twenty percent of the households were randomly selected for household survey in enclosures, settlements in the fringes and along the selected transects (Fig 7). This formed 2174 houses. The questionnaire was formulated in such a way that information on the population, education, employment, agriculture practices, forest dependence, social and cultural activities and their attitude towards the management and conservation of forest and wildlife were collected. The households at 50 m points along the 1 km transects were selected for the survey.

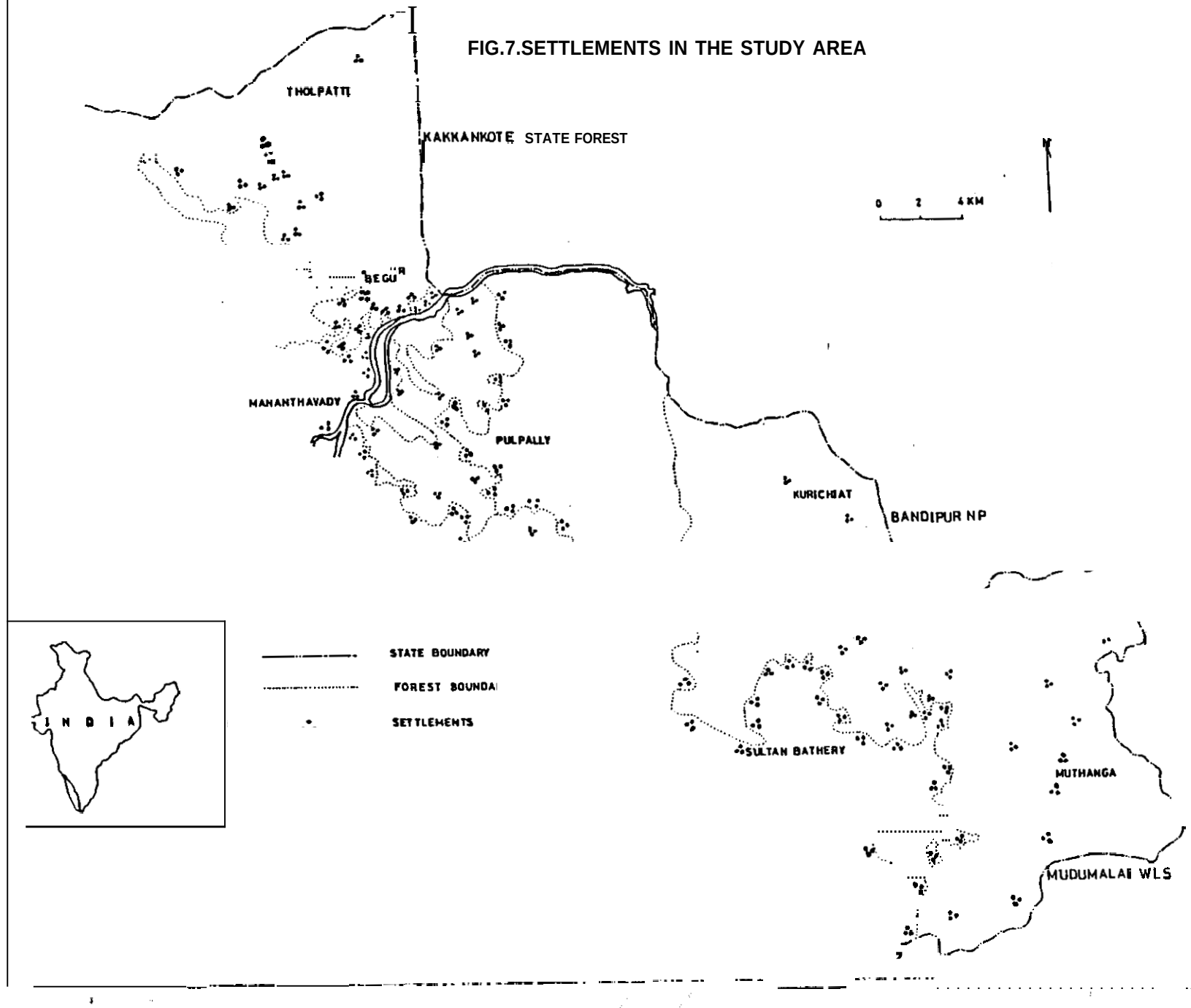



FIG.7.SETTLEMENTS IN THE STUDY AREA

## Results

### Enclosure

There are about 69 enclosures in the study area and are scattered in a mosaic form. Most of the settlements are near to the streams, rivers or vayals (marshy area). The name Wayanad is derived from two colloquial words 'Vayal' (Swamps) and 'Nadu' (place/locality). Recently, most of these vayals were converted into agricultural lands. The enclosures have both the tribals and non-tribals. Most of the non-tribals are immigrants from other parts of Kerala. Golur, Ammavayal and Kurichiat settlements are situated in the most interior of the forest. Large number of tribal settlements is situated along the fringes and away from the forest. Most of them are dependent on the forest for NWFP, grazing, food and firewood.

Most of the enclosures surrounded by teak plantations (43.44%) and moist deciduous forests (39.12%). Percentages of households in different vegetation types are given in Table 5.

**Table 5. Percentage of house holds in different vegetation types**

| SL. No. | Vegetation | % of households |
|---|---|---|
| 1 | Moist deciduous forest | 39.12 |
| 2 | Dry deciduous forest | 5.88 |
| 3 | Semi evergreen | 2.90 |
| 4 | Eucalyptus plantation | 8.44 |
| 5 | Teak plantation | 43.44 |
| 6 | Silveroak plantation | 0.22 |

### Demography and habitation

Kuruman (Mullukuruman), Kattunaikan (Then Kuruman), Adiyan, Paniyan, Urali and Kurichiars are the tribals in the enclosures. Non-tribals like Wayanadan chetties, Gowdas, Christians and Muslims constitute about 40% of the population (Table. 6). In the fringes, the tribals form about 61% and non-tribals about 39%. The non-tribal dominate the population away from the forest. Region wise analysis shows

that tribal population is more in Northern Ranges (80%) followed by Central (67%) and Southern Ranges (50%). In the fringes, the tribal population is more in Southern Ranges (80%) than Central (61%) and Northern Ranges (54%). But the non-tribals dominate the population along the transects in all the three regions (Table 7).

**Table 6. Percentage of human population**

| | **Enclosure** | **Periphery** | **Transect** |
|---|---|---|---|
| Tribals | 59.79 | 61.08 | 10.41 |
| Non-tribals | 40.21 | 38.92 | 89.59 |

**Table 7. Details of human population in different ranges (%)**

| **Range** | **Enclosure** | | **Periphery** | | **Transect** | |
|---|---|---|---|---|---|---|
| | **Tribals** | **Non-tribals** | **Tribals** | **Non-tribals** | **Tribals** | **Non-tribals** |
| Southern | 50.24 | 49.76 | 79.30 | 20.70 | 11.04 | 88.96 |
| Central | 66.63 | 33.37 | 61.11 | 38.89 | 9.86 | 90.14 |
| Northern | 79.83 | 20.17 | 54.22 | 45.79 | 10.59 | 89.41 |

An analysis of the tribal population indicate an almost equal proportion of Kattunaikan and Kuruman in the enclosures (Table 8) Kattunaikans and Paniyans dominate the tribal population in the fringes where as Paniyan formed about 50% of the population along the transect.

**Table 8. Percentage of tribal population in Wayanad**

| **Caste** | **Enclosure** | **Periphery** | **Transect** |
|---|---|---|---|
| Kattunaikan | 33.99 | 28.42 | 5.95 |
| Kuruman | 30.12 | 19.63 | 23.78 |
| Paniyan | 20.29 | 24.78 | 50.27 |
| Adiyan | 5.49 | 10.95 | 15.68 |
| Urali | 3.83 | 5.37 | 0.00 |
| Kurichian | 6.27 | 10.85 | 4.32 |

The Hindus, Christians and Muslims constituting the non-tribals, along with

others within the enclosures are immigrants from the plains, settled long back. Hindus form 68.67% of non-tribals followed by 19.39% of Christians and 11.93% Muslims (Table 9). Christians are mostly from Travancore and Cochin where as Muslims immigrated from Malabar. Hindus have come from various places. The Gowadas and Chetties moved from the adjacent Karnataka State. The male-female proportion in the population is almost equal in enclosure, periphery and transect (Table 10).

**Table 9. Percentage of non-tribals in Wayanad**

| Caste | Enclosure | Periphery | Transect |
|---|---|---|---|
| Christian | 19.39 | 22.30 | 34.61 |
| Muslim | 11.93 | 2.98 | 19.35 |
| Hindu | 68.67 | 74.72 | 46.04 |

**Table 10. Percentage of males and females in the population**

| Sex | Enclosure | Periphery | Transect |
|---|---|---|---|
| **Over all** | | | |
| Male | 50.68 | 51.34 | 52.25 |
| Female | 49.92 | 48.66 | 47.75 |
| **Tribals** | | | |
| Male | 50.06 | 51.36 | 48.11 |
| Female | 49.94 | 48.64 | 51.89 |

**Land**

About 48% of the people within the enclosure have title deeds for their land Others are in lease, revenue or forest land (Table 11). Majority of the non-tribals is in patta or leased lands. Caste wise analysis of the tribals in enclosure shows that most of them are living in patta or leased lands. Nearly 25% of Kattunaikans are settled in reserve forest followed by Uralies (17%) and Paniyans (16%) (Table 12). Paniyans are settled in dry land and Kurumans in fertile wet land for crop cultivation. Wayanadan

chetties and Mullukurumans have forest leases. Leases have to be renewed annually by paying rent. Leases may not be sold or transferred to outsiders. However, there are many cases of leases being sold to outsiders mainly the immigrants.

**Table 11. Right of land in enclosure (in %)**

| Type | Overall | Non-tribals | Tribals |
|---|---|---|---|
| Title deed | 48.65 | 73.82 | 32.51 |
| Lease | 36.57 | 17.38 | 48.90 |
| Revenue | 5.11 | 6.65 | 4.13 |
| Reserve forest | 9.64 | 2.15 | 14.46 |

**Table 12. Right of land holdings (in %) in enclosures by tribals**

| Source | Kattu naikan | Kuruman | Paniyan | Adiyan | Urali | Kurichian |
|---|---|---|---|---|---|---|
| Title deed | 16.98 | 37.56 | 47.41 | 52.50 | 3.45 | 56.82 |
| Lease | 55.85 | 53.05 | 32.59 | 30.00 | 72.41 | 38.64 |
| Revenue | 1.89 | 5.63 | 3.70 | 10.00 | 6.90 | 4.55 |
| Reserve forest | 25.28 | 3.76 | 16.30 | 7.50 | 17.24 | 0.00 |

In the enclosures, about 72% of the settlers acquired the land by deforestation, 1.47% as dowry, 0.60% as compensation (resettled). About 81% of the tribals and 57% of non-tribals occupied the land by clearing the forest. The details are given in the Table 13. Caste wise analysis of the tribals in enclosure shows that most of them obtained the land by deforestation (Table 14).

**Table 13. Source of land in percentage (enclosure)**

| Source | Overall | Non-tribals | Tribals |
|---|---|---|---|
| Cleared the forest | 71.79 | 57.49 | 80.76 |
| Dowry | 1.47 | 2.46 | 0.84 |
| Compensation | 0.60 | 0.67 | 0.56 |
| Others | 26.14 | 39.37 | 17.86 |

**Table 14. Source of land in enclosures in Percentage (tribals)**

| Source | Kattu naikan | Kuruman | Paniyan | Adiyan | Urali | Kurichian |
|---|---|---|---|---|---|---|
| Cleared the forest | 79.92 | 84.88 | 75.56 | 81.58 | 96.55 | 70.73 |
| Dowry | 1.14 | 1.46 | 0.00 | 0.00 | 0.00 | 0.00 |
| Compensation | 1.14 | 0.00 | 0.74 | 0.00 | 0.00 | 0.00 |
| Others | 17.80 | 13.66 | 23.70 | 18.42 | 3.45 | 29.27 |

**Occupation**

The people living in the forest and outside areas have a wide range of employment pattern. An overall analysis shows that the main source of income of people living in enclosure, periphery and transect were from daily wage labour (coolies) followed by agriculture related works. Details of the occupation are given in Table 15.

**Table 15. Overall source of income (in percentage)**

| Sl.No | Source | Enclosure | Periphery | Transect |
|---|---|---|---|---|
| 1 | Cultivator | 30.94 | 34.04 | 58.57 |
| 2 | Cattle owner | 3.91 | 8.06 | 7.14 |
| 3 | Fire watcher –Forest | 10.29 | 4.70 | 0.24 |
| 4 | Daily wage labour | 46.62 | 51.40 | 26.43 |
| 5 | Fire wood collection | 1.12 | 0.45 | 0 |
| 6 | NWFP collection | 5.21 | 0.22 | 0 |
| 7 | Government employment | 1.61 | 1.12 | 5.24 |
| 8 | Merchant | 0.31 | 0 | 2.38 |

The main occupations of non-tribals in enclosure are agriculture related and the tribals depend on daily wages from different sources. The major crops cultivated are paddy, ginger, coffee, pepper, coconut, arecanut, plantain, tapioca, colacacia, alocacia, turmeric, green yam, vegetables, ragi, *etc*. The same pattern was observed in fringes and transects (Table 16).

**Table 16. Source of income in different locations**

| Sl.No. | Source | Tribals | Non-tribals |
|---|---|---|---|
| **Enclosure** | | | |
| 1 | Cultivation | 16.19 | 58.61 |
| 2 | Livestock | 2.78 | 6.04 |
| 3 | Fire watcher –Forest | 14.94 | 1.78 |
| 4 | Daily wage labour | 55.94 | 29.84 |
| 5 | Fire wood collection | 1.82 | 0.00 |
| 6 | NWFP collection | 1.82 | 0.36 |
| 7 | Government employees | 7.18 | 2.49 |
| 8 | Merchant | 1.15 | 0.89 |
| **Periphery** | | | |
| 1 | Cultivator | 22.51 | 51.11 |
| 2 | Cattle owner | 5.44 | 11.94 |
| 3 | Fire watcher –Forest | 6.75 | 1.67 |
| 4 | Daily wage labour | 64.16 | 32.50 |
| 5 | Fire wood collection | 0.75 | 0.00 |
| 6 | NWFP collection | 0.38 | 0.00 |
| 7 | Government employees | 0.00 | 2.78 |
| 8 | Merchant | 0.00 | 0.00 |
| **Transect** | | | |
| 1 | Cultivator | 25.00 | 62.83 |
| 2 | Cattle owner | 4.55 | 7.49 |
| 3 | Fire watcher –Forest | 0.00 | 0.27 |
| 4 | Daily wage labour | 65.91 | 21.12 |
| 5 | Fire wood collection | 0.00 | 0.00 |
| 6 | NWFP collection | 0.00 | 0.00 |
| 7 | Government employees | 4.55 | 4.81 |
| 8 | Merchant | 0.00 | 3.47 |

Paniyans, Uralis and Naikans were dependant on daily wage labour and the Kurumans and Kurichians on agriculture (Table 17).

**Table 17. Overall source of income of different communities (in percentage)**

| Source | Kattu-naikan | Kuruman | Paniyan | Adiyan | Urali | Kuric-hian | Non-tribals |
|---|---|---|---|---|---|---|---|
| Cultivation | 5.47 | 36.09 | 11.59 | 19.38 | 11.27 | 34.81 | 57.84 |
| Livestock | 1.70 | 5.52 | 1.66 | 5.43 | 1.41 | 10.37 | 8.11 |
| Fire watcher | 13.96 | 16.55 | 1.99 | 6.20 | 1.41 | 8.15 | 1.31 |
| Daily wage | 66.60 | 38.16 | 77.28 | 68.99 | 71.84 | 45.93 | 28.34 |
| Fire wood | 3.21 | 0.23 | 0.99 | 0.00 | 2.82 | 0.00 | 0.00 |
| NWFP | 8.49 | 1.38 | 5.96 | 0.00 | 11.27 | 0.00 | 0.00 |
| Governmente mployees | 0.57 | 2.07 | 0.33 | 0.00 | 0.00 | 0.74 | 3.24 |
| Merchant | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.16 |

**Education**

Among the tribals, Kuruman (64%) and Kurichians (57.84%) had the highest literacy rate. The non-tribals had a comparatively higher literacy rate. The details are given the Table 18. There are residential schools and tribal hostels in Wayanad. A number of voluntary organizations are currently working among the tribal people to promote education.

**Table 18. Literacy among different communities**

| Caste | Literacy % | Illiteracy % |
|---|---|---|
| Kattunaikan | 26.99 | 73.01 |
| Kuruman | 64.01 | 35.99 |
| Paniyan | 33.08 | 66.92 |
| Adiyan | 36.95 | 63.05 |
| Urali | 38.46 | 61.54 |
| Kurichian | 57.84 | 42.16 |
| Christian | 87.47 | 12.53 |
| Muslim | 80.63 | 19.37 |
| Hindu | 79.70 | 20.30 |

Most of tribals terminate schooling at the primary level. In enclosures, nearly 55.75% of the people are uneducated, compared to 44.55% in periphery and 16.33% along the transect (Table 19).

**Table 19. Education status (%)**

| Education | Enclosure | Periphery | Transect |
|---|---|---|---|
| Uneducated | 55.75 | 44.55 | 16.33 |
| 1-4 | 19.55 | 16.19 | 13.80 |
| 5-7 | 6.78 | 16.92 | 18.53 |
| 8-10 | 11.75 | 18.61 | 36.00 |
| Pre-degree | 4.67 | 3.31 | 1.01 |
| Degree | 1.13 | 0.49 | 0.95 |
| Post degree | 0.12 | 0.00 | 0.22 |
| Professional | 0.21 | 0.00 | 0.45 |

**House construction**

The design and mode of construction differ from one tribal community to another. The materials used also differ accordingly. Ninety-nine percentage of the people collected the construction materials from the forest and consists mainly of bamboo, grass and soil. Most of the tribal hamlets are thatched with grass (Table 20). Among the non-tribals, only 27.49% of the houses are thatched with grass. The materials used for the construction of wall is mainly bamboo and the floor is mainly of soil. Most of them have only 1 or 2 rooms. The details are given in Table 20. Agencies like bank, government agencies and voluntary organizations help the tribals in the form of money and material's for house construction. However, only 27.37% in enclosure, 17.98% in periphery and 41.17% out side areas received such assistance.

**Light and Water**

Kerosene is still the main source of light for majority of the people. About 89% of the settlers in enclosure, 91% in periphery and 59% away from the forest are using kerosene for lighting. Few people use traditional method of lighting. The details are given in Table 21.

**Table 20. Material used by tribals for house construction (in percentage)**

| Material | Kattunaikan | Kuruman | Paniyan | Adiyan | Urali | Kurichian | Non-tribals |
|---|---|---|---|---|---|---|---|
| **Roof** | | | | | | | |
| Grass | 45.08 | 56.65 | 30.06 | 65.71 | 43.75 | 65.79 | 27.49 |
| Tiles | 39.02 | 37.93 | 42.33 | 28.57 | 43.75 | 28.95 | 42.31 |
| Asbestos | 7.95 | 4.43 | 2.46 | 0 | 3.13 | 2.63 | 5.79 |
| Concrete | 3.41 | 0 | 6.13 | 0 | 0 | 0 | 4.70 |
| Others | 4.55 | 0.99 | 19.02 | 5.71 | 9.38 | 2.63 | 19.71 |
| **Wall** | | | | | | | |
| Soil | 22.72 | 40.75 | 24.70 | 25.29 | 23.68 | 29.07 | 16.64 |
| Stone | 8.88 | 8.30 | 10.84 | 10.34 | 2.63 | 4.65 | 2.84 |
| Bamboo | 41.78 | 23.40 | 33.13 | 55.17 | 42.11 | 47.67 | 24.57 |
| Others | 26.63 | 27.55 | 31.33 | 9.20 | 31.58 | 18.60 | 55.95 |
| **Floor** | | | | | | | |
| Soil | 97.16 | 95.60 | 98.25 | 96.30 | 62.96 | 94.74 | 65.41 |
| Cement | 2.84 | 4.40 | 1.75 | 3.70 | 37.04 | 5.26 | 34.59 |
| **No of rooms** | | | | | | | |
| 1 | 24.24 | 15.20 | 25.93 | 28.95 | 17.24 | 5.00 | 4.45 |
| 2 | 58.33 | 47.06 | 48.89 | 50.00 | 75.86 | 30.00 | 15.59 |
| 3 | 14.02 | 21.08 | 22.96 | 21.05 | 6.90 | 45.00 | 18.71 |
| 4 | 2.65 | 11.76 | 0.74 | 0 | 0 | 12.50 | 24.05 |
| Above 4 | 0.76 | 4.90 | 1.48 | 0 | 0 | 7.50 | 37.19 |

Tribals in the enclosures depend on Kerosene. Nearly 51% of Kattunaikans and few Kurichiars and Uralis still follow the traditional method of torches (locally called ‘Pantham’) (Table 22)

**Table 21. Source of light (%)**

| Source | Enclosure | Periphery | Transect |
|---|---|---|---|
| **Overall** | | | |
| Kerosene | 89.32 | 91.32 | 59.46 |
| Electricity | 7.63 | 7.63 | 40.27 |
| Solar | 1.53 | 0.75 | 0.27 |
| Others | 1.53 | 0.30 | 0.00 |
| **Tribals** | | | |
| Kerosene | 86.02 | 90.70 | 92.11 |
| Electricity | 11.35 | 5.81 | 7.89 |
| Solar | 0.26 | 3.26 | 0.00 |
| Others | 2.37 | 0.23 | 0.00 |
| **Non-tribals** | | | |
| Kerosene | 89.14 | 84.29 | 54.05 |
| Electricity | 10.20 | 13.79 | 45.66 |
| Solar | 0.67 | 1.53 | 0.29 |
| Others | 0.00 | 0.38 | 0.00 |

**Table 22. Source of lighting for tribals in enclosure (in percentage)**

| Source | Kattu naikan | Kuruman | Paniyan | Adiyan | Urali | Kurichian |
|---|---|---|---|---|---|---|
| Kerosene | 88.89 | 87.96 | 89.63 | 84.21 | 100 | 97.56 |
| Electricity | 4.07 | 6.94 | 9.63 | 13.13 | 0.00 | 0.00 |
| Solar | 1.85 | 4.63 | 0.00 | 0.00 | 0.00 | 0.00 |
| Others (Traditional) | 5.19 | 0.46 | 0.74 | 2.63 | 0.00 | 2.44 |

Overall analysis show that wells are the major source of drinking water for the people in the enclosures, periphery and transect. A few of them depend on streams and rivers. Small pits (locally called 'Keny') are dug near to streams and rivers for collection of drinking water. The details of analyses are summarized in Table 23.

**Table 23. Source of drinking water (in %)**

| Source | Enclosure | Periphery | Transect |
|---|---|---|---|
| **Overall** | | | |
| Well | 74.68 | 75.63 | 92.10 |
| Streams | 3.92 | 1.04 | 1.09 |
| River | 5.12 | 2.08 | 1.91 |
| Others (pit) | 16.28 | 21.25 | 4.90 |
| **Tribals** | | | |
| Well | 68.85 | 77.88 | 86.84 |
| Streams | 4.51 | 1.68 | 0.00 |
| River | 6.28 | 1.92 | 7.89 |
| Others (pit) | 19.13 | 18.51 | 5.26 |
| **Non-tribals** | | | |
| Well | 82.67 | 71.98 | 92.71 |
| Streams | 2.89 | 0.00 | 1.22 |
| River | 3.11 | 2.33 | 1.22 |
| Others (pit) | 11.33 | 25.68 | 4.86 |

An overall analysis of the data from enclosures show that wells are the main source of drinking water followed by small pits. The details are given in Table 24.

**Table 24. Source of drinking water for tribals in enclosure (in percentage)**

| Source | Kattu naikan | Kuruman | Paniyan | Adiyan | Urali | Kurichian |
|---|---|---|---|---|---|---|
| Well | 67.42 | 73.08 | 73.91 | 56.41 | 76.67 | 60.98 |
| Streams | 7.12 | 2.88 | 3.62 | 0.00 | 6.67 | 2.44 |
| River | 8.24 | 3.37 | 7.97 | 7.69 | 3.33 | 4.88 |
| Others (pit) | 17.23 | 20.67 | 14.49 | 35.90 | 13.33 | 31.71 |

## Health

The health conditions of the tribals are very poor. Mortality is common among the tribal especially the Kattunaikans. The common health problems are diarrhea, anemia due to malnutrition and infections.

**Table 25. Details of medical attention (in percentage)**

| | Enclosure | Periphery | Transect |
|---|---|---|---|
| **Overall** | | | |
| Allopathy | 55.75 | 75.15 | 70.45 |
| Ayurvedic | 25.18 | 14.27 | 18.59 |
| Homeo | 9.82 | 3.80 | 9.00 |
| Traditional | 8.78 | 6.18 | 1.17 |
| Others (Pray) | 0.47 | 0.59 | 0.78 |
| **Tribals** | | | |
| Allopathy | 57.58 | 72.73 | 86.36 |
| Ayurvedic | 20.28 | 14.02 | 4.55 |
| Homeo | 6.97 | 3.03 | 9.09 |
| Traditional | 14.11 | 10.23 | - |
| Others (Pray) | 1.06 | 0.00 | - |
| **Non-tribals** | | | |
| Allopathy | 52.27 | 79.23 | 69.10 |
| Ayurvedic | 31.82 | 14.70 | 20.3 |
| Homeo | 13.01 | 5.11 | 9.44 |
| Traditional | 2.65 | 0.96 | 1.07 |
| Others (Pray) | 0.25 | - | - |

The basic factors responsible for the health problem are lack of proper sanitation and unhygienic conditions, addiction to smoking, alcohol, tobacco chewing, irregular food habits, etc. Overall analysis show that 55.75% of settlers in enclosure, 75.15% in periphery and 70.45% in transect depend on allopathy for treatment. Only few people depend on traditional methods. The details are given in Tables 25 and 26. Voluntary organizations and Tribal Development Departments are working in the enclosures to make the people aware of the importance of health care. Primary health

centers are functioning in several settlements. Infant mortality rate is high among the tribals and they have no easy access to hospitals because most of the remoteness of the settlement.

**Table 26. Medical attention among the tribals in enclosure (%)**

| | Kattu naikan | Kuruman | Paniyan | Adiyan | Urali | Kurichian |
|---|---|---|---|---|---|---|
| Allopathy | 53.21 | 58.21 | 56.36 | 94.87 | 56.25 | 61.29 |
| Ayurvedic | 18.12 | 22.39 | 20.00 | 2.56 | 35.42 | 22.58 |
| Homeo | 7.57 | 11.34 | 4.55 | 0.00 | 0.00 | 6.45 |
| Traditional | 19.27 | 7.46 | 19.09 | 0.00 | 6.25 | 9.68 |
| Others (Pray) | 1.84 | 0.60 | 0.00 | 2.56 | 2.08 | 0.00 |

**Food habits**

Majority of the settlers are non-vegetarians (Table 27). They consume meat of buffalo, cow, goat, wild animals and fish. Fresh water fishes are mainly collected from the streams and rivers. Vegetables are mostly purchased from the market.

Thirty three percentage of the people in the enclosures, 20% in the people fringes and 34% along transects cultivate vegetables for their own purpose (Table 28). Dependence on forest for food materials is negligible. The leaves of *Cassia tora*, tender leaves of ferns, fresh shoots of bamboo, etc. are collected from the forests for consumption.

**Table 27. Food habits of the respondents**

| | Enclosure | Periphery | Transect |
|---|---|---|---|
| **Overall** | | | |
| Vegetarian | 0.43 | 0.75 | 1.37 |
| Non-vegetarian | 99.57 | 99.25 | 98.63 |
| **Tribals** | | | |
| Vegetarian | 0.28 | 0.24 | 0 |
| Non-vegetarian | 99.72 | 99.76 | 100.00 |
| **Non-tribals** | | | |
| Vegetarian | 0.67 | 1.56 | 1.52 |
| Non-vegetarian | 99.33 | 98.44 | 98.48 |

**Table 28. Source of vegetables**

| Source | Enclosure | Periphery | Transect |
|---|---|---|---|
| Cultivation | 32.91 | 19.90 | 33.76 |
| Market | 57.35 | 66.87 | 65.88 |
| Collected from forest | 9.74 | 13.23 | 0.36 |

**Agriculture**

The people of Wayanad are predominantly agriculturists. Land use varies with community, size of land-holding and the proportion of dry and wet lands. Agriculture is characterized by a mixture of subsistence farming and mixed cash crops. Cultivation is one of the major source of income and the crops cultivated are paddy, ginger, ragi, pepper, coffee, plantain, coconut, arecanut, vegetables, tapioca, jack tree, etc. The agricultural implements mainly used are spade, pick-axe, iron rod, knife, and shovel. The percentage share of each equipment in agricultural practice in enclosure, periphery and transect are summarized in Table 29.

Most of the people had their own equipments and are purchased from out side (Table 30). Modern agricultural implements like tractor were used together with the traditional methods like buffalo and bullock. The percentage uses of modern implements in agriculture are summarized in Table 31.

**Table 29. Details of implements used for agriculture purpose (in percentage)**

| Implements | Enclosure | Periphery | Transect |
|---|---|---|---|
| Spade | 65.34 | 76.61 | 58.35 |
| Pick-axe | 9.22 | 3.71 | 21.65 |
| Iron rod | 11.30 | 2.72 | 14.88 |
| Others (Knife, shovel) | 14.14 | 16.96 | 5.12 |

**Table 30. Source of agricultural implements used (in Percentage)**

| Source | Enclosure | Periphery | Transect |
|---|---|---|---|
| Own made | 3.11 | 0.80 | 0.81 |
| Borrowed | 4.57 | 1.76 | 3.52 |
| Purchased from Outside | 92.32 | 97.44 | 95.66 |

**Table 31. Percentage of modern implements used for ploughing**

| Source | Enclosure | Periphery | Transect |
|---|---|---|---|
| Tractor | 7.82 | 6.38 | 14.84 |
| Buffalo | 7.48 | 3.52 | 2.47 |
| Bullock | 21.12 | 19.27 | 15.05 |
| Spade | 63.58 | 70.83 | 67.63 |

**Table 32. Source of implements for ploughing (in %)**

| Source | Enclosure | Periphery | Transect |
|---|---|---|---|
| Issued by Government | 0.61 | 0.00 | 0.00 |
| Borrowed | 18.58 | 14.72 | 28.30 |
| Purchased from outside | 77.34 | 84.82 | 71.46 |
| Others (Helped by others) | 3.47 | 0.46 | 0.24 |

Most of the agricultural implements are purchased from outside though a few borrow from their neighbors. Very few people go for help from others for ploughing. The various sources of implements in enclosure, periphery and transect are summarized in Table 32. The agricultural practices in Wayanad are dependent mainly on rainfall. However, some them have diesel pump sets for irrigation. Others depend on the near by streams and rivers for irrigation (Table 33). Pesticides and fertilizers are used in the cultivation. Only a small proportion uses the seeds of high yielding varieties. The use of all these are more or less same in enclosure, periphery and away from the forest (Table 34).

**Table 33. Percentage of various source of water for irrigation**

| Source | Enclosure | Periphery | Transect |
|---|---|---|---|
| Pump set | 4.89 | 2.98 | 2.17 |
| Streams | 25.69 | 16.99 | 13.59 |
| Weather | 69.42 | 80.03 | 84.24 |

**Table 34. Percentage use of modern agriculture practices**

| Method | Enclosure | Periphery | Transect |
|---|---|---|---|
| Pesticides | 35.48 | 33.81 | 42.98 |
| Fertilizers | 50.95 | 58.99 | 49.90 |
| Hybrid seeds | 13.57 | 7.19 | 7.13 |

**Table 35. Percentage use of agriculture loans for various purpose**

| | Enclosure | Periphery | Transect |
|---|---|---|---|
| Fertilizer | 39.88 | 53.73 | 31.18 |
| Pesticides | 19.65 | 28.36 | 23.66 |
| Seeds | 16.76 | 1.49 | 26.88 |
| Pump set | 2.02 | 1.49 | 1.08 |
| Wages | 6.94 | 3.48 | 3.23 |
| Cattles | 14.74 | 11.44 | 13.98 |

Agricultural loans are also available for purchase of fertilizer, pesticides, seeds, pump-set and cattles (Table 35). Voluntary agencies, bank, private agency and co-operative societies are the sources for agricultural loans (Table 36).

**Table 36. Source of agriculture loans (in percentage)**

| Source | Enclosure | Periphery | Transect |
|---|---|---|---|
| Voluntary agency | 3.16 | 0.00 | 1.32 |
| Bank | 86.84 | 74.59 | 89.47 |
| Private agency | 6.84 | 14.75 | 9.21 |
| Co-operative society | 3.16 | 10.66 | 0.00 |

Crop damage is a severe problem in most of the settlements. Animals responsible for crop damage problems were wild boar, elephant, porcupine, sambar, spotted deer, common langur and bonnet macaque (Table 37). Marginal increases in crop raiding incidences have been reported by majority of the respondents in the enclosures as well as periphery. About 73.53% of respondents opined that crop damage was more in rainy season. Even though most of them are aware of the compensation provisions, only a smaller proportion of the affected parties avail the facility mainly because of the procedural complexity. No compensation is paid for damages due to wild boar and people having the licensed gun are not eligible for compensation.

**Table 37. Animals responsible for crop damage (% of respondents)**

| Animals | Enclosure | Periphery | Transect |
|---|---|---|---|
| Wild boar | 42.54 | 32.82 | 68.32 |
| Elephant | 49.83 | 64.08 | 29.81 |
| Porcupine | 0.11 | 0.00 | 0.00 |
| Sambar deer | 0.44 | 0.26 | 0.62 |
| Spotted deer | 1.77 | 0.52 | 0.00 |
| Common langur | 0.11 | 0.00 | 0.00 |
| Bonnet macaque | 5.19 | 2.33 | 1.24 |

A questionnaire survey among the farmers in the enclosures indicate that about 52% of them had paddy cultivation about 10 years back. About 18% of them have abandoned paddy cultivation. However, about 6% of the farmers initiated paddy cultivation recently (Table 38). Though a number of farmers shifted from ginger to some other crops during the last 10 years (11% reduction), an additional 35.43% started cultivating ginger. About 10 to 14% of the farmers cultivating pepper, coffee, plantain and coconut abandoned these. While a considerable increase in these plantation was recorded because a number of people started these afresh.

**Table 38. Changes in crops cultivated during the last ten years in Wayanad**

| | Enclosure | | Periphery | | Transect | |
|---|---|---|---|---|---|---|
| Crops | % of the farmers with cultivation 10 years back | Newly started (% of the farmers ) | % of the farmers with cultivation 10 years back | Newly started (% of the farmers ) | % of the farmers with cultivation 10 years back | Newly started (% of the farmers ) |
| Paddy | 52.06 (82.62) | 5.94 | 39.67 (81.50) | 17.73 | 33.78 (78.22) | 13.62 |
| Ginger | 30.60 (83.10) | 35.43 | 13.62 (81.31) | 39.97 | 28.97 (88.18) | 40.05 |
| Pepper | 26.81 (86.50) | 28.18 | 14.82 (90.90) | 42.81 | 46.59 (93.56) | 37.60 |
| Coffee | 25.08 (91.07) | 22.06 | 13.77 (89.13) | 34.73 | 45.77 (92.26) | 36.23 |
| Plantain | 21.99 (90.98) | 30.17 | 9.88 (86.36) | 57.18 | 40.59 (91.27) | 31.33 |
| Coconut | 10.60 (86.99) | 31.46 | 6.58 (90.90) | 36.82 | 25.88 (94.73) | 52.86 |

Figures in parantheses denoted the percentage of the farmers who had paddy 10 years back and still continuing the same crops

In periphery also, the tendency of shifting from one crop to some other due to various reasons was observed (Table 38). But the percentage of farmers who have initiated cultivation of crops other than paddy during the last 10 years was remarkable. Only 7% increase was recorded in the case of paddy. This pattern was true for the area away from the forest also but for increased number of person engaged in paddy cultivation.

Majority of respondents attributed the crop damage 10 years back to a number of animal including elephant, wild boar, deer and monkeys. However, elephant and wild boar topped among the most damaging ones. Interestingly, the number of respondent finding elephant as responsible in the past was high among those residing away from the forest. This was true in the case of wild boar also. The number of

respondents holding wild boar responsible for crop damage increased from enclosures to periphery and then far away places (Table 39). The deer and monkeys were less problematic.

**Table 39. Crop damage by animals – a comparison of the past with present (% of respondents)**

| Animals | Enclosure | Periphery | Transect |
|---|---|---|---|
| Elephant | 40.55 (38.08)* | 41.66 (12.92) | 48.21 (28.13) |
| Gaur | 1.56 (0.05) | 1.30 (0.30) | 2.86 (0.00) |
| Wild boar | 30.46 (35.91) | 40.76 (40.21) | 41.79 (63.84) |
| Deer | 13.94 (12.57) | 6.09 (7.23) | 2.50 (2.24) |
| Monkeys | 13.50 (12.84) | 10.19 (9.33) | 4.64 (5.80) |
| Birds | 0.00 (0.16) | 0.00 (0.00) | 0.00 (0.00) |
| Porcupine | 0.00 (0.38) | 0.00 (0.00) | 0.00 (0.00) |

* Figures in perantheses denote the present

**Fishing**

The people in the enclosures (61%), periphery (78%) and away (93%) from the forest had a preference marine fishes.

The entire forest is the catchment area of Kabini, a tributary of the Cauvary River. A number of tributaries like Noolpuzha, Mavinahalla, Kurichiat puzha, Golur, Baveli, Ammavayal and Begur drain to Kabini. All these streams are diverse in terms of both fishes and turtles. Most of the people are living near the streams/ rivers.

Nearly 42% of people in enclosure, 71% in periphery and 88% away from the forest obtain fishes from market. The remaining collect the fishes from streams, rivers and lakes in and around the forest. The details are summarized in Table 40.

**Table 40. Source of fresh water fishes (in percentage)**

| Source | Enclosure | Periphery | Transect |
|---|---|---|---|
| Streams | 20.45 | 7.53 | 5.73 |
| River | 37.03 | 31.07 | 6.17 |
| Lake | 0.08 | 0.00 | 0.44 |
| Market | 42.44 | 71.40 | 87.67 |

Both the tribals and non-tribals (Table 41) employ different types of fishing methods. Conventional methods like bund making and sieving are mostly adopted by tribals.

**Gears**: - Different types of gears are used. An overall analysis showed that 22% of the people in enclosure, 87% in periphery and 16% in transect employed this method.

**Trap**: - Both tribals and non-tribals used this traditional method. An overall analysis showed that traps are used in enclosure (16%), periphery (21%) and transect (9%).

**Rod and line**: - People in the periphery (44%) use rod and line to a great extent compared to those along the transect and in enclosures. Earth worms, frogs, fruits and flowers are the baits commonly used.

**Bund**: - Temporary bunds were constructed for trapping the fishes. Stone and leaves are used for constructing the bund. This method was mainly employed in summer season. Both tribals and non-tribals employed this method. Twenty two percentage of people in the enclosure, 7% in periphery and 15% along the transect employed this method.

**Sieving**: - Both the tribal and non-tribals used cloth for the collection of small fishes. About 14% of the people in the enclosure used this method.

**Dynamite (**Locally called **Thotta)**: This is a destructive method of fishing used both by the tribals and non-tribals. This method is mainly employed in summer season. However, only very few go for this method.

**Poisoning**: - This is another destructive method. The fruits of *Randia brandis*, *Sapinelus* sp. *Hydnocarpus pentandra*, bark of *Syzigium carophyllaeum*, *Acatia ruguta* are mainly used for poisoning the fishes during summer season.

**Table 41. Percentage of respondent using different fishing methods**

| Method | Enclosure | Periphery | Transect |
|---|---|---|---|
| **Overall** | | | |
| Gears | 22.48 | 7.38 | 15.56 |
| Trap | 15.84 | 20.92 | 8.89 |
| Rod and line | 21.87 | 43.69 | 37.78 |
| Poisoning | 4.02 | 0.92 | 0.00 |
| Dynamiting | 2.19 | 5.54 | 6.67 |
| Sieving | 14.26 | 9.85 | 8.89 |
| Bund | 19.34 | 11.69 | 22.22 |
| **Tribals** | | | |
| Gears | 15.69 | 6.69 | 26.32 |
| Traps | 11.26 | 22.18 | 21.05 |
| Rod and line | 33.31 | 42.61 | 26.32 |
| Poisoning | 3.38 | 0.00 | 0.00 |
| Dynamiting | 7.40 | 4.93 | 0.00 |
| Cloth | 12.95 | 10.56 | 5.26 |
| Bund | 16.01 | 13.03 | 21.05 |
| **Non-tribals** | | | |
| Gears | 24.39 | 12.20 | 7.41 |
| Trap | 17.48 | 12.20 | 3.70 |
| Rod and line | 43.09 | 51.22 | 40.74 |
| Poisoning | 0.81 | 7.32 | 0.00 |
| Dynamiting | 2.03 | 9.76 | 14.81 |
| Sieving | 3.25 | 4.88 | 11.11 |
| Bund | 8.94 | 2.44 | 22.22 |

The survey reveal that most of the methods adopted by both the tribals and non-tribals are not eco-friendly. About 99% of the respondents go for fishing for their own consumption (Table 42).

**Table 42. Purpose of fishing (% of respondents)**

| Purpose | Enclosure | Periphery | Transect |
|---|---|---|---|
| Sale | 0.86 | 0.30 | 0.82 |
| Own use | 99.14 | 99.70 | 99.18 |

**Hunting**

Even though hunting is banned totally, some of the settlers practice it occasionally. Many settlers controlled the crop damage by hunting problematic animals like deer, wild boar and monkeys. Many of them have guns and hunting is done in groups. They hunt and consume wild boar, spotted deer, sambar deer, flying squirrel, Malabar giant squirrel, barking deer, mouse deer, black naped hare, mangoose and mouse deer (Table 43). Traps were used for capturing smaller mammals like black naped hare, mouse deer, mongoose, *etc*. Birds were captured by using small sticks containing adhesive substance, kept on the trees.

**Table 43. Percentage of respondents going for hunting animals**

| Animal | Enclosure | Periphery |
|---|---|---|
| Wild boar | 23.41 | 32.38 |
| Sambar deer | 6.49 | 7.62 |
| Spotted deer | 31.05 | 30.48 |
| Bonnet macaque | 0.00 | 0.95 |
| Gaur | 4.64 | 1.90 |
| Jungle fowl | 4.52 | 1.90 |
| Hare | 20.05 | 14.29 |
| Civet | 0.46 | 0.00 |
| Barking deer | 5.33 | 7.62 |
| Birds | 1.39 | 0.00 |
| Rat | 0.35 | 0.00 |
| Porcupine | 0.35 | 2.86 |
| Monitor lizard | 0.24 | 0.00 |
| Flying squirrel | 1.62 | 0.00 |
| Giant squirrel | 0.12 | 0.00 |

People staying in enclosures and the fringes of the forest hunt more. About 25%

of the people in the enclosures are engaged in hunting of whom 35% belong to tribal communities. In periphery, 3.89% go for hunting out of which 5.34% were tribals (Table 43). Hunting is reported to be for own consumption

Bow and arrow are used extensively both in the enclosures (67.16%) and periphery (84.21%). The people in the enclosures (20.15%) and periphery (5.26%) also used crackers as explosives (Table 44). The tribals consume the deer and wild boar, which were predated upon by tiger and leopard.

Among the tribals, there are festivals related to hunting namely 'Thulampath' and 'Uchal'. This is mainly celebrated by Mullukurumans. During the particular day, they went to the forest as groups for hunting and share the flesh of hunted animals. Other tribal communities also accompany them. Bow and arrow are used for hunting in these days. About 3% of the tribals in enclosures and 3.5% in periphery used to go for hunting on this particular day.

**Table 44. Methods used for hunting (% of respondents)**

| Method | Enclosure | Periphery |
|---|---|---|
| **Overall** | | |
| Gun | 12.69 | 10.53 |
| Bow and arrow | 67.16 | 84.21 |
| Crackers | 20.15 | 5.26 |
| **Tribals** | | |
| Gun | 8.77 | 9.68 |
| Bow and arrow | 74.56 | 87.10 |
| Crackers | 16.67 | 3.23 |
| **Non-tribals** | | |
| Gun | 31.82 | 14.29 |
| Bow and arrow | 45.45 | 71.43 |
| Crackers | 22.73 | 14.29 |

**Religious and cultural activities**

The people belonging to tribal and other Hindu communities have cultural and religious association with the forest area. There are a number of small temples and sacred places through out. Each community has its own festivals, ''Uchal' and 'Thulampath' are famous among them. These two festivals are celebrated mainly by Mullukurumans. Information collected from other sources reported fishing and hunting using trained dogs are engaged for detecting wild boar, deer and other small mammals. The festivals at Valliyurkavu in Manathavady and Seetha Devi temple festival in Pulpally are yet other famous celebrations.

**Cattle lifting, human death and house damage**.

Cattle lifting incidences in Wayanad were comparatively few and were by panther (*Panthera pardus*), Tiger (*Panthera tigris*) and wild dog (*Cuon alpinus*). Most of the incidences occurred at night or rarely when the cattle went for grazing in the forest areas during daytime. Panther and tiger preyed upon goat, cow and dog. Wild dogs preferred goats and cow calves. Incidences of two cows being killed by a solitary tusker was also reported near Erulam of Chedleth Range. Cattle lifting were more in the enclosures (68.50) than periphery (25.96%) and away from the forest (5.52%).

Human casualties' by elephant is common in Wayanad. About 73% of human deaths reported were inside the forest, 36% near to forest and 9% on roads while passing through the Sanctuary. Solitary tuskers were responsible for most of the deaths. Only seventy percentage of the cases were compensated.

House damage by elephant was also reported by respondents. Damages in enclosure (91.66%) were higher than periphery (5.55%) and away from forest (2.77%). Only 27.27% of the affected were compensated.

**Forest dependence**

Firewood was collected for both domestic use and sale in hotels and teashops in and around. Ninety eight percentage of the people collected firewood for self use and only 2% for sale. Thirty different species were exploited for firewood. People living near to the plantations are mainly depending on teak and eucalypts.

About 70% of the people in the enclosures, 80% in periphery and 25.36% along in Southern Ranges transect depend on forest for firewood. Dependence by tribals were higher than the non-tribals irrespective of location of the houses. The people even from half a kilometer away depend a lot on the forest for firewood (Table 45, 46 and 47).

The people in the enclosures and surroundings in Central Range depend almost exclusively on forest for their firewood requirement (Tables 49, 50 and 51). Almost the entire population in the enclosures and in fringes meet their firewood demand from the forests in Northern Ranges. The number of people residing away and depending on firewood supply from the forest was comparatively high in this area (Table 45, 46, 47 ).

NWFP (Non Wood Forest Products) is the main source of income for the tribals. The major items of NWFP collected from the forest were honey, wax, soapnut, pepper, cheevakai, wild ginger, turmeric and medicinal plants like *Rauvolfia Serpantina, Sida rhombifolia, Desmodium gangeticum, Desmodium velutinum, Solanum torvum, Pseudarthria viscida, Emblica officinalis*, etc. Honey is mainly collected by Kattunaikans and the area of operation extend even to the forests of Tamil Nadu and Karnataka. Mostly the women engage themselves in collection of medicinal plants.

Only a small proportion of the population is engaged in NWFP collection in Southern range and majority of them are tribals.

Only 17% of people in the enclosures and 5.39% in periphery go for NWFP collection in Central range. People along the transect are not involved in NWFP

collection. A higher proportion of the people in the Northern Ranges are involved in NWFP collection. This was 74% in the enclosures, 12.42% in periphery and 1.82% along transect.

The design and mode of construction of house differ from one community to another. Most of the tribal houses were tatched and consists of only 1 or 2 rooms. The materials for construction such as bamboo, grass, etc are mostly collected from the forest. About 55% of the people in the enclosures, 53% periphery and 23% along transect in Southern Ranges depend on forest for the construction materials. Tribals in the enclosures, periphery and transect depend exclusively on the forests (Tables 45, 46, 47 & 48).

In Central Range, the dependence on forest for house construction materials were comparatively higher in enclosures 61%, periphery 61%. However, only a few from faraway places depended the forest for construction materials. The dependence by tribals were comparatively higher (Tables 49-52).

Dependence on forest for house constriction material was higher in the enclosures in the Northern Range. This was 87% in enclosures, 75% in periphery and 31% along the transect (Tables 53-56). Materials from the forest do not contribute much to the food of the people in Wayanad. However, the traditional method is still followed to a certain expects. The main food materials collected from the forest include mushrooms, tubers, fruits, leaves and tender bamboo shoots. Tender bamboo shoots are collected during the monsoon season.

About 47% of the people in the enclosures, 90% in periphery and 12% along transect collect food materials in Southern Ranges. This was about 93%. in enclosure, 72% in periphery and 6% along the transect in Central Range. Food gathering was prevalent more in the Northern Ranges. Ninety six percentage of people in the enclosures, 76.47% in periphery and 35% along the transect depending forest for food

gathering in Northern ranges.

Forty three percentage of people in the enclosures, 13.73% in periphery and 2.90% along the transect n Southern Ranges depend on the streams and rivers in the forest.In Central Range, 77% of the people in the enclosures, 26.08% in periphery and 8.05% along the transect go for fishing (Table 110, 111 and 112). Fishing was not a major activity of the people in the Northern Ranges (Table 49, 50 and 51).

**Table 45. Forest dependence in the enclosures in Southern Ranges**

| Caste | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| **Tribals** | 333 | 91.89 | 62.88 | 39.34 | 66.67 | 94.59 | 70.87 |
| Non-tribals | 326 | 47.55 | 22.08 | 4.91 | 42.94 | 53.37 | 15.03 |
| Combined | 659 | 69.95 | 36.56 | 22.31 | 54.93 | 47.20 | 43.25 |

**Table 46. Forest dependence in the periphery in Southern Ranges**

| Caste | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| Tribals | 40 | 97.50 | 75.00 | 20.00 | 60.00 | 100 | 17.50 |
| Non-tribals | 11 | 18.18 | 44.44 | 0.00 | 27.27 | 54.55 | 0.00 |
| Combined | 51 | 80.39 | 64.00 | 15.69 | 52.94 | 90.20 | 13.73 |

**Table 47. Forest dependence along the transect in Southern Ranges**

| Caste | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| Tribals | 14 | 71.43 | 33.33 | 0.72 | 35.71 | 42.86 | 14.29 |
| Non-tribals | 124 | 20.16 | 26.09 | 0.00 | 21.77 | 8.06 | 1.61 |
| Combined | 138 | 25.36 | 26.53 | 0.72 | 23.19 | 11.59 | 2.90 |

**Table 48. Forest dependence along the transect in Southern Ranges**

| Transect point | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| 0-250 | 43 | 37.21 | 37.93 | 0.00 | 18.60 | 20.93 | 2.33 |
| 250-500 | 29 | 17.24 | 18.18 | 3.45 | 31.03 | 6.90 | 0.00 |
| 500-750 | 32 | 31.25 | 33.33 | 0.00 | 21.88 | 6.25 | 6.25 |
| 750-1000 | 34 | 11.76 | 15.38 | 0.00 | 23.53 | 8.82 | 2.94 |

**Table 49. Forest dependence in the enclosures in Central Range**

| Caste | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| Tribals | 152 | 97.37 | 19.18 | 23.68 | 66.45 | 98.68 | 81.48 |
| Non-tribals | 74 | 64.86 | 7.81 | 4.05 | 50.00 | 83.78 | 58.11 |
| Combined | 226 | 86.73 | 13.87 | 17.26 | 61.06 | 93.81 | 77.43 |

**Table 50. Forest dependence in periphery in Central Range**

| Caste | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| Tribals | 289 | 91.70 | 39.56 | 7.96 | 64.36 | 91.35 | 38.41 |
| Non-tribals | 175 | 52.57 | 28.70 | 1.14 | 54.29 | 38.86 | 5.71 |
| Combined | 464 | 76.94 | 33.50 | 5.39 | 60.56 | 71.55 | 26.08 |

**Table 51. Forest dependence along the transect in Central Range**

| Caste | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| Tribals | 16 | 75.00 | 60.00 | 0.00 | 12.50 | 62.50 | 50.00 |
| Non-tribals | 158 | 15.82 | 6.25 | 0.00 | 17.09 | 0.63 | 3.80 |
| Combined | 174 | 21.26 | 10.66 | 0.00 | 16.67 | 6.32 | 8.05 |

**Table 52. Forest dependence along the transect in Central Range**

| Transect point | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| 0-250 | 61 | 29.51 | 20.00 | 0.00 | 26.23 | 9.84 | 9.84 |
| 250-500 | 43 | 16.28 | 10.71 | 0.00 | 11.63 | 6.98 | 6.98 |
| 500-750 | 31 | 25.81 | 8.70 | 0.00 | 16.13 | 3.23 | 6.45 |
| 750-1000 | 39 | 10.26 | 0.00 | 0.00 | 7.69 | 2.56 | 7.69 |

**Table 53. Forest dependence in the enclosures in Northern Ranges**

| Caste | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| Tribals | 227 | 96.48 | 89.74 | 74.89 | 89.43 | 97.80 | 70.93 |
| Non-tribals | 48 | 87.50 | 52.38 | 70.83 | 77.08 | 89.58 | 64.58 |
| Combined | 275 | 94.91 | 79.87 | 74.18 | 87.27 | 96.36 | 69.82 |

**Table 54. Forest dependence in periphery in Northern Ranges**

| Caste | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| Tribals | 83 | 97.59 | 82.61 | 18.07 | 75.90 | 97.59 | 30.12 |
| Non-tribals | 70 | 72.86 | 33.33 | 5.71 | 74.29 | 51.43 | 25.71 |
| Combined | 153 | 86.27 | 50.00 | 12.42 | 75.16 | 76.47 | 28.10 |

**Table 55. Forest dependence along the transect in Northern Ranges**

| Caste | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| Tribals | 8 | 100.00 | 0.00 | 12.50 | 37.50 | 75.00 | 75.00 |
| Non-tribals | 47 | 48.94 | 11.11 | 0.00 | 29.79 | 27.66 | 12.77 |
| Combined | 55 | 56.36 | 10.81 | 1.82 | 30.91 | 34.55 | 21.82 |

An estimated 3500 cattles and goats graze in the forest in Wayanad. Most of the cattles are of poor breed

**Table 56. Forest dependence along the transect in Northern Ranges**

| Transect point | N | Fire wood % | Grazing % | NWFP % | House % | Food % | Fishing % |
|---|---|---|---|---|---|---|---|
| 0-250 | 15 | 33.33 | 15.38 | 0.00 | 20.00 | 26.67 | 6.67 |
| 250-500 | 13 | 69.23 | 14.29 | 0.00 | 38.46 | 46.15 | 23.08 |
| 500-750 | 16 | 62.50 | 9.09 | 6.25 | 31.25 | 25.00 | 18.75 |
| 750-1000 | 11 | 63.64 | 0.00 | 0.00 | 36.36 | 45.45 | 45.45 |

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About 57% of the respondent in the enclosures in Southern Ranges own cattle. Out of the 74% of the non-tribal having cattle, about 22% leave the cattle in the forest for grazing. However, only 45% of the non-tribals in the periphery leave the cattle in the forest for grazing (Table 57 & 58).

The dependence of tribals on forest for cattle grazing was comparatively higher. This was about 63% in the enclosures and 75% in periphery. Others either stall feed or depend on homestead or other source for cattle feed. About 27% of the cattle owners along the transect in Southern Ranges depend on the forest for feeding (Table 59)

The number of tribals as well as non-tribal with cattles depending on the forest for grazing is higher both in the enclosures and in periphery in Northern ranges (Table 60 & 61). Interestingly, even the people in the outskirts sent their cattle to the forest in this range (Table 62).

In Central range, the number of persons having cattles were comparatively higher. About 87% of the non-tribals and 48% of the tribals in the enclosures have cattle (Table 63). However, only very few depend on forest for cattle grazing. The dependence on forest by cattle owners in the periphery are considerable higher (Table 64). Those in the outskirts do not depend much on the forest for cattle grazing (Table 65).

**Table 57. Details of live-stock and the mode of feeding in Southern Ranges (enclosure)**

| Caste | N | % of having cattle | Forest | Stall feeding | Other sources |
|---|---|---|---|---|---|
| Tribals | 333 | 36.63 | 62.88 | 2.27 | 34.85 |
| Non-tribals | 326 | 73.61 | 22.08 | 20.42 | 57.50 |
| Combined | 659 | 56.44 | 36.56 | 13.98 | 49.46 |

**Table 58. Details of live-stock and the mode of feeding in Southern Ranges (periphery)**

| Caste | N | % of having cattle | Forest | Stall feeding | Other sources |
|---|---|---|---|---|---|
| Tribals | 40 | 40.00 | 75.00 | 6.25 | 18.75 |
| Non-tribals | 11 | 81.81 | 44.44 | 11.11 | 44.44 |
| Combined | 51 | 49.01 | 64.00 | 8.00 | 28.00 |

**Table 59. Details of live-stock and the mode of feeding in Southern Ranges (Transect)**

| Caste | N | % of having cattle | Forest | Stall feeding | Other sources |
|---|---|---|---|---|---|
| Tribals | 14 | 42.85 | 33.33 | 0.00 | 66.67 |
| Non-tribals | 124 | 74.19 | 26.09 | 1.09 | 73.91 |
| Combined | 138 | 71.01 | 26.53 | 1.02 | 73.47 |

**Table 60. Details of live-stock and the mode of feeding in Northern Ranges (enclosures)**

| Caste | N | % of having cattle | Forest | Stall feeding | Other sources |
|---|---|---|---|---|---|
| Tribals | 227 | 57.54 | 89.74 | 0.85 | 9.40 |
| Non-tribals | 48 | 87.50 | 52.38 | 0.00 | 47.62 |
| Combined | 275 | 57.81 | 79.87 | 0.63 | 19.50 |

**Table 61. Details of live-stock and the mode of feeding in Northern Ranges (periphery)**

| Caste | N | % of having cattle | Forest | Stall feeding | Other sources |
|---|---|---|---|---|---|
| Tribals | 83 | 27.70 | 82.61 | 0.00 | 17.39 |
| Non-tribals | 70 | 64.28 | 33.3 | 2.22 | 64.44 |
| Combined | 153 | 44.44 | 50.00 | 1.47 | 48.53 |

**Table 62. Details of live-stock and the mode of feeding in Northern Ranges (transect)**

| Caste | N | % of having cattle | Forest | Stall feeding | Other sources |
|---|---|---|---|---|---|
| Tribals | 8 | 6.25 | 0.00 | 0.00 | 100.00 |
| Non-tribals | 47 | 22.78 | 11.11 | 11.11 | 77.78 |
| Combined | 55 | 21.26 | 10.81 | 10.81 | 78.38 |

**Table 63. Details of live-stock and the mode of feeding in Central Range (enclosure)**

| Caste | N | % of having cattle | Forest | Stall feeding | Other sources |
|---|---|---|---|---|---|
| Tribals | 152 | 48.00 | 19.18 | 13.70 | 67.12 |
| Non-tribals | 74 | 86.48 | 7.81 | 15.63 | 76.56 |
| Combined | 226 | 60.61 | 13.87 | 14.60 | 71.53 |

**Table 64. Details of live-stock and the mode of feeding in Central Range (periphery)**

| Caste | N | % of having cattle | Forest | Stall feeding | Other sources |
|---|---|---|---|---|---|
| Tribals | 289 | 31.48 | 39.56 | 1.10 | 59.34 |
| Non-tribals | 175 | 65.71 | 28.70 | 4.35 | 66.96 |
| Combined | 646 | 44.39 | 33.60 | 2.91 | 63.59 |

**Table 65. Details of live-stock and the mode of feeding in Central Range (transect)**

| Caste | N | % of having cattle | Forest | Stall feeding | Other sources |
|---|---|---|---|---|---|
| Tribals | 16 | 62.5 | 60.00 | 0.00 | 40.00 |
| Non-tribals | 158 | 70.88 | 6.25 | 1.79 | 91.96 |
| Combined | 174 | 70.11 | 10.66 | 1.64 | 87.70 |

Among the tribals in the enclosures, nearly 100% of Adiyans and Uralies collect firewood from forests. Dependence of Kurichian (44.39%), Kurumans (44.34%) and Kattunaikans (23.86%) were for firewood. Kattunaikans (56.06%) are depending the forest more for NWFP followed by Kurichian (48.78%) and Adiyans (47.38%). Most of the construction materials of majority of Adiyan (84.21%), Kurumans (80%) and Kattunaikans (75%) came from the forest. Though food from the forest do not contribute much to the diet, Kurichians and Adiyans do collect food materials. Hunting was mainly done by Kurichian (51.22%), Kurumans (43.41%) and Kattunaikans (35.23%). Fishing was mainly by Kurichian (97.56%), Adiyans (81.58%) and Kattunaikans (72.73%). The details are summarised in Table 66.

**Table 66. Forest dependence in enclosure (caste wise tribals)**

| | Kattu naikan | Kuruman | Paniyan | Adiyan | Urali | Kurichian |
|---|---|---|---|---|---|---|
| Fire wood | 96.59 | 87.80 | 99.25 | 100 | 100 | 92.68 |
| Grazing | 70.00 | 59.86 | 73.17 | 83.30 | 42.85 | 38.46 |
| NWFP | 56.06 | 42.93 | 39.26 | 47.38 | 34.48 | 48.78 |
| House | 75.38 | 80.00 | 62.96 | 84.21 | 62.07 | 68.29 |
| Food | 17.42 | 94.15 | 97.18 | 100 | 93.10 | 100 |
| Hunting | 35.23 | 43.41 | 25.19 | 31.58 | 13.79 | 51.22 |
| Fishing | 72.73 | 72.68 | 71.85 | 81.58 | 68.97 | 97.56 |

**Table 67. Type of area for resettling**

| Location | enclosure |
|---|---|
| Periphery | 23.56 |
| Town | 16.08 |
| Village | 60.42 |

**Table 68. Importance of forest and wildlife conservation**

| Response | Enclosures | Periphery | Transect |
|---|---|---|---|
| Should be protected | 18.64 | 18.89 | 3.54 |
| No need of protection | 6.04 | 13.94 | 5.18 |
| Should be protected without affecting settlers | 74.89 | 66.57 | 91.28 |
| No response | 0.43 | 0.60 | 0.00 |

**Table 69. Awareness about wildlife protection**

| Response | Enclosures | Periphery | Transect |
|---|---|---|---|
| Aware | 87.40 | 80.99 | 77.93 |
| Not aware | 12.60 | 19.01 | 22.07 |

About 48.32% of the respondent in Wayanad are willing to be resettled outside the forest. Of this, about 60% of the people preferred villages and 16.08% town and 23.56% in periphery (Table 67). Nearly 75% of the people in the enclosures, 66.57% in periphery and 91.81% along transect have the opinion that forest and wild life should be protected without affecting the people (Table 68). About 87% of the people in the enclosures, 80.99% in periphery and 77.93% along the transect aware of the need to conserve the wildlife (Table 69).

**Discussion**

Kothari *et.al*. (1995) have summarised the major reasons leading to human-

wildlife conflict in the Protected Areas in India. Irrationality in planning, curtailment of local community land and forest rights, access to natural resources inside Protected Areas, increase in the animal population as a result of increased protection offered by PAs and the urban industrial pressure for the resources are the major factors contributing to the human wildlife conflict.

The survey has brought out the details of dependence on forest by the people of Wayanad. The dependence by the tribal communities for firewood, house construction materials and NWFP clearly indicate their interrelationship with the forest ecosystem. However, the removal of the resources, especially bamboo from Wayanad for the industrial purpose could have more impacts to the system by way of continued human disturbance and also by way of denying the fringe benefits to the local community. The negative impacts on the system due to dependence by the local community would be rather minimal compared to the exploitation for industrial purpose.

Majority of the respondents considers only a marginal increase in the crop raiding by animals and only a few of them attribute this to the increase in animal numbers. Confronted with the crop damage and other related problems, at least about half of the respondents feel resettlement as a viable solution. The high awareness of the people in the area is evident from their statements that the wildlife should be protected but without causing damage to the life and properties of human beings.

The conflicting interests in wildlife conservation and the need to protect the interests of both the wildlife and the people have been stressed by a number of workers who have dealt with the problem. However, decisions based on site specific studies and opinions collected from the local people have been lacking. The present survey indicate the necessity of mitigation measures to protect the interests of the people in Wayanad as a long term solution to the conflict. Resettlement of willing people would help in consolidation of the areas, providing problem free contiguous areas for the animals and a relief to the people spending sleepless nights to protect their crops.

# CHAPTER 6

# ANIMAL POPULATION, DENSITY, GROUP SIZE AND COMPOSITION

## Introduction

Information on the population of animals in an area is an important pre request for the ecological studies. This is especially true in the case of gregarious animals contributing to the biomass to a greater extent. Various authors have reported that the population size, structure and herd size effect the overall utilization of the habitat and also its behaviour (Laws, 1974; Eltringham, 1977; Downing, 1980).

## Methods

### Population density estimate

The study area was divided into blocks based on the vegetation types and 29 transects of 2 Km length were laid in proportion to habitat size. Care was taken to have some of these transects in areas bordering the adjacent Rajiv Gandhi National Park, Bandipur Tiger Reserve and Mudumalai Wildlife Sanctuary and a few radiating from the settlements for correlating the density distribution with cropping pattern.

These transects were followed seasonally (once in four months) taking the rainy season of the study area into consideration (Chapter 2). Information on the number of animals and the details of herd size and composition were collected along with the sighting angle (using a compass) and the sighting distance (using a range finder) (Burnham *et al*., 1980). The analyses of line transect (direct) data indicated very low sample size resulting in highly unreliable density estimates. Hence, only the indirect evidences were collected subsequently. A fixed width of one meter on both sides were used for Sambar deer and spotted deer. The pellet groups within this were counted while covering the transects. Indefinite width was used for gaur and elephants and the

perpendicular distance from the transect to the sighted dung was measured (Barnes and Jensen 1987). In the case of elephants, the decay stage of the dung was also noted. The time spent for sampling and the effort taken was uniform.

**Herd size, structure and composition**

The entire study area was covered every month on foot from January 1994 to December 1996. Size, composition and structure of the animal herds sighted were recorded by direct observation, spending time in all habitat types proportionately. Elephants were classified into different age/sex categories following the criteria suggested by Sukumar (1985).

| Category | | Age class |
|---|---|---|
| Infant or calf | | 0 - 1 |
| Juvenile | I | 1 - 2 |
| | II | 2 - 3 |
| | III | 3 - 5 |
| Sub-adult | I | 5 - 7 |
| | II | 7 - 10 |
| | III | 10 - 15 |
| Adult | I | 15 - 20 |
| | II | 20 - 30 |
| | III | 30 - 40 |
| | IV | 40 - 50 |
| | V | > 50 |

The other animals were classified into young ones, juveniles and adults based on visual estimation of size.

**Analyses**

**Density distribution**

**Functional relationship of elephant density with the environmental variables**

Pearson's product moment correlation coefficient (r) was computed to find the influence of various environmental variables on the elephant density.

A number of factors may influence the density of elephants in different habitat types, which are not directly observable. It is very difficult to determine any single factor influencing the distribution of elephants. For instance, water availability and grass growth can be expressed as a function of rainfall pattern, which attract the elephants to a particular habitat. Factor analysis, a statistical method to identify a relatively small number of significant factors that can be used to represent relationship among sets of many interrelated variables, was used in the analysis. The mathematical model for factor analysis is almost similar to multiple regression equation. Each observed variable is expressed as a linear combination of factors, which are not actually observed. The model for the with standardised variable is

$$X_i = A_{i1} F_1 + A_{i2} F_2 + ... + A_{ik} F_k + U_i$$

where the Fs are the common factors, U is the unique factor, which is assumed to be uncorrelated with common factors and As are the constants used to combine the k factors. The factors are inferred from the observed variables and can be estimated as linear combinations of them. The expression for the $_j$th factor $F_j$ is

$$F_j = \sum_{i=1} W_{ji} X_i$$

where $W_{ji}$ s are factor score coefficients for the $F_j$th factor and p is the number of variables.

Factor analysis was carried out with the program FACTOR of SPSS/PC+ (Anonymous, 1987).

**Density estimates**

The data on indirect evidences of elephant from different transects were pooled for analysis of density estimates in the area using the computer program DISTANCE (Laake *et al*., 1994). The density of indirect evidences of other animals were also similarly pooled and analysed using the same program.

**Estimation of elephant density from dung density**

The elephant density, based on the dung density was calculated using the following formula:

$E = (Y \times r)/D$

Where E = elephant density/$km^2$

Y = density of dung piles/$km^2$

r = dung decay rate per day

and

D = Defecation rate per day

The defecation rate of 16.33/day, obtained from the study at Mudumalai by Watve (1992) was used in the present analysis since this could not be collected from the study area. Experiments were conducted for dung decay rate (Barnes and Jenson, 1987) in different vegetation types in different seasons in the Southern Ranges (Balasubramanian, 1998). The results obtained are summarized in Table 70 and were used in the present analyses.

**Table 70. Summary of dung decay rate in Wayanad Wildlife Sanctuary**

| Season | Habitat | Sample Size | Mean decay rate/day | Standard Error | Confidence Level (95%) |
|---|---|---|---|---|---|
| Dry | DDF | 122 | 0.0192 | 0.0004 | 0.0184 - 0.0200 |
| | MDF | 42 | 0.0187 | 0.0006 | 0.0175 - 0.0200 |
| | Combined | 164 | 0.0191 | 0.0003 | 0.0184 - 0.0198 |
| Wet-1 | DDF | 27 | 0.0754 | 0.0074 | 0.0610 - 0.0899 |
| | MDF | 87 | 0.2037 | 0.0054 | 0.1931 - 0.2144 |
| | Combined | 114 | 0.1406 | 0.0097 | 0.1215 - 0.1596 |
| Wet-2 | DDF | 64 | 0.0360 | 0.0022 | 0.0317 - 0.0402 |
| | MDF | 47 | 0.0615 | 0.0040 | 0.0538 - 0.0693 |
| | Combined | 111 | 0.0436 | 0.0023 | 0.0391 - 0.0482 |
| Overall | DDF | 213 | 0.0251 | 0.0008 | 0.0235 - 0.0267 |
| | MDF | 176 | 0.0512 | 0.0041 | 0.0432 - 0.0592 |
| | Combined | 389 | 0.0335 | 0.0012 | 0.0311 - 0.0359 |

Dry = Dry Season; Wet1 = First Wet Season; Wet2 = Second Wet Season;
DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests

**Herd size, composition and structure**

Only the completely classified herds of elephants were taken for the analyses of herd size and structure. Herd size, composition and proportion of different age and sex classes in the population were derived on the basis of all sightings during the study period. The solitaries were not considered for calculating mean herd size.

**Result**

**Density estimate of animals**

The density estimates for elephants in Southern Ranges was 1.33/km$^2$ and 1.35/km$^2$ in 1995 and 1996 respectively. The dung and elephant density estimates in different seasons in Southern Ranges are given in Table 71 and Figure 8.

Seasonal differences in the density of elephants in Southern Ranges were evident and the differences in 1995 ($\chi^2$ = 1862.44, df =2, P< 0.000) and 1996 (($\chi^2$ =1015.6829, df =2, P< 0.000) were significant.

**Table 71. Density of elephants in Southern Ranges in different seasons**

| Season | Dung density /km$^2$ | % CV | 95 % CI | | Elephant density /km$^2$ |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| **1995** | | | | | |
| Dry | 1746.10 | 7.88 | 1496.60 | 2037.00 | 2.04 |
| Wet-1 | 125.12 | 8.91 | 105.11 | 148.90 | 1.08 |
| Wet-2 | 473.91 | 7.74 | 286.15 | 387.30 | 0.89 |
| **1996** | | | | | |
| Dry | 1183.20 | 9.11 | 990.07 | 1414.00 | 1.38 |
| Wet-1 | 154.13 | 11.71 | 118.75 | 189.51 | 1.33 |
| Wet-2 | 385.01 | 19.95 | 259.80 | 570.58 | 0.85 |

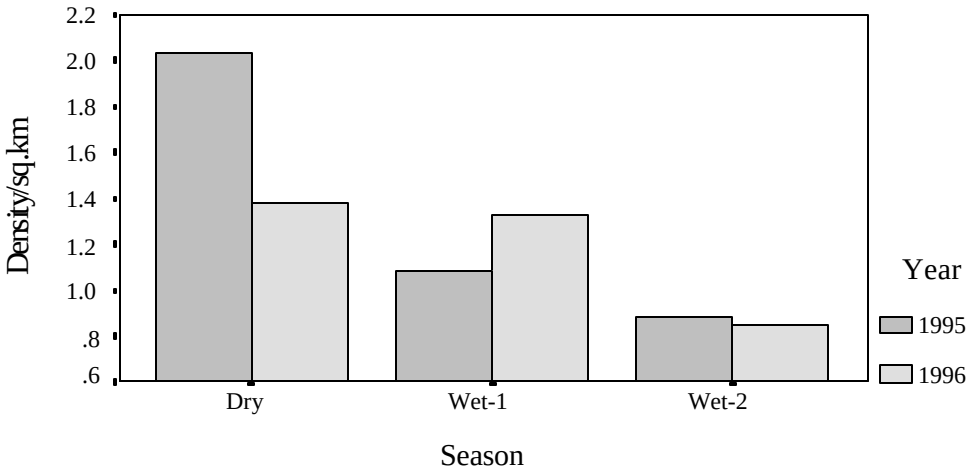



**Fig 8. Density of elephants in Southern Ranges in different seasons**

There were considerable seasonal variations in elephant density in Northern Ranges (Table 72). The difference was highly significant between seasons in 1995 ($\chi^2$ = 1687.3879, df=2, P< 0.000) and 1996 ($\chi^2$ = 809.0164, df=2, P< 0.000) (Fig 9). The density was not following any pattern. The seasonal difference in density was high in dry season of 1995 where as it was high in second wet season of 1996.

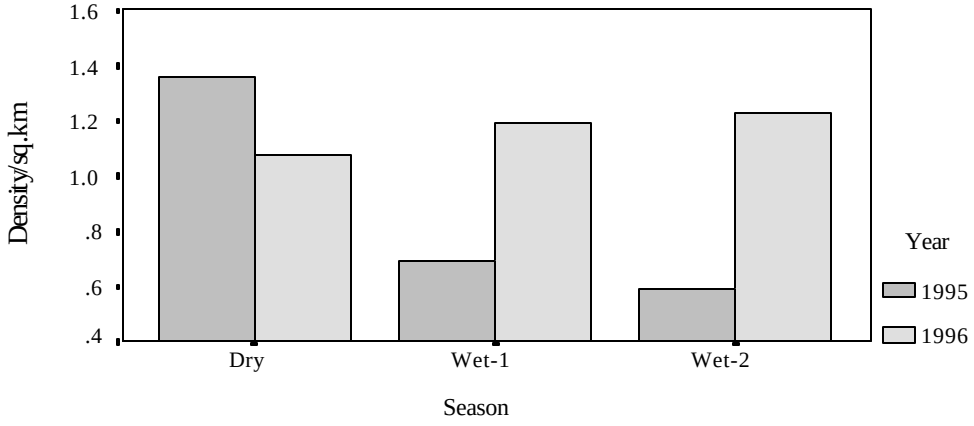



**Fig 9. Density of elephants in Northern Ranges in different seasons**

**Table 72. Density of elephants in Northern Ranges in different seasons**

| Season | Dung density /km$^2$ | %CV | 95 % CI | | Elephant density /km$^2$ |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| 1995 | | | | | |
| Dry | 1190.00 | 41.42 | 526.36 | 2694.40 | 1.36 |
| Wet-1 | 54.94 | 40.44 | 23.70 | 127.35 | 0.69 |
| Wet-2 | 156.94 | 33.92 | 80.32 | 306.67 | 0.59 |
| Overall | 128.30 | 17.73 | 90.402 | 182.09 | 0.26 |
| 1996 | | | | | |
| Dry | 921.58 | 12.70 | 719.17 | 1181.00 | 1.08 |
| Wet-1 | 95.83 | 20.85 | 62.53 | 146.85 | 1.19 |
| Wet-2 | 327.88 | 19.09 | 224.07 | 479.77 | 1.23 |
| Overall | | 449.76 | 9.83 | 371.13 | 545.05 |

Analysis indicate a higher density of elephant in Central Range in first wet season in both 1995 and 1996. However, there was a difference in the first and second wet seasons in these years. The density was highest in the first wet season of 1996 (Table73 and Fig 10). The differences in density between seasons in 1995 ($\chi^2$ =819.9946, df = 2, P< 0.000) and 1996 ($\chi^2$ =453.9091, df = 2, P< 0.000) were significant.

**Table 73. Density of elephants in Central Range in different seasons**

| Year | Season | Dung density/km$^2$ | % of CV | 95% CV Lower | Upper | Elephant density/km$^2$ |
|---|---|---|---|---|---|---|
| 1995 | Dry | 809.72 | 11.98 | 638.94 | 1026.20 | 0.93 |
| | Wet-1 | 81.00 | 24.25 | 49.35 | 135.35 | 1.01 |
| | Wet-2 | 213.61 | 16.66 | 153.48 | 297.28 | 0.80 |
| | Overall | 418.93 | 10.45 | 341.53 | 513.86 | 0.85 |
| 1996 | Dry | 552.34 | 20.63 | 366.82 | 861.68 | 0.63 |
| | Wet-1 | 123.00 | 25.00 | 73.03 | 207.43 | 1.53 |
| | Wet-2 | 181.25 | 28.96 | 100.27 | 327.64 | 0.69 |
| | Overall | 260.25 | 13.38 | 199.77 | 339.05 | 0.53 |

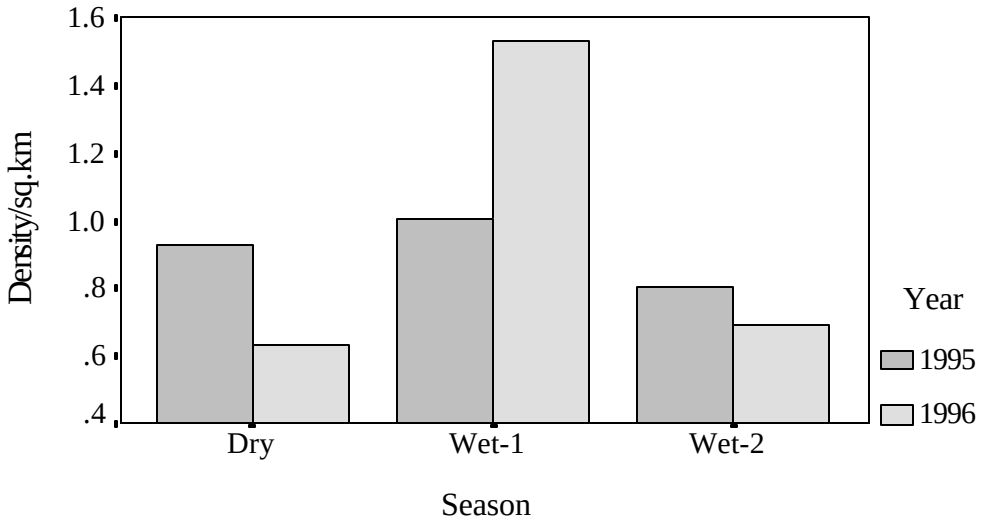



**Fig 10. Density of elephants in Central Range in different seasons**

**Density estimate of gaur**

The density of gaur is expressed in dung density/km$^2$.Seasonal variations in dung density of gaur were observed in Southern Ranges (Table 74 and Fig 11). This was highly significant between seasons in 1995 ($\chi^2$ = 60.6867, df = 2, P< 0.000) and 1996 ($\chi^2$ = 35.0832, df = 2, P< 0.000). Further, there was a marked difference especially in the dry seasons.

**Table 74. Dung density of gaur in Southern Ranges in different seasons**

| Season | Dung density /km$^2$ | % CV | 95 % CI Lower | Upper |
|---|---|---|---|---|
| **1995** | | | | |
| Dry | 690.41 | 7.62 | 587.30 | 793.53 |
| Wet-1 | 428.50 | 18.12 | 276.32 | 580.68 |
| Wet-2 | 582.48 | 19.46 | 360.31 | 804.65 |
| **1996** | | | | |
| Dry | 486.35 | 9.82 | 392.74 | 579.96 |
| Wet-1 | 371.21 | 12.12 | 283.03 | 459.39 |
| Wet-2 | 549.68 | 18.48 | 379.48 | 796.21 |

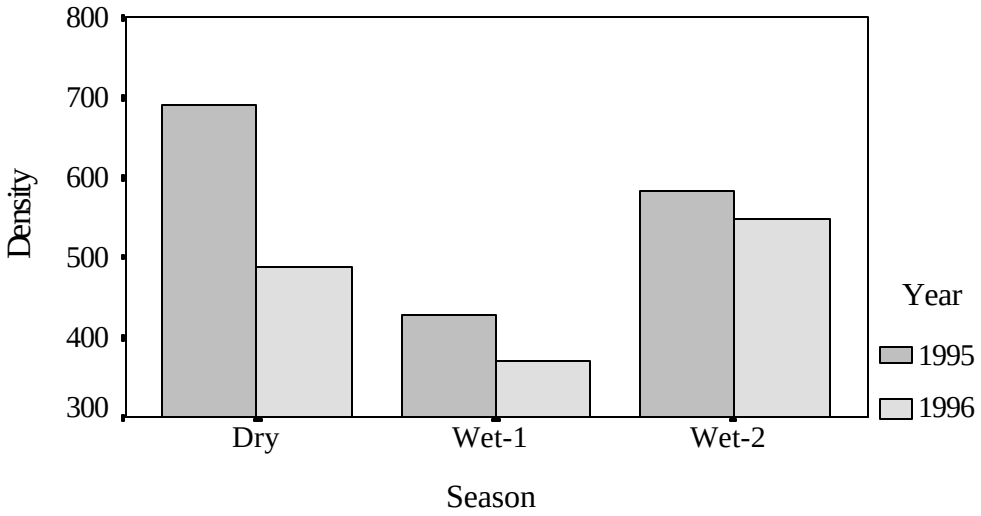



**Fig 11. Dung density of gaur in Southern Ranges in different seasons**

Seasonal variation in gaur dung density was observed also in Northern Ranges (Table 75 and Fig 12). The difference between seasons were significant in 1995 ($\chi^2$ = 133.0463, df = 2, P< 0.000) and 1996 ($\chi^2$ = 116.0942, df = 2, P< 0.000). However, the pattern was different in both years.

**Table 75. Dung density of gaur in Northern Ranges in different seasons**

| Season | Dung density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| **1995** | | | | |
| Dry | 125.00 | 37.80 | 52.61 | 296.64 |
| Wet-1 | 338.00 | 42.20 | 141.85 | 805.39 |
| Wet-2 | 380.00 | 44.43 | 150.85 | 959.22 |
| **1996** | | | | |
| Dry | 281.44 | 34.07 | 140.97 | 561.88 |
| Wet-1 | 147.82 | 60.60 | 40.70 | 536.85 |
| Wet-2 | 399.39 | 24.99 | 242.61 | 657.48 |

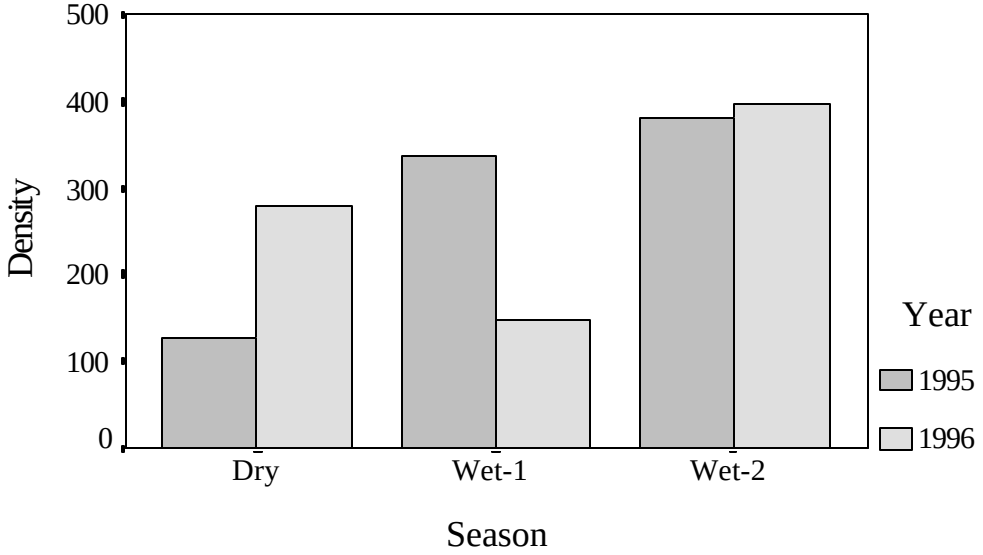



**Fig 12. Dung density of gaur in Northern Ranges in different seasons**

There was no indirect evidence of gaur in Central Range.

**Density estimates of sambar**

Density of sambar deer is expressed in pellet density/km$^2$. Seasonal variation was observed in pellet density in Southern Ranges and the difference was highly significant in 1995 ($\chi^2$ = 504.5695, df = 2, P< 0.000) and 1996 ($\chi^2$ = 112.5284, df = 2, P< 0.000). The pellet density was higher in first wet season (2767/km$^2$) followed by second wet season (2627/km$^2$) and dry season (1394.30/km$^2$) in 1995. In 1996, pellet density was high in first wet (1559/km$^2$) followed by second wet season (1210.50/km$^2$) and dry seasons (1033.60/km$^2$). The details are summarized in Table 76 and Fig 13.

**Table 76. Pellet density of sambar deer in Southern Ranges in different seasons**

| Season | Density /km$^2$ | % CV | 95 % CI Lower | Upper |
|---|---|---|---|---|
| **1995** | | | | |
| Dry | 1394.30 | 22.84 | 770.12 | 2018.48 |
| Wet-1 | 2767.00 | 28.85 | 1202.37 | 4331.63 |
| Wet-2 | 2627.00 | 16.55 | 1774.85 | 3479.15 |
| **1996** | | | | |
| Dry | 1033.60 | 9.34 | 844.39 | 1222.81 |
| Wet-1 | 1559.00 | 23.34 | 845.81 | 2272.19 |
| Wet-2 | 1210.50 | 20.88 | 794.23 | 1845.00 |

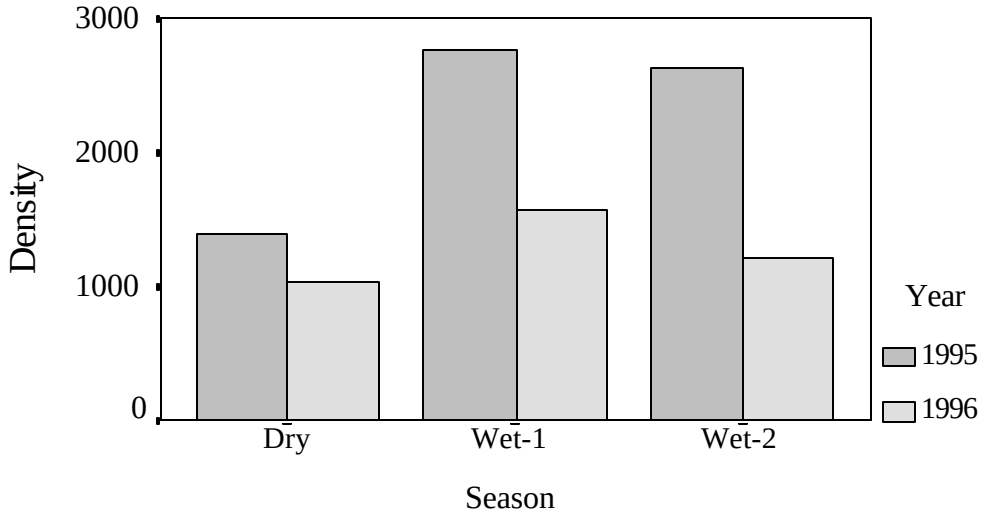



**Fig 13. Pellet density of sambar deer in Southern Ranges in different seasons**

Seasonal variation in pellet density was also observed in Northern Ranges and the difference was highly significant between seasons in 1995 ($\chi^2$ = 1243.7949, df = 2, P< 0.000) and significant in 1996 ($\chi^2$ = 277.2531, df = 2, P< 0.000). Pellet density was high in second wet season (997.36/km$^2$) followed by dry season (143.98/km$^2$) and first wet season (96.16/km$^2$) in 1995. The pellet density in 1996 followed almost a similar pattern (Table 77 and Fig 14).

**Table 77. Pellet density of sambar deer in Northern Ranges in different seasons**

| Season | Density /km$^2$ | % CV | 95 % CI Lower | 95 % CI Upper |
|---|---|---|---|---|
| **1995** | | | | |
| Dry | 143.98 | 64.55 | 27.98 | 741.00 |
| Wet-1 | 96.16 | 76.38 | 5.26 | 1777.50 |
| Wet-2 | 997.36 | 141.42 | 127.83 | 7781.30 |
| **1996** | | | | |
| Dry | 168.19 | 58.55 | 41.63 | 679.06 |
| Wet-1 | 106.85 | 76.38 | 5.78 | 1975.10 |
| Wet-2 | 449.18 | 25.63 | 264.94 | 761.53 |

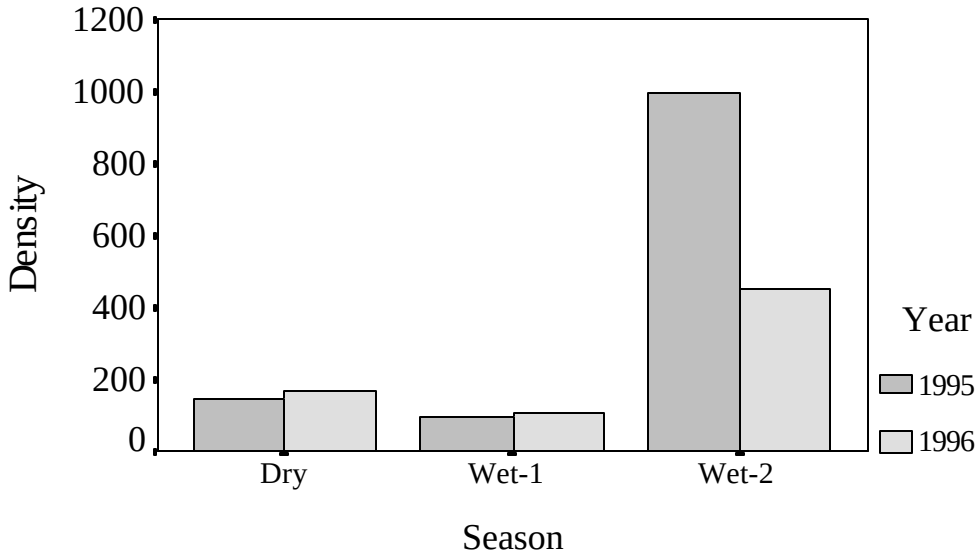



**Fig 14. Pellet density of sambar deer in Northe rn Ranges in different seasons**

The observations of sambar deer evidences were so low in Central Range that no analysis was attempted.

**Density estimates of spotted deer**

The density of spotted deer is expressed in pellet/km$^2$. Though there was no fixed pattern in seasonal density figures between years, the differences

between seasons with in an year were evident. The seasonal differences was found to be highly significant in 1995 ($\chi^2$ = 585.3022, df = 2, P< 0.000) and 1996 ($\chi^2$ = 69.2711, df = 2, P< 0.000) (Table 78 and Fig 15).

**Table 78. Pellet density of spotted deer in Southern Ranges in different seasons**

| Season | Density /km$^2$ | % CV | 95 % CI Lower | Upper |
|---|---|---|---|---|
| **1995** | | | | |
| Dry | 985.00 | 27.55 | 411.72 | 1378.28 |
| Wet-1 | 1749.00 | 29.30 | 744.58 | 2753.42 |
| Wet-2 | 628.40 | 26.40 | 303.24 | 953.56 |
| **1996** | | | | |
| Dry | 1287.01 | 31.35 | 496.19 | 2077.83 |
| Wet-1 | 953.06 | 11.24 | 743.10 | 1163.02 |
| Wet-2 | 1319.30 | 18.88 | 902.37 | 1929.00 |

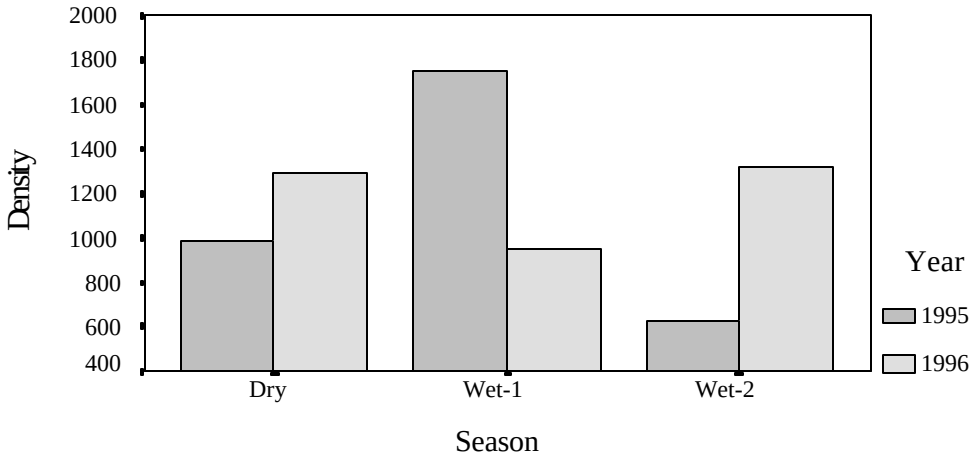



**Fig 15. Pellet density of spotted deer in Southern Ranges in different seasons**

The density of spotted deer in Northern Range also showed seasonal variation (Table 79). This was significant between seasons in 1995 ($\chi^2$ = 29.2681, df = 2, P< 0.000) and 1996 ($\chi^2$ = 354.4233, df = 2, P< 0.000). The

pellet density was high in first wet season followed by second wet season and dry season in 1995. Pellet density in 1996 was high in second wet season followed by dry season and first wet season (Fig 16).

**Table 79. Pellet density of spotted deer in Northern Ranges in different seasons**

| Season | Density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| **1995** | | | | |
| Dry | 192.32 | 64.01 | 55.77 | 663.22 |
| Wet-1 | 301.57 | 49.74 | 90.03 | 1010.10 |
| Wet-2 | 210.48 | 78.57 | 10.65 | 4159.20 |
| **1996** | | | | |
| Dry | 160.30 | 76.38 | 8.62 | 2963.10 |
| Wet-1 | 134.14 | 88.36 | 5.12 | 3537.80 |
| Wet-2 | 527.94 | 38.65 | 221.92 | 1212.30 |

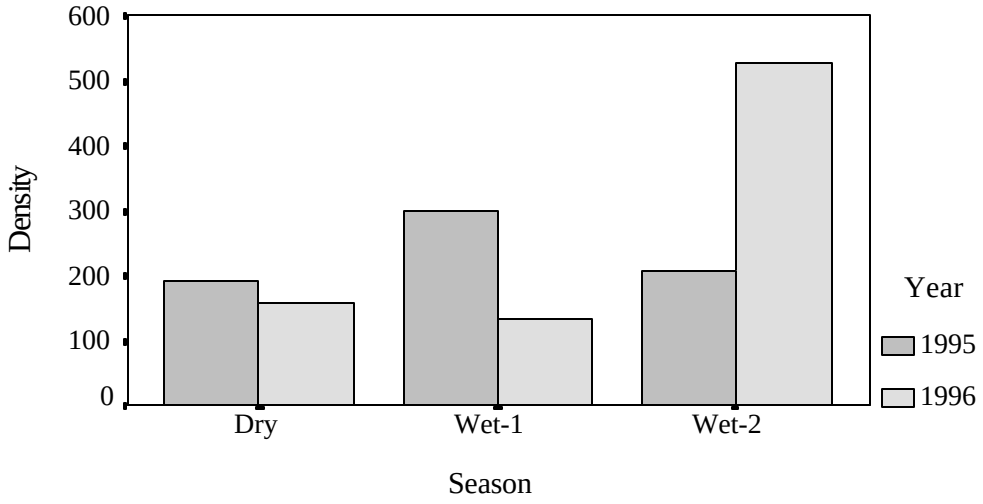



**Fig 16. Pellet density of spotted deer in Northern Ranges in different seasons**

Sighting as well as indirect evidences of spotted deer in Central Range was low making the analysis impossible.

**Group composition**

**Elephant**

A total of 208 herds with 1985 individuals were sighted in Southern Ranges and the herd size ranged from 1 to 38. Out of 208 sightings, 14.42% were loners (Fig 17).

A total of 668 individuals in 126 herds were sighted in Northern Ranges. The herds size ranged from 1 to 33 and only 3.89% of the sighting were of loners (Fig 18).

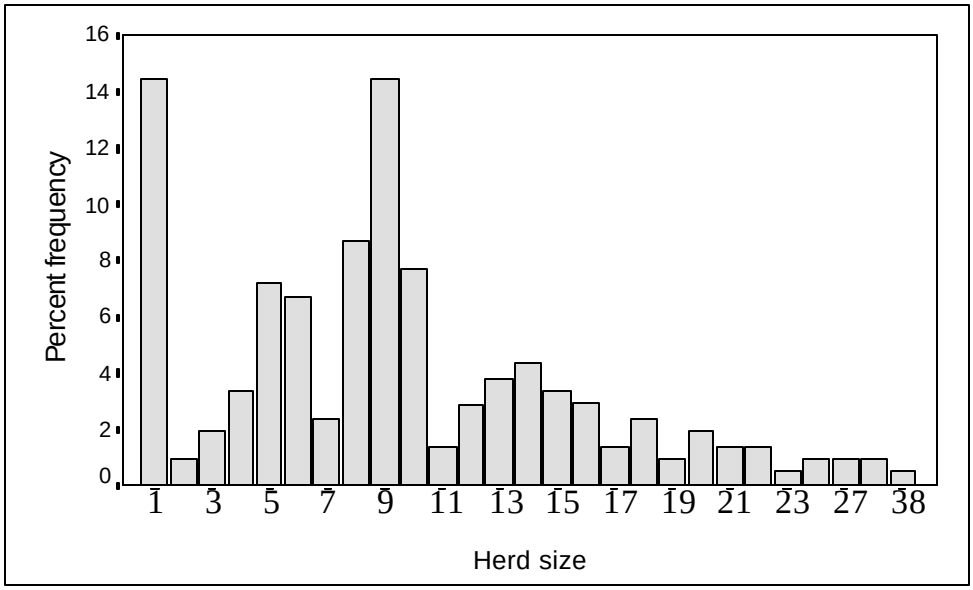



**Fig 17. Percentage frequency distribution of herd size of elephants in Southern Ranges**

Proportion of age sex categories in the elephant population in Southern and Northern Ranges are presented in Table 80 and 81 respectively. A schematic presentation of various age-sex classes of elephants is also given in Figures 19 and 20.

Adult females formed a major portion of the population (42.31%) in Southern Ranges followed by juvenile females (15.61%) and sub adult females

(13.40%). The males formed about 1.05%, sub adult males 9.92% and juvenile males 9.52%. The proportion of calves was about 8.16%.

In Northern Ranges, adult females formed 46.71% of the population followed by sub adult females (16.32%). The males formed about 13.02% and sub adult males 7.19%. Juveniles and calves were not sexed and formed 9.88% and 2.40% respectively.

**Table 80. Percentage frequency of age sex classes of elephants in Southern Ranges**

| Sex/class | Total | Percentage |
|---|---|---|
| Adult male | 21 | 1.05 |
| Adult female | 840 | 42.31 |
| Sub-adult male | 197 | 9.92 |
| Sub-adult female | 266 | 13.40 |
| Juvenile male | 189 | 9.52 |
| Juvenile female | 310 | 15.61 |
| Calf | 162 | 8.16 |
| Total | 1985 | 100.00 |

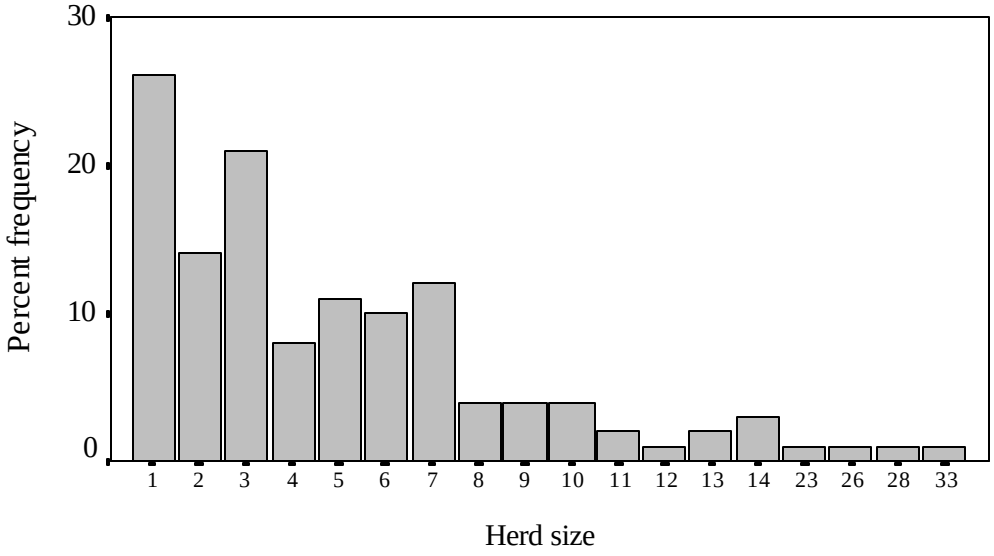



**Fig 18. Percentage frequency distribution of herd size of elephants in Northern Ranges**

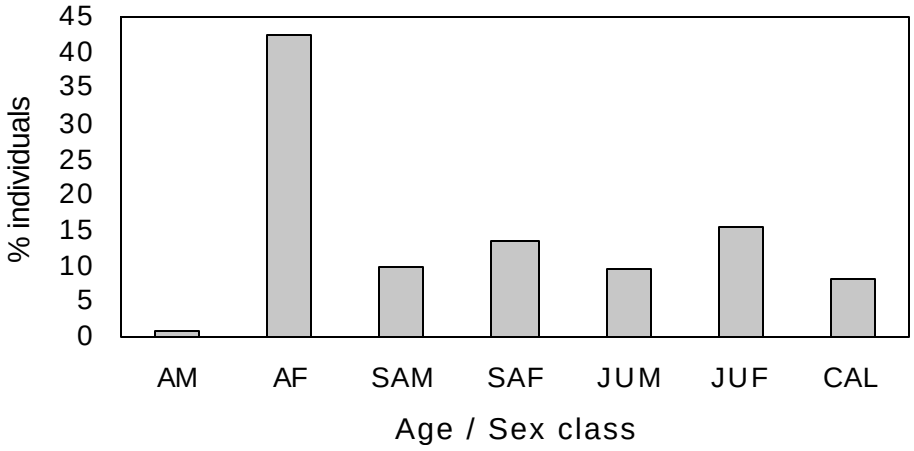
**Table 81. Percentage frequency of age sex classes of elephants in Northern Ranges**

| Sex/class | Total | Percentage |
|---|---|---|
| Adult male | 87 | 13.02 |
| Adult female | 312 | 46.71 |
| Sub-adult male | 48 | 7.19 |
| Sub-adult female | 109 | 16.32 |
| Juvenile | 30 | 4.49 |
| Calf | 66 | 9.88 |
| Unknown | 16 | 2.40 |
| Total | 668 | 100.00 |

The overall sex ratio in Southern Ranges was 1: 3.5 while the adult male to adult female sex ratio was 1: 40. Sub adult male to sub adult female ratio was 1: 1.35 and juvenile male to juvenile female 1: 1.64. The overall sex ratio of elephants in Northern Ranges was 1: 3.12. Adult male to adult female sex ratio of 1: 3.59 and sub adult male to sub adult female 1: 2.27 were observed (Table 13).

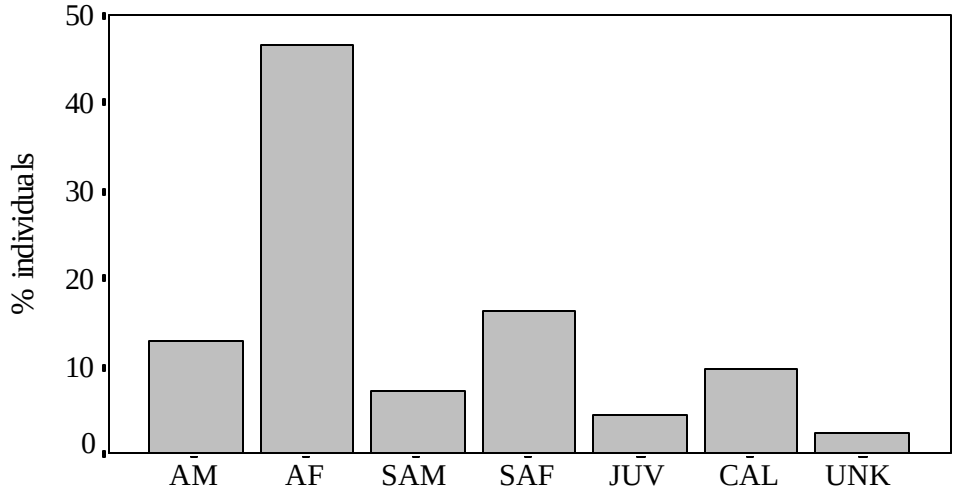
**Table 13. Sex ratio of elephants in different Ranges in Wayanad**

| Sex/class | Southern Ranges | Northern Ranges |
|---|---|---|
| | Sex ratio | |
| Adult male : Adult female | 1: 40.0 | 1: 3.59 |
| Sub-adult male : Sub-adult female | 1: 1.35 | 1: 2.27 |
| Juvenile male : Juvenile female | 1: 1.64 | ** |
| Over all | 1: 3.50 | 1: 3.12 |




AM= Adult male, AF= Adult female, SAM= Sub adult male,
SAF= Sub adult female, JUV= Juvenile, UNK= Unknown

**Fig 16. Percentage frequency of age and sex classes of elephants in Southern Ranges**




AM= Adult male, AF= Adult female, SAM= Sub adult male,
SAF= Sub adult female, JUM= Juvenile male, JUF= Juvenile female, CAL= Calf

**Fig 17. Percentage frequency of age and sex classes of elephants in Northern Ranges**

**Gaur**

Only the completely classified herds had been taken for analysis of herd size and structure.

A total of 495 animals in 62 herds were recorded were from Southern Ranges (Fig 21) and a total of 364 in 56 herds from Northern Ranges (Fig 22). The herd size ranged from 1 to 26 in Southern Ranges and 1 to 30 in Northern Ranges. There was no sighting of gaur in the Central Range.

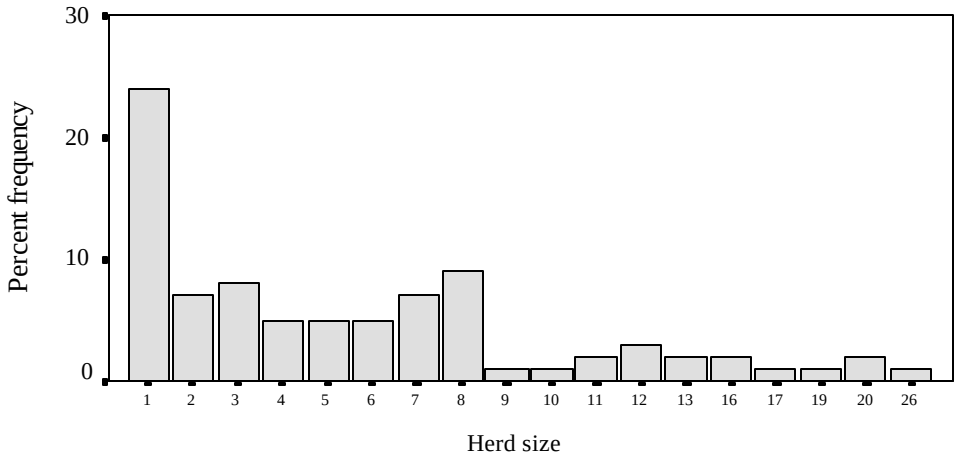



**Fig 21. Percentage frequency distribution of herd size of gaur in Southern Ranges**

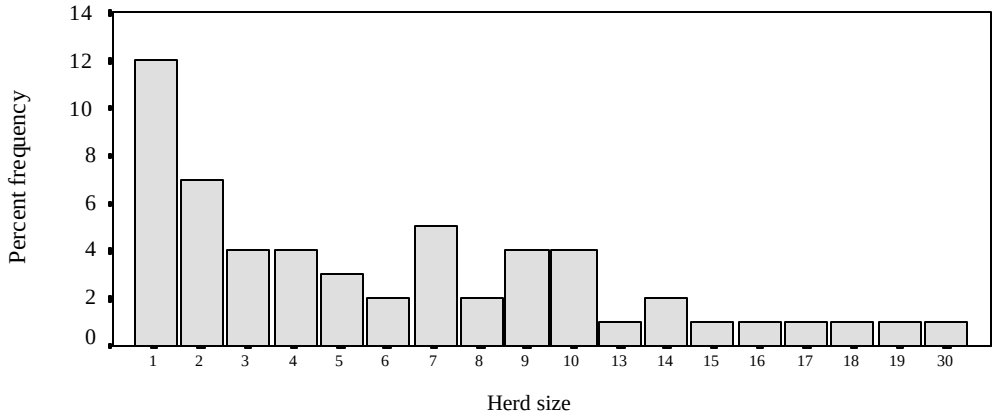



**Fig 22. Percentage frequency distribution of herd size of gaur in Northern Ranges**

Proportion of age-sex categories of gaur population in Southern Ranges and Northern Ranges are presented Tables 83 and 84. A schematic presentation of percentage frequency distribution of various age-sex classes of gaur is given in Figs 23 and 24.

In both the regions, adult females formed major portion of the population followed by sub adult females. Adult males constituted 15.35% in the Southern Ranges and 15.66% in the Northern Ranges. Proportion sub adult males and juveniles were comparatively higher in the Southern Ranges where as calves were higher in the Northern Ranges.

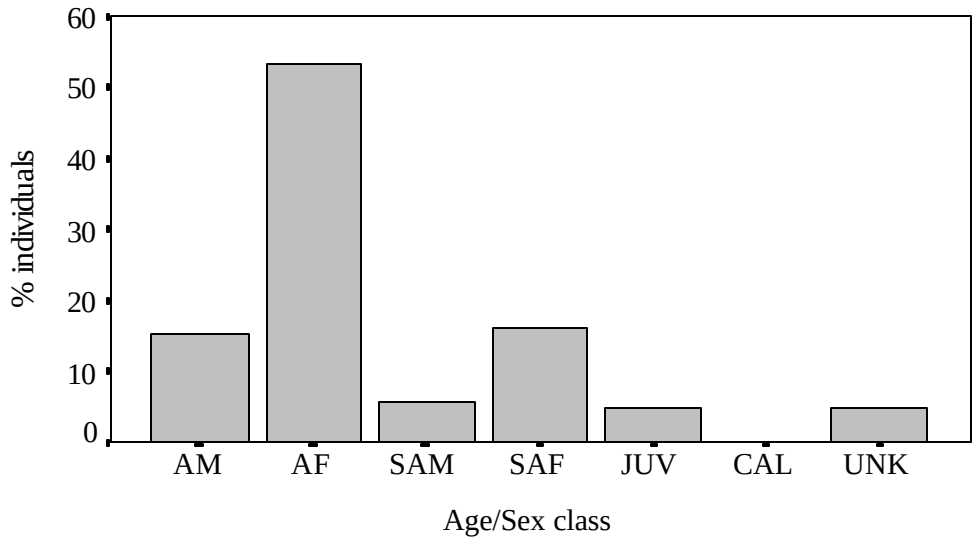
**Table 83. Percentage frequency of age sex classes of gaur in Southern Ranges**

| Sex/class | Total | Percentage |
|---|---|---|
| Adult male | 76 | 15.35 |
| Adult female | 265 | 53.54 |
| Sub-adult male | 28 | 5.66 |
| Sub-adult female | 79 | 15.96 |
| Juvenile | 23 | 4.65 |
| Calf | 0 | 0.00 |
| Unknown | 24 | 4.85 |
| Total | 495 | 100.00 |

The sex ratio of gaur in Southern and Northern Ranges are summarized in Table 85. The overall male to female sex ratio in Southern Ranges was 1: 3.31 compared to 1: 4.24 in Northern Range. Adult male to female sex ratio of 1: 3.49 and sub adult sex ratio of 1: 2.82 were observed in Southern Ranges. The sub adult sex ratio in Northern was highly skewed.

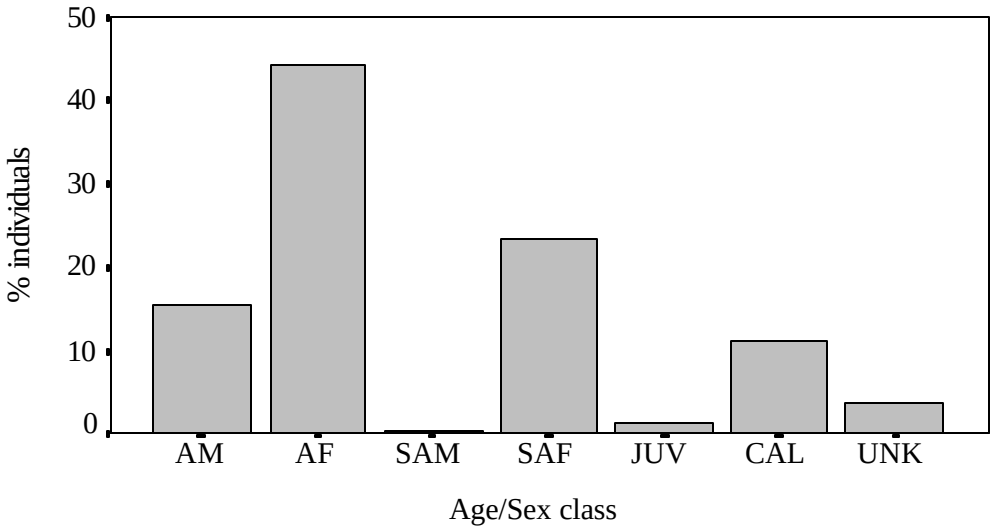
**Table 84. Percentage frequency of age sex classes of gaur in Northern Ranges**

| Sex/class | Total | Percentage |
|---|---|---|
| Adult male | 57 | 15.66 |
| Adult female | 161 | 44.23 |
| Sub-adult male | 1 | 0.27 |
| Sub-adult female | 85 | 23.35 |
| Juvenile | 5 | 1.37 |
| Calf | 41 | 11.26 |
| Unknown | 14 | 3.85 |
| Total | 364 | 100.00 |




AM= Adult male, AF= Adult female, SAM= Sub adult male,
SAF= Sub adult female, JUV= Juvenile, CAL= Calf, UNK= Unknown

**Fig 23. Percentage frequency of age and sex classes of gaur in Southern Ranges**




AM= Adult male, AF= Adult female, SAM= Sub adult male,
SAF= Sub adult female, JUV= Juvenile, CAL= Calf, UNK= Unknown

**Fig 24. Percentage frequency of age and sex classes of gaur in Northern Ranges**

**Table 85. Sex ratio gaur in Southern Ranges and Northern Ranges**

| Sex/class | Southern Ranges | Northern Ranges |
|---|---|---|
| | Sex ratio | |
| Adult male : Adult female | 1: 3.49 | 1: 2.82 |
| Sub-adult male : Sub-adult female | 1: 2.82 | 1: 85.00 |
| Over all | 1: 3.31 | 1: 4.24 |

**Sambar**

A total of 637 animals were sighted in 231herds in Southern Ranges. The herd size observed ranged from 1 to 11 (Fig 25).

In Northern Ranges, a total of 128 individuals were sighted in 41 herds. The herd size to ranged from 1 to 11 (Fig 26). Only 27 animals in 9 herds were sighted in Central Range. The herd size varied from 1 to 13 (Fig27).

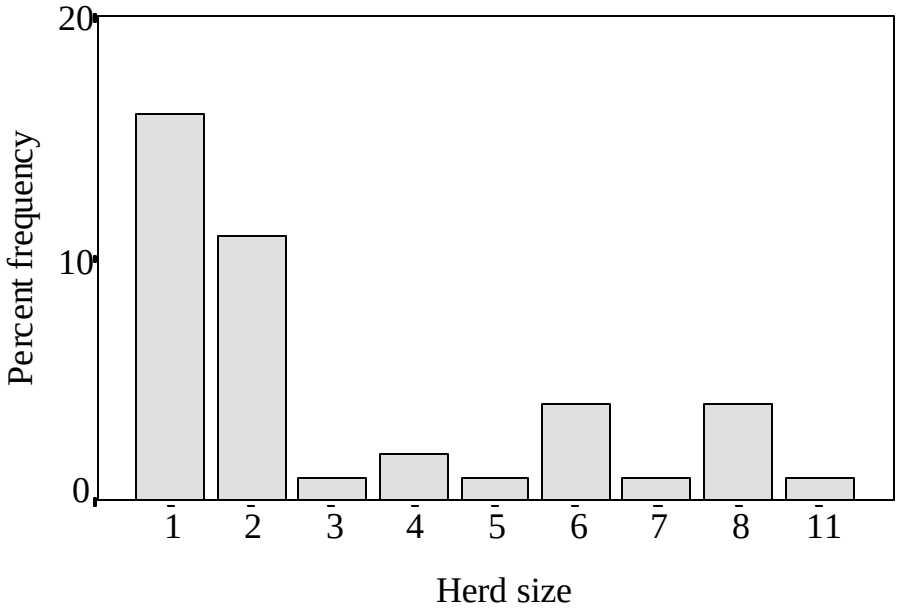



**Fig 25. Percent frequency distribution of herd size of sambar in Southern Ranges**

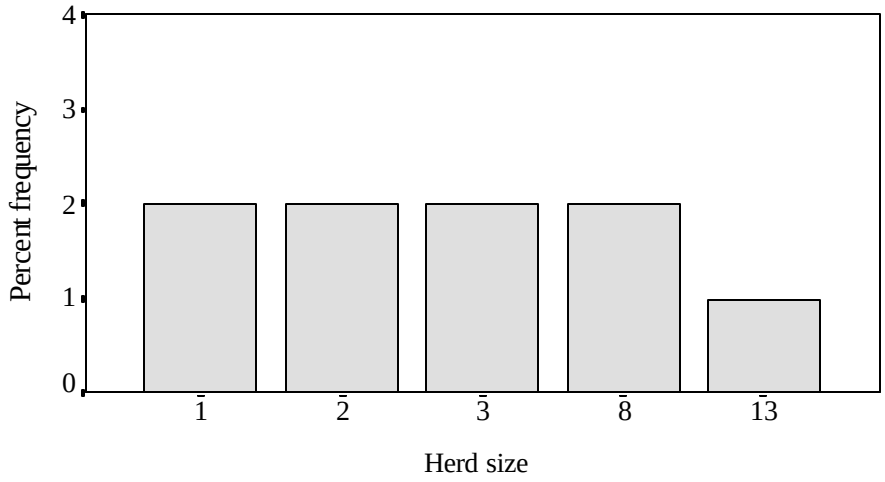



**Fig 26. Percentage frequency distribution of herd size of sambar deer in Northern Ranges**

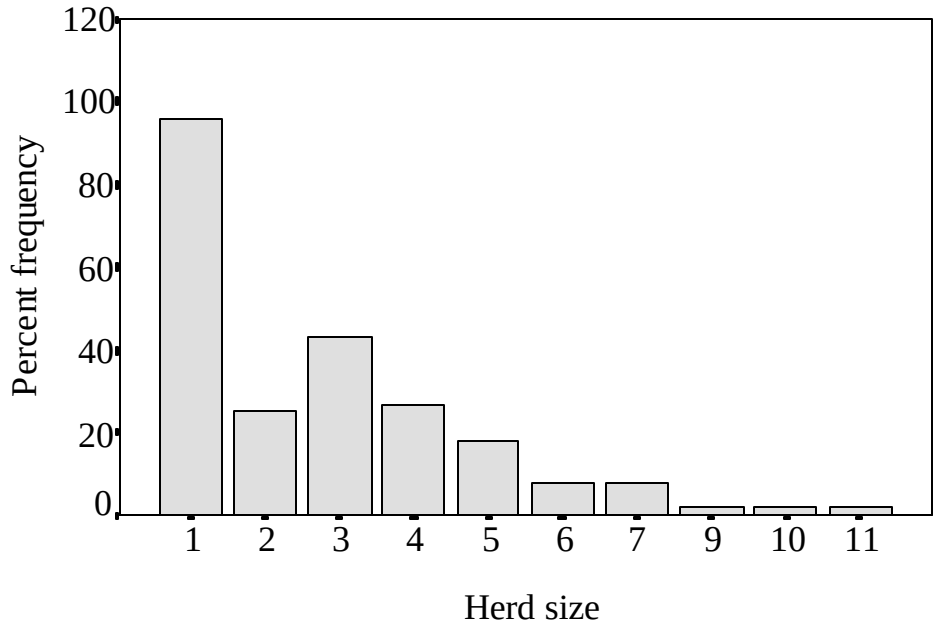



**Fig 27. Percentage frequency distribution of herd size of sambar deer in Central Range**

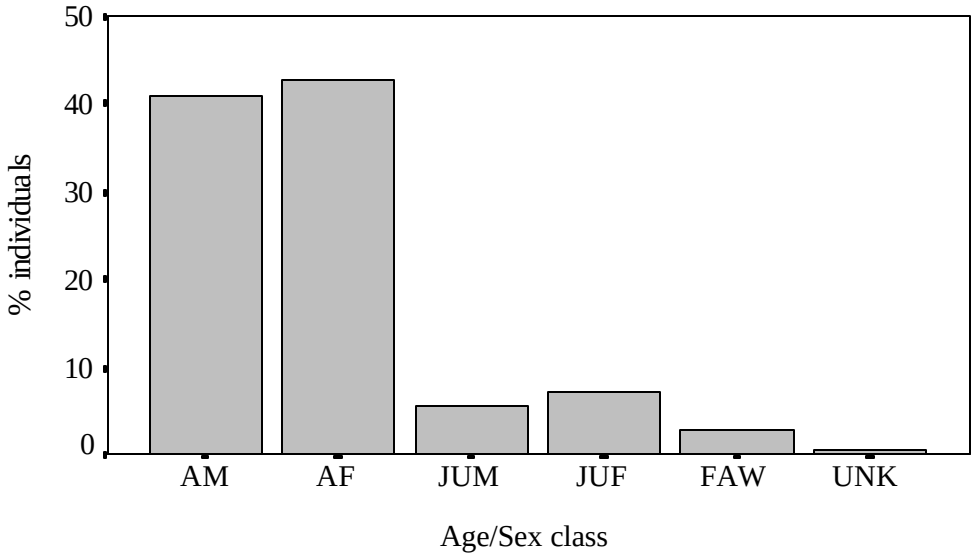
In Southern Ranges, adult females (42.86%) formed a major portion of the population followed by adult males (40.97%). The juvenile females were 7.06%, juvenile male 5.56% and fawns 2.83% of the population (Table 86 and Fig 28).

The adult females dominated the population (60.94%) followed by adult male (26.56%) in Northern Ranges also. The juvenile females were only 6.25% of the population. The percentage of fawns were only 1% of the population (Table 87 and Fig 29).

In Central Range, adult females formed a major portion of the population (78.05%) followed by adult males (9.76%) and juvenile females (9.76%) and fawns are nearly 2.44% of the population (Table 88 and Fig 30).

**Table 86. Percent frequency of age sex classes of sambar deer in Southern Ranges**

| Sex/class | Total | Percentage |
|---|---|---|
| Adult male | 261 | 40.97 |
| Adult female | 273 | 42.86 |
| Juvenile male | 36 | 5.65 |
| Juvenile female | 45 | 7.06 |
| Fawn | 18 | 2.83 |
| Unknown | 4 | 0.63 |
| Total | 637 | 100.00 |

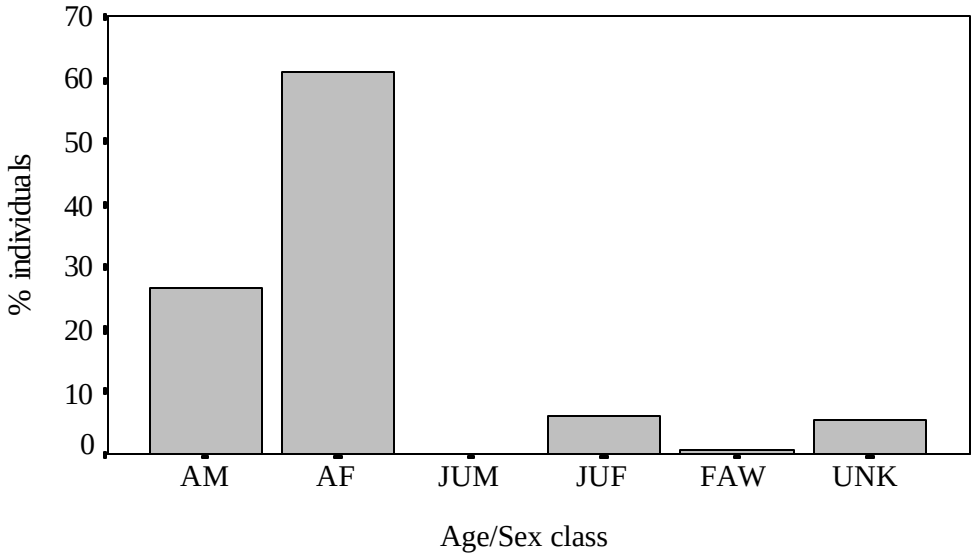



AM= Adult male, AF= Adult female, JUM= Juvenile male,
JUF= Juvenile female, FAW= Fawn, UNK= Unknown

**Fig 29. Percentage frequency of age and sex classes of sambar deer in Southern Ranges**

**Table 87. Percent frequency of age sex classes of sambar deer in Northern Ranges**

| Sex/class | Total | Percentage |
|---|---|---|
| Adult male | 34 | 26.56 |
| Adult female | 78 | 60.94 |
| Juvenile male | 0 | 0.00 |
| Juvenile female | 8 | 6.25 |
| Fawn | 1 | 0.78 |
| Unknown | 7 | 5.47 |
| Total | 128 | 100.00 |

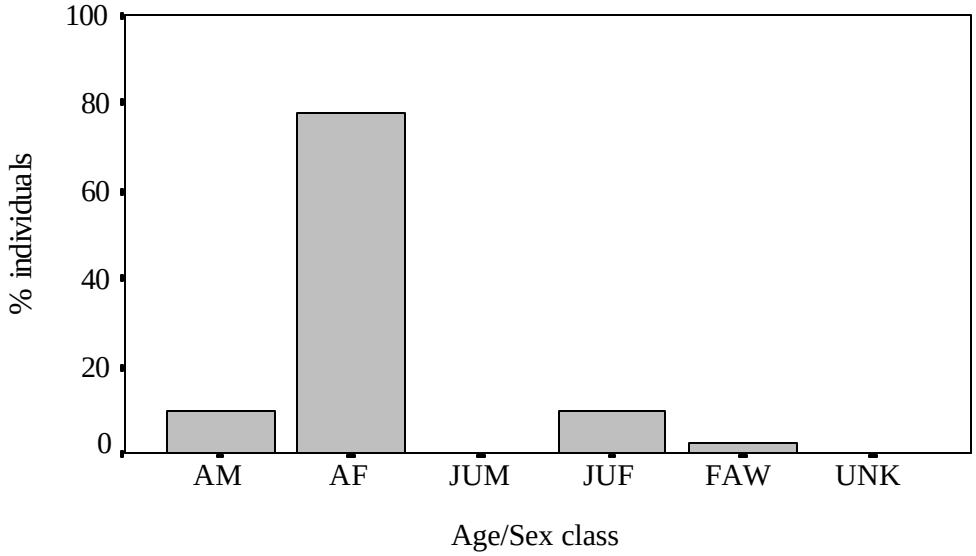



AM= Adult male, AF= Adult female, JUM= Juvenile male,
JUF= Juvenile female, FAW= Fawn, UNK= Unknown

**Fig 29. Percentage frequency of age sex classes of sambar deer in Northern Ranges**

**Table 88. Percentage frequency of age sex classes of Sambar deer in Central Range**

| Sex/class | Total | Percentage |
|---|---|---|
| Adult male | 4 | 9.76 |
| Adult female | 32 | 78.05 |
| Juvenile male | 0 | 0.00 |
| Juvenile female | 4 | 9.76 |
| Fawn | 1 | 2.44 |
| Unknown | 0 | 0.00 |
| Total | 41 | 100.00 |




AM= Adult male, AF= Adult female, JUM= Juvenile male,
JUM= Juvenile female, JUV= Juvenile, FAW= Fawn, UNK= Unknown,

**Fig 30. Percentage frequency of age sex classes of sambar deer in Central Range**

Overall sex ratio of sambar in Southern Ranges was 1: 1.07. It was 1: 2.53 and 1: 9 in Northern Ranges and Central Range respectively. Adult male to adult female sex ratio was 1: 1.05 in Southern, 1: 2.29 in Northern and 1: 8 in Central Range (Table 89).

**Table 89. Sex ratio sambar deer in different Ranges in Wayanad**

| Sex/class | Southern Ranges | Northern Ranges | Central Range |
|---|---|---|---|
| | Sex ratio | | |
| Adult male : Adult female | 1: 1.05 | 1: 2.29 | 1: 8.00 |
| Juvenile male: Juvenile female | 1: 1.25 | ** | ** |
| Over all | 1: 1.07 | 1: 2.53 | 1: 9.00 |

**Spotted deer**

A total of 1891 animals in 286 herds were sighted in Southern Ranges during the study. This was 1810 in 69 herds in Northern Ranges and 188 in 38 herds in Central Range.

Percentage frequency distribution of herd size in the Southern Ranges, Northern Ranges and Central Range are given in Figures 31, 32 and 33. The herd size was found to range from 1 to 26 in Southern Ranges, 1 to 88 in Northern and 1 to 12 in Central Ranges.

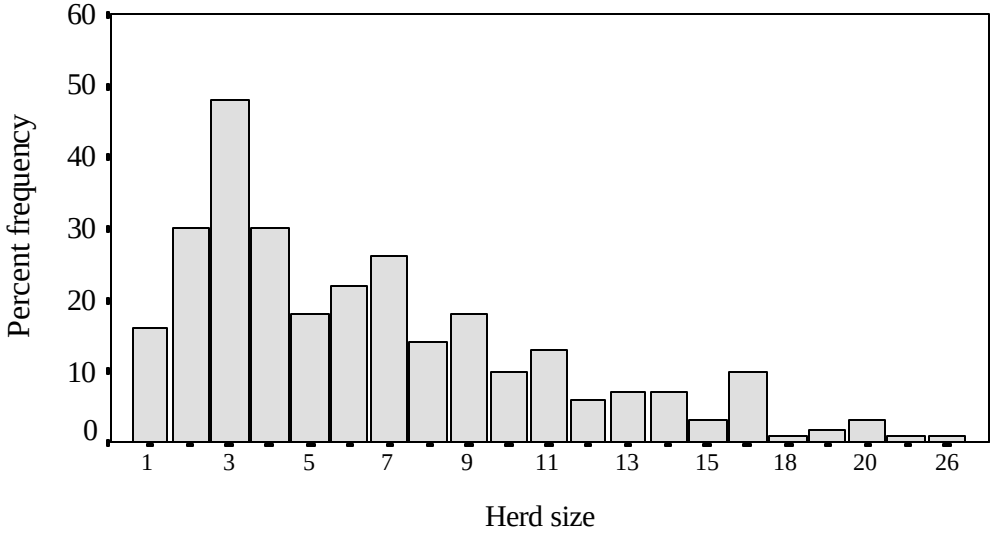



**Fig 31. Percent frequency distribution of herd size of spotted deer in Southern Ranges**

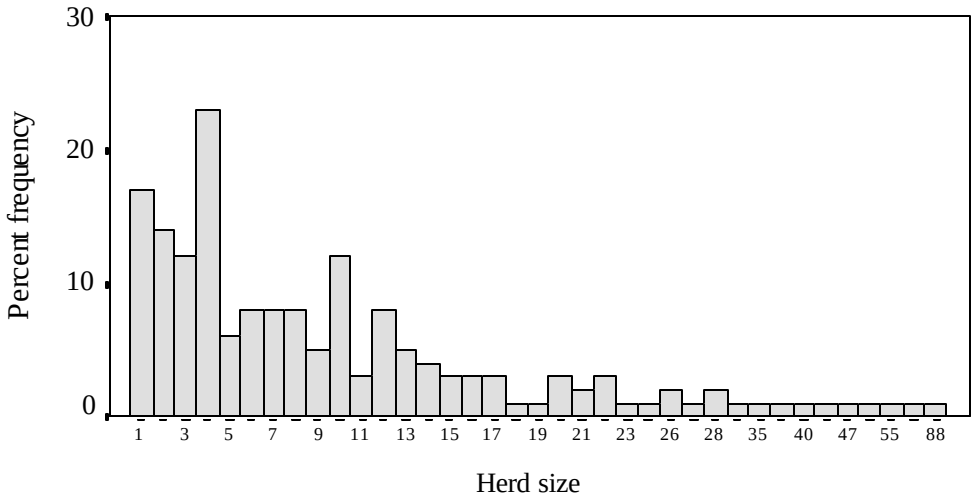



**Fig 32. Percentage frequency distribution of herd size of spotted deer in Northern Range**

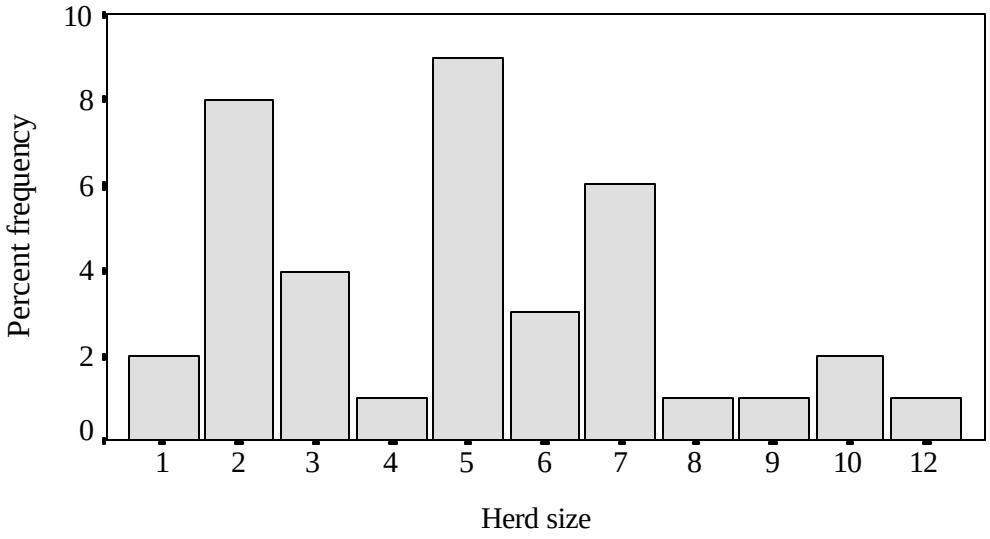


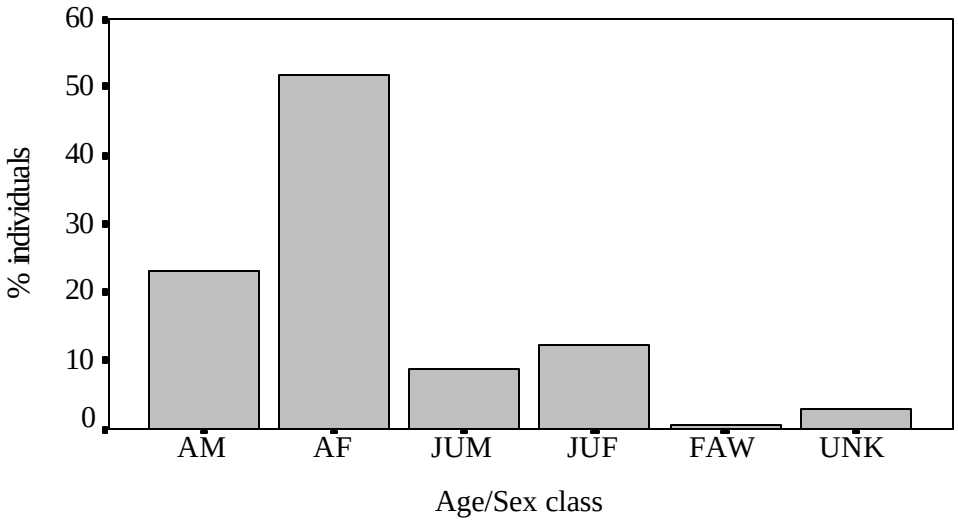

**Fig 33. Percentage frequency distribution of herd size of spotted deer in Central Range**

Proportion of age-sex categories of spotted deer population in Southern Ranges, Northern Ranges and Central Range are presented in Tables 90 - 92. A schematic presentation of percentage frequency distribution of various age-sex classes of spotted deer in the Ranges are given in Figures 34, 35 and 36.

Adult females formed a major portion of the population (51.98%) in Southern, Northern (50.81%) and Central (60.64%). Adult males were about 23% in Southern, 15.58% in Northern and 16.49% in Central Range. The percentage of fawns were higher in Northern Ranges.

**Table 90. Percentage frequency of age sex classes of spotted deer in Southern Ranges**

| Sex/class | Total | Percentage |
|---|---|---|
| Adult male | 436 | 23.06 |
| Adult female | 983 | 51.98 |
| Juvenile male | 166 | 8.78 |
| Juvenile female | 234 | 12.37 |
| Fawn | 16 | 0.85 |
| Unknown | 56 | 2.96 |
| Total | 1891 | 100.00 |

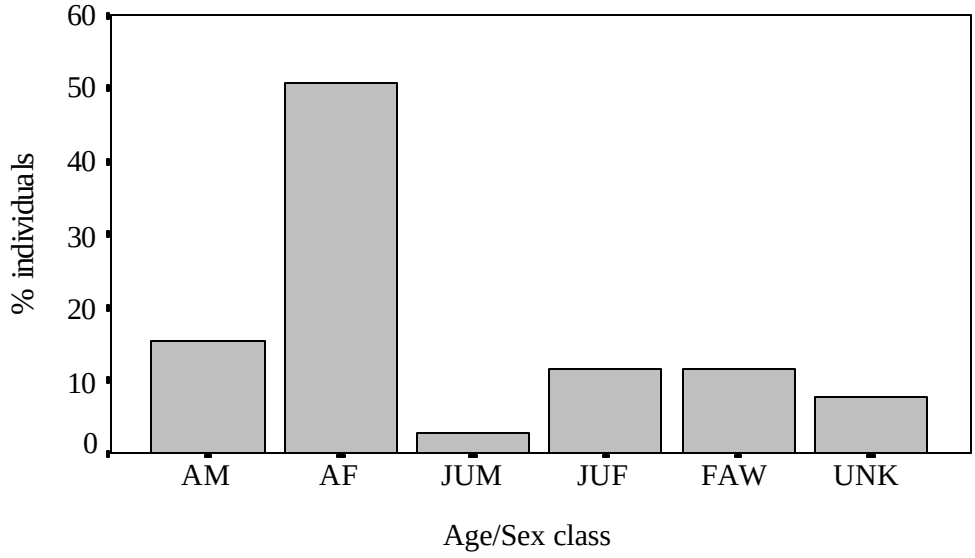



AM= Adult male, AF= Adult female, JUM= Juvenile male,
JUF= Juvenile female, FAW= Fawn, UNK= Unknown

**Fig. 34. Percentage frequency of age and sex classes of spotted deer in Southern Ranges**

**Table 91. Percentage frequency of age sex classes of spotted deer in Northern Ranges**

| Sex/class | Total | Percentage |
|---|---|---|
| Adult male | 282 | 15.58 |
| Adult female | 920 | 50.83 |
| Juvenile male | 48 | 2.65 |
| Juvenile female | 211 | 11.66 |
| Fawn | 211 | 11.66 |
| Unknown | 138 | 7.62 |
| Total | 1810 | 100.00 |

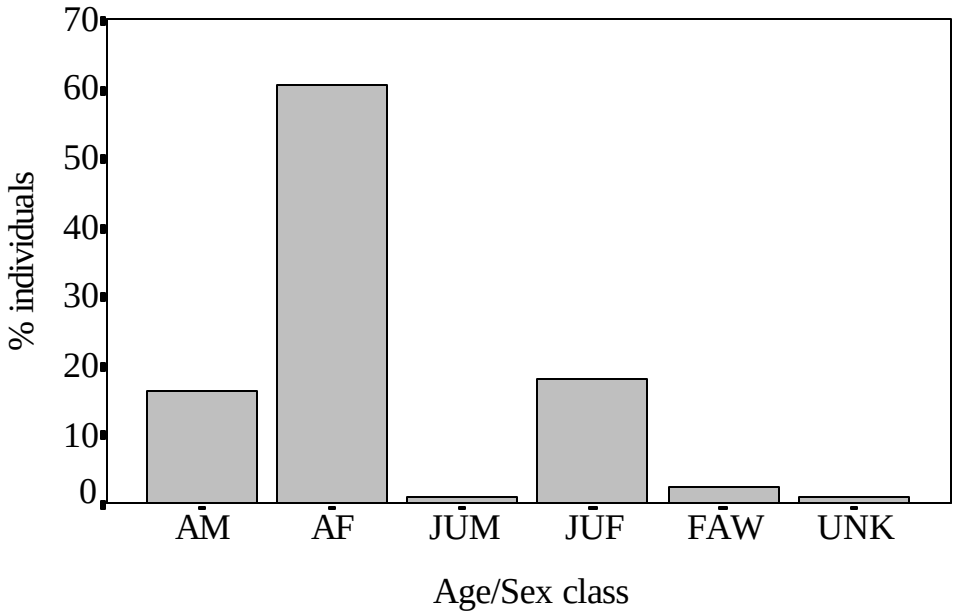



AM= Adult male, AF= Adult female, JUM= Juvenile male,
JUF= Juvenile female, FAW= Fawn, UNK= Unknown

**Fig 35. Percentage frequency of age sex classes of spotted deer in Northern Ranges**

**Table 92. Percentage frequency of age sex classes of spotted deer in Central Range**

| Sex/class | Total | Percentage |
|---|---|---|
| Adult male | 31 | 16.49 |
| Adult female | 114 | 60.64 |
| Juvenile male | 2 | 1.06 |
| Juvenile female | 34 | 18.09 |
| Fawn | 5 | 2.66 |
| Unknown | 2 | 1.06 |
| Total | 188 | 100.00 |




AM= Adult male, AF= Adult female, JUM= Juvenile male,
JUF= Juvenile female, FAW= Fawn, UNK= Unknown

**Fig 36. Percentage frequency of age sex classes of spotted deer in Central Range**

The sex ratio of spotted deer in Southern, Northern and Central Ranges are summarized in Table 93. The overall sex ratio was 1: 2.02 in Southern Ranges. Adult male to adult female was 1: 2.25 and juvenile male to juvenile female was 1: 1.41.

The sex ratio of 1: 3.43 was observed in Northern Ranges. Adult male to adult female ratio was 1: 3.26 and juvenile male to female sex ratio was1: 4.40.

In Central Range, overall sex ratio was 1: 4.48, adult male to adult female 1: 3.68 and juvenile male to juvenile female 1: 17.

**Table 93. Sex ratio spotted deer in different Ranges in Wayanad**

| Sex/class | Southern Ranges | Northern Ranges | Central Range |
|---|---|---|---|
| | Sex ratio | | |
| Adult male : Adult female | 1: 2.25 | 1: 3.26 | 1: 3.68 |
| Juvenile male : Juvenile female | 1: 1.41 | 1: 4.40 | 1: 17.0 |
| Over all | 1: 2.02 | 1: 3.43 | 1: 4.48 |

**Discussion**

**Density estimates**

Density of elephants in all the Ranges showed annual differences .The estimate ranged from 1.02/km2 to 1.35/km2 in the Southern Ranges. It was .26 to0.92 in Northern Ranges and 0.53 to 0.85 in Central Ranges The crude density in Southern Ranges comparatively higher than reported for other areas (Sukumar,1985; Nair,etal 1985; Easa, 1989 b)

However, the density estimate based on the dung density for the adjacent Mudumalai was 1.74/km2 during 1991-92 (Varman *et al*., 1995). Eisenberg and Seindensticker (1976) have mentioned the possibility of elephant density ranging from 0.12 to 1/km2 in suitable south east Asian habitats.

The seasonal differences in the density of elephants in 1995 and 1996 were significant. The dry season density of 2.04/km2 in 1995 in southern Ranges was much higher compared to the figures obtained throughout the study

period. This has probably contributed to the higher overall density of elephants in the Ranges. The seasonal density values in Southern Ranges of Wayanad recorded a uniformly higher value in the dry season. However, the pattern was different in other Ranges. The dry season of 1995 and second wet season of 1996 had the highest density in Northern Ranges. The central range had the highest density in first wet season. Studies in Africa (Buechner *et al*., 1963; Leuthold, 1976b; Lewis 1987) and in Asia (Eisenberg and Lockhart 1972; Sukumar, 1985; Easa, 1989b; Sivaganesan, 1991; Desai and Baskaran, 1996) have shown the influences of food and water availability on density distribution of elephants. The seasonal distribution is also influenced by a number of proximate factors (Lamprey *et al.*, 1967; Bell, 1971; Jarman and Jarman, 1973; Western and Lindsay, 1984; Lamprey, 1985; Dublin and Douglas-Hamilton, 1987).

Varman *et al*., (1995) reported a decrease in density of elephants in the adjacent Mudumalai during dry season and an increase in the subsequent wet season. The drying up of water sources in Mudumalai and Bandipur areas along with frequent occurrence of fire could be the factors leading to a higher density of elephants in the Southern Ranges during the dry season. This could be especially true in the wake of the extensive fire in Mudumalai and Bandipur in 1995. The perennial streams in the study area – Mavinhalla, Nulpuzha and Kurichiat thodu provide much needed water source for elephants during the pinch period of dry season. The density figures in Southern Ranges do not seem to be influenced by the food availability The seasonal difference in the density of elephants in the Northern Ranges within an year was significant. The difference in 1996 was not very evident though the dry season of 1995 had a much higher density. The available information on food availability in Northern ranges indicate direct correlation grass food availability in 1995. The higher

browse availability recorded during the second wet season in Northern Ranges probably explain the uniform density in different seasons in 1996.

**Herd size, composition and structure**

The matriarchal social set up among the elephants have been described by several authors (Buss, 1961; Laws and Parker, 1968; Douglas – Hamilton, 1972; Olivier, 1978a; Sukumar, 1985). The present observation in Wayanad that the herds are centered around females along with sub-adults and juveniles confirms these findings.

Herd size is a measure of the ecological health and larger herd size reflects stressful condition (Laws, 1974). Eltringham (1977) have reported the possibilities of larger herd size due to the poaching pressure. The herd size frequency of the elephants in the Southern ranges showed a polymodal distribution with peaks occurring at 5, 9 and 14 with several minor peaks. The peaks were at 3,5 and 7 in Northern Ranges. Similar observations have been reported for African (Laws, 1969; Laws *et al*., 1975) and Asian elephants (Sukumar, 1985; Daniel *et al*., 1987; Easa, 1989b). The smaller herds frequented more in the study area could be the reflection of the forested habitats (Peak *et al*., 1974; Leuthold, 1976b). The least frequented larger herd size could be aggregation of different family units forming extended family (Laws *et al*., 1975) and have no long-term cohesion (Ishwaran, 1984).

All male herds (bachelor herds) were not frequented in the study area. A herd of two males was observed only once in Southern ranges and a herd of three adults were observed once in Central Ranges. Large sized male herds have been reported from Lake Manyara (Douglas-Hamilton, 1972), Murchison Falls (Laws *et al*., 1975) and Seronera (Croze, 1974). McKay (1973) reported all male herds of 7 individuals in Lahugala in Sri Lanka. Sukumar (1985) observed such herds in his study area. Large sized all male herds could be an indication of the higher number of the bulls in the population (Croze, 1974).

The fewer occurrence of all male herds in the population could probably be an indication of the low proportion of males in the study area. The overwhelming proportion of solitary hulls could also be pointing to the low male proportion in the population in Wayanad Wildlife Sanctuary.

Gaur is a gregarious animal and the group centered around the adult females (Vairavel, 1998). The proportion of solitaries in Southern Ranges was higher compared to Northern Ranges. Most of these were males. The tendency of bulls to the solitaries is considered to be a property of males of the genus Bison (Krasinska and Krasinski, 1978). However, observations in Parambikulam have also indicated a higher proportion of males among the solitaries. The most frequented group size of gaur in Southern Ranges was 2, 3, 7 and 8 and in Northern Ranges 2 and 7. However, largest herd size of 26 and 30 were observed the Southern and Northern Ranges respectively. The larger groups could be aggregations of smaller units probably due to the environmental factors in these areas.

Sambar deer is considered to form small groups (Schaller, 1967). The herd size in different ranges of Wayanad vary considerably where the solitaries dominate in the southern and northern ranges. Solitaries formed about 60% of the sites in Wilpattu National Park (Eisenberg and Lockhart 1972), 36% in Bhandipur (Johnsingh, 1980), 48% in Periyar (Ramachandran *et al*., 1980) and 25% in Parambikulam (Easa, unpublished information).

The average group size of chital at Kanha was between 5 and 10, and the largest group was of about 175 animals (Schaller, 1967). The more frequented groups in Chitwan in Nepal were of 6-10 individuals and the largest group had 40 animals. (Seidensticker, 1976).The larger group sizes observed in Northern Range could be aggregations during lean period.

**Sex Ratio**

Downing (1980) considered sex ratio as a measure of reproductive performance of the population. Sukumar (1989) has discussed in detail the possible influence of disparate sex ratio on the fertility of the population. Most mammalian population reported to have an adult sex ratio biased towards females. This has been attributed to the higher natural mortality of males. The dynamics of large mammal population are influenced by stochastic environmental protuberation or long term population cycles (Wu and Botkin, 1980; Croze *et al*., 1981). The advantage of the polygynous mammals have been described by Clutton-Brock *et al*., (1982). Sukumar (1989) suggested that the operational adult sex ratio need not be as disparate as observed sex ratio in the population. Further, considering the non seasonality of breeding in elephants, a disparate sex ratio can still ensure mating of almost all mature females. Cowan (1950) and Clutton-Brock *et al*. (1982) have mentioned a female biased adult sex-ratios in population close to carrying capacity.

The proportion of different age-sex classes in the elephant population in Wayanad indicate a shift towards the older age classes with adult, sub-adult and juvenile females contributing maximum. The calves form only 8.13% and 9.8% of the population in the two Ranges indicating a low recruitment or reduced number of breeding females. These could be normally taken as a negative trend in the population growth rate. However, the conclusions arrived from the observed age distribution have been strongly criticized (Caughley, 1974 & 1977). Sukumar (1989) also showed the unreliability of such interpretation of age ratio without information on other parameters such as fertility and mortality rates. The sex ratio at stable age distribution depends on the magnitude of difference in mortality rate of male and female elephants (Sukumar, 1989).

The mortality figures for Mudumalai and Eastern Ghats have been reported to be 1.2% for adult-females and 14.5% for adult-males (Daniel *et al.*, 1987). Sukumar (1985) reported a mortality of 1.7% for females and 11.84% for males. The present observation of 3.28% and 29.17% for females and males respectively in the Southern ranges is considerably higher. The mortality was higher during summer. The observations also indicate a higher male mortality in summer in the Range. This coincided with higher density within the area. Further, evidences from studies on cervids and sheep predict that adult or adolescent males are more likely to die during periods of food shortage than females of same age in several dimorphic species (Robinette *et al*., 1957; Klein, 1968; Grubb, 1974). The increased human pressure leading human-elephant conflict could also be contribution to the problems as evident from the causes of mortality.

The increased density during dry season, decreased availability of quality forage during the period and the low percentage of area available – all exert pressure on the elephant population in Wayanad. Mortality rate was high during the dry season. Sukumar (1985) attributed 20% of the female and 65% of the male mortality in South India to human beings. Daniel *et al*. (1987) reported 80.7% of the mortality due to human interference. In the Southern Ranges, 11.54% of the mortality of males were due to poaching and 23.1% due to human-elephant conflict. In fact, these figures could be underestimates since the post mortem often fails to diagnose or pinpoint the cause of death since the carcass would be putrefied making it difficult to collect parts for laboratory examination. About 90% of the tusker carcasses examined had bullet injuries inflicted either during crop-raiding or due to poaching attempts. Six out of 17 adult and sub adult tuskers observed in May, 1995 had bullet injuries.

The fertility rate of 0.19 per adult-female per year or a mean calving interval of 5.1 years have been calculated for the study area. The estimated mortality was 8.43% for males compared to 2.04% for females. The mortality was higher in the 7-10 years sub-adult category in both the males and females. Sukumar (1989) has used simulation to predict population growth rate with different calving intervals. A high male – low female mortality with 1: 28.7 male-female sex ratio and calving intervals of 5.5 years predict a growth rate of 1.08%. Sukumar (1989) have suggested a possible widening adult sex ratio for a short term of about 5 year before narrowing down due to a higher mortality in the 7-10 and 10-15 age classes. As long as the female mortality is low, the population could still have capacity to increase or remain stable in spite of decreased fertility due to higher mortality rate (Sukumar, 1989). Considering the mortality of males in the population as high and those of females as low and with a mean calving interval of 5.19 years, the elephant population in Wayanad could be considered as healthy.

Schaller (1967) and Vairavel (1998) have reported distorted sex ratio of gaur, favouring females. This has been attributed to the high mortality rate among the males (Krikrasinski, 1978; Vairavel, 1998) Adult females dominate the population of sambar deer in all the ranges. Though there are variations in the proportion, the number of adult males in the southern range is almost equal to adult female. Fewer number of fawns in the northern central ranges probably indicate the slow recruitment to the population. The sex ratio of spotted deer in Chitwan was almost 1:1 (Seidensticker, 1976) and about 1:1.4 in Kanha (Schaller, 1967) Schaller (1967) attributed the disparate sex ratio to the selective predation on females. This seems to be true in the case of the populations in Wayanad, especially the Northern and Southern Ranges where the populations are comparatively higher.

Considering the contiguity of Wayanad with larger extent of forests, the mammal population in the area could be considered as viable without the problems of loss of genetic variation. However, the deer population in the Central Range are almost isolated and do not seem to be viable.

# CHAPTER 7

# DENSITY DISTRIBUTION AND HABITAT UTILIZATION OF ANIMALS

## Introduction

Mammals, especially the gregarious ones often respond to climatic changes and the resultant changes in the habitat by altering herd size and pattern of habitat utilization (McNaughton, 1985). Distribution pattern of large herbivores is influenced by resource availability such as food, shelter and water (Owen-Smith, 1988). Wild animals try to achieve the presumed goal of fitness maximisation by maintaining intake and avoiding environment stresses. This could be attained by selection of landscapes through migrations, home range placements or nomadism at behavioural frequencies of a few times in a year. Ranging behaviour of wild ungulates over wide geographical areas are normally in response to the temporal abundance and quality of forages (McNaughton, 1987). Watson and Moss (1970) have given examples to support that the dispersion of animals are related to food supply. Seasonal habitat selection has been reported in several species (Fuller, 1960; Shackleton, 1968; Shult, 1972; Dunckan, 1975; Owen-Smith, 1979; Krasinska *et al*., 1987).

## Methods

### Density distribution

### Food availability

Food species of animals in the study area were identified through direct observation and by examination of feeding sites immediately after the animal left the location. The above ground biomass of food plants were estimated as follows:

The study area were divided into grids of 2 $km^2$ size on 1 : 50,000 scale topo sheets. These grids were identified in the field and a transect of 500 m. length laid in each grid. Plots of 5 $m^2$ were laid at 100 m. interval for browse species biomass estimation and 1 $m^2$ at 50 m. interval for grass.

The plant species within the sample plots laid for biomass estimation were cut and food species segregated (Boutton *et al.*, 1988). The food species were then weighed in the field. These were later oven dried at constant temperature till a constant weight was obtained and then weighed for dry weight. Care was taken to have such biomass plots in all vegetation types in proportion to the size. The biomasses of the food species were later estimated using the formula suggested by Wiegert (1962).

**Functional relationship of elephant density with the environmental factors**

A number of factors are intertwined with the seasonal density distribution of elephants in different habitat types. These could be broadly classified into food availability, palatability, cover, rainfall and water availability. These factors were quantified seasonally in all the habitats to find their functional relationship with the seasonal density distribution of elephants in different habitat types. The following variables were collected from the Southern Ranges alone during the study period.

Grass biomass (GB) and browse biomass (BB) were derived from the food availability study. From the grass plots, the grass cover (GC) was examined and percentage ratings were given based on qualitative assessment. The texture of the grass was determined based on the abrasiveness of the leaf blade and stem thickness (Jarman and Sinclair, 1979). On the basis of the texture, they were classified into soft grass (SG) and fibrous grass (FG), and quantified using percentage rating scales. The density of bamboo (DB) in different habitat types was estimated from sample plots. The percentage of young leaves (BY) and matured leaves (BM) of bamboo were also qualitatively assessed by periodical visits to the sample plots in different habitat types. Water availability (WA) was quantified using percentage ratings in different seasons across the habitats. Rainfall (RF) data were collected on monthly basis from the permanent rain gauges installed by the Forest Department and used for the analysis.

## Analysis

### Density distribution

The data from the blocks in the border areas were pooled and analysed for dung/pellet density estimates using computer program DISTANCE (Laake, *et al*., 1994). Similarly, the transect data for the interior areas were pooled together and analysed for the density estimates. The transect data from different habitats were also pooled together for density estimates in different habitats.

### Food availability

The biomass data from the plots for each habitat type were pooled separately and analysed for food availability estimation in different habitats.

## Results

### Seasonal distribution of elephants in different habitats

### Southern Ranges

The dung density and estimated elephant density in Southern Ranges in different vegetation types in 1995 and 1996 are given in Tables 94 and 95 Figures 37 and 38.

**Table 94. Estimated elephants density in different habitats in Southern Ranges in 1995**

| Season | Area | Dung density /km$^2$ | % CV | 95 % CI Lower | 95 % CI Upper | Elephant density /km$^2$ |
|---|---|---|---|---|---|---|
| Dry | DDF | 2127.70 | 10.99 | 1716.50 | 2637.00 | 2.50 |
| | MDF | 1744.10 | 13.10 | 1346.70 | 2258.00 | 2.00 |
| | PLN | 1029.80 | 20.01 | 687.84 | 1541.00 | 1.18 |
| Wet-1 | DDF | 127.03 | 14.59 | 94.87 | 170.00 | 0.59 |
| | MDF | 145.77 | 14.14 | 109.89 | 193.30 | 1.82 |
| | PLN | 136.79 | 18.57 | 93.87 | 199.30 | 1.71 |
| Wet-2 | DDF | 303.03 | 11.18 | 242.78 | 378.20 | 0.67 |
| | MDF | 362.64 | 12.31 | 283.90 | 463.20 | 1.37 |
| | PLN | 226.29 | 21.82 | 144.49 | 354.40 | 0.85 |

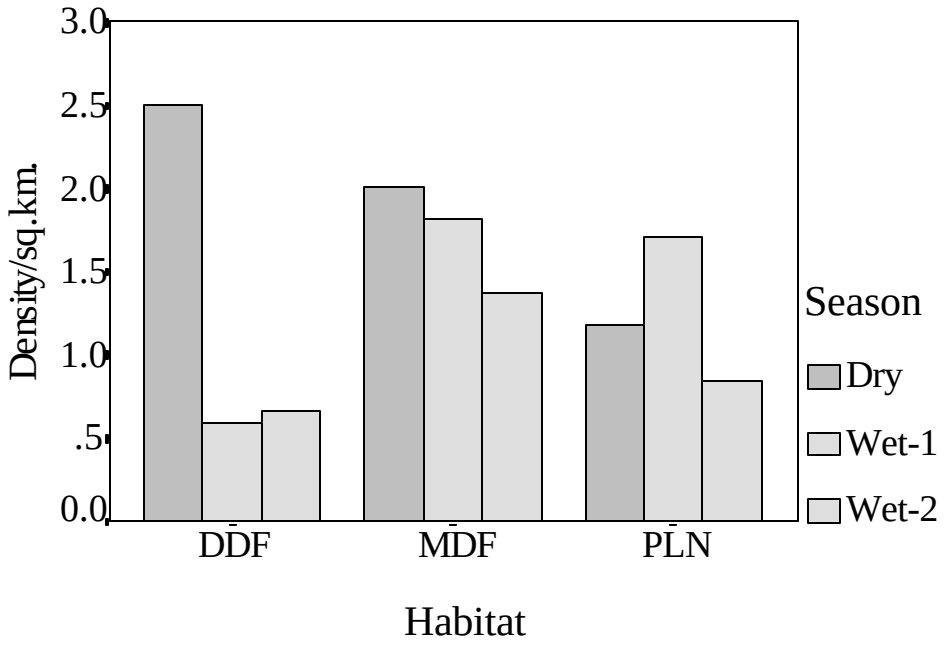
DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN = Plantations

Elephant density was higher in dry deciduous forest in the dry season in both 1995 and 1996. Moist deciduous had the highest density in first and second wet seasons.

**Table 95. Estimated elephants density in different habitats in Southern Ranges in 1996**

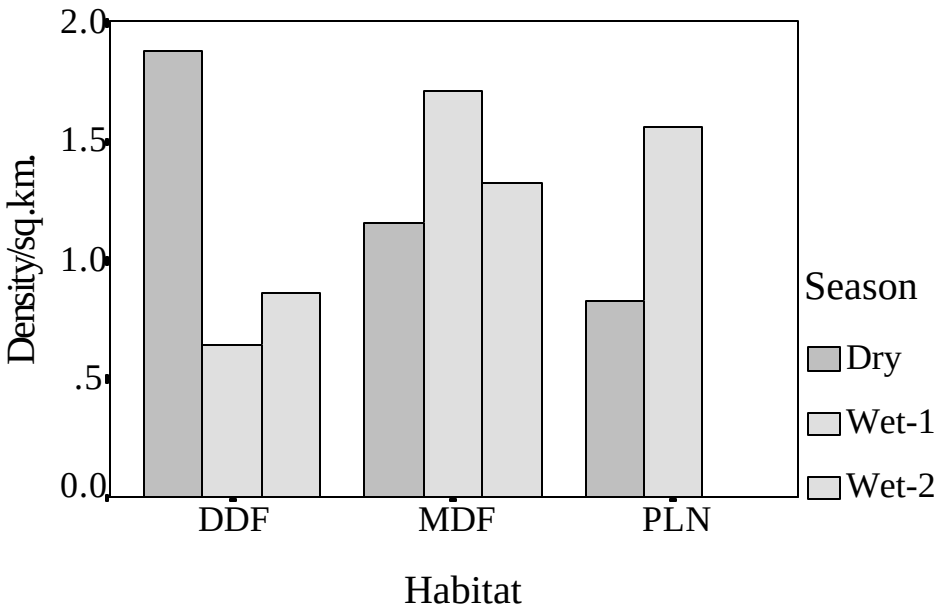
| Season | Area | Dung density /km$^2$ | % CV | 95 % CI Lower | Upper | Elephant density /km$^2$ |
|---|---|---|---|---|---|---|
| Dry | DDF | 1601.80 | 12.64 | 1251.50 | 2050.00 | 1.88 |
| | MDF | 1009.60 | 16.49 | 727.76 | 1400.00 | 1.16 |
| | PLN | 725.77 | 24.38 | 441.46 | 1193.00 | 0.83 |
| Wet-1 | DDF | 138.04 | 23.87 | 91.26 | 184.82 | 0.64 |
| | MDF | 137.15 | 26.47 | 85.27 | 189.03 | 1.71 |
| | PLN | 125.21 | 33.49 | 59.56 | 190.86 | 1.56 |
| Wet-2 | DDF | 395.44 | 20.41 | 262.40 | 595.94 | 0.87 |
| | MDF | 355.46 | 19.60 | 240.22 | 526.00 | 1.33 |

DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN = Plantations




DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 37. Density of elephant in different habitat types in 1995 –Southern Ranges**




DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 38. Density of elephant in different habitat types in 1996 -Southern Ranges**

**Northern Ranges**

The estimated elephant density in Northern Ranges (Tholpetty) in different vegetation types are given in Tables 27 and 28 and are presented in Figures 36 and 37.

**Table96. Estimated elephants density in different habitats in Northern Ranges in 1995**

| Season | Area | Dung density /km$^2$ | % CV | 95 % CI Lower | 95 % CI Upper | Elephant density /km$^2$ |
|---|---|---|---|---|---|---|
| Dry | PLN | 1349.30 | 48.45 | 519.20 | 3506.50 | 1.55 |
| | MDF | 125.00 | 40.82 | 47.83 | 326.70 | 0.14 |
| Wet-1 | PLN | 61.91 | 45.61 | 23.78 | 161.17 | 0.77 |
| | MDF | 166.67 | 70.71 | 10.76 | 2581.10 | 2.08 |
| Wet-2 | PLN | 85.50 | 27.33 | 48.84 | 149.67 | 0.32 |
| | MDF | 765.00 | 82.19 | 163.84 | 3572.00 | 2.88 |

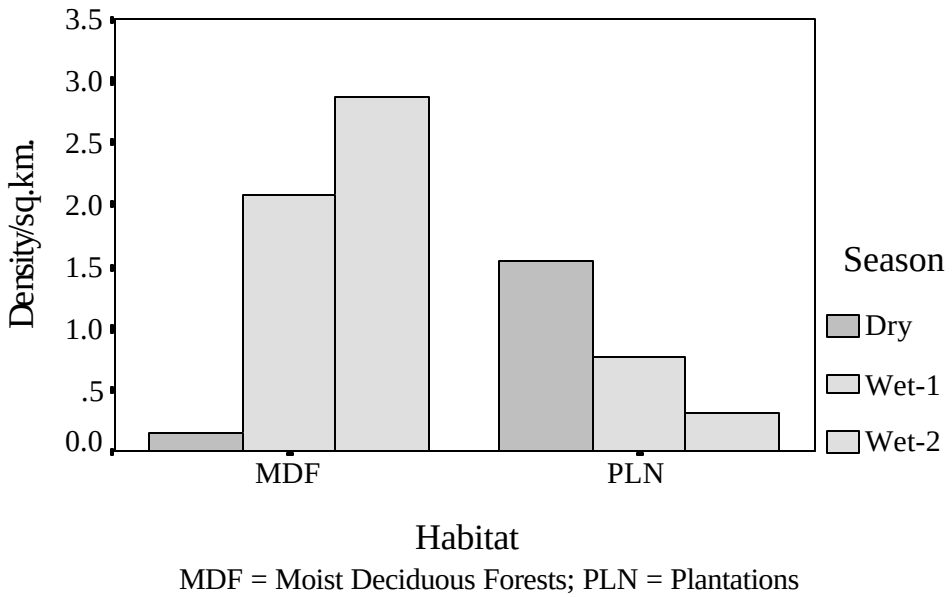
MDF = Moist Deciduous Forests; PLN = Plantations

Plantation areas had higher density in the dry season of 1995 where as moist deciduous recorded higher density in 1996. First and second wet seasons of 1995 recorded higher density in moist deciduous forests. There was no difference in elephant density between types in first wet season of 1996. However, there were marked difference in second wet season during the year.

**Table 97. Estimated elephants density in different habitats in Northern Ranges in1996**

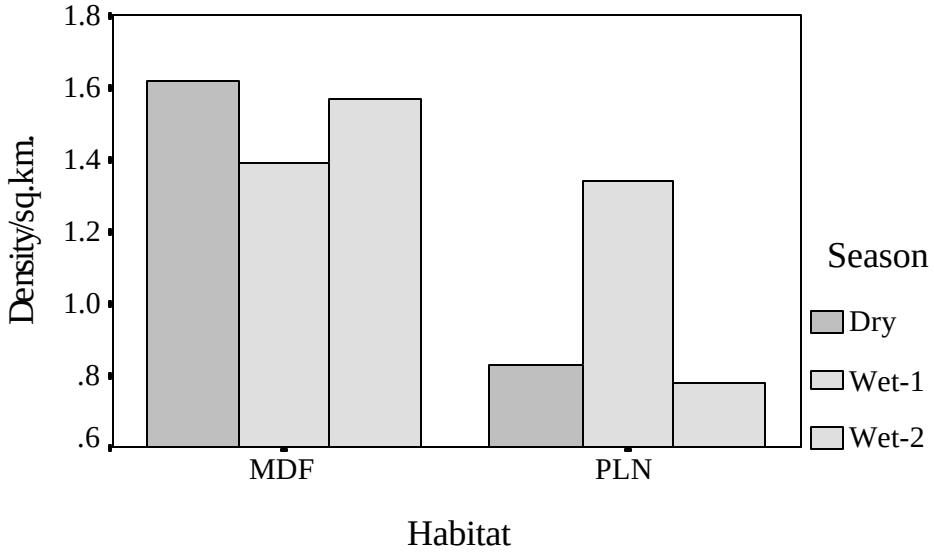
| Season | Area | Dung density /km$^2$ | % CV | 95 % CI | | Elephant density /km$^2$ |
|---|---|---|---|---|---|---|
| | | | | Lower | Upper | |
| Dry | PLN | 725.67 | 17.22 | 515.82 | 1020.90 | 0.83 |
| | MDF | 1411.70 | 19.37 | 959.45 | 2077.10 | 1.62 |
| Wet-1 | PLN | 107.14 | 25.82 | 62.35 | 184.11 | 1.34 |
| | MDF | 111.11 | 35.36 | 50.36 | 245.17 | 1.34 |
| Wet-2 | PLN | 208.33 | 18.90 | 141.95 | 305.76 | 0.78 |
| | MDF | 416.67 | 21.82 | 266.04 | 652.57 | 1.57 |

MDF = Moist Deciduous Forests; PLN = Plantations




MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 39. Elephant density in different habitat types in1995 - Northern Ranges**




MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 40. Elephant density in different habitat types in1996 – Northern Ranges**

**Central Range**

The estimated elephant density in different habitat types in the Central Ranges is summarised in Tables 99 and 100. These are presented in Figures 38 and 39.

Elephant density was comparatively higher in moist deciduous forest in dry season and plantations in first wet season and second wet seasons in 1995. In 1996, moist deciduous had the higher density in dry and first wet seasons. Plantation had more elephants in second wet season.

**Table 99. Density of elephants in different habitats in Central Ranges in 1995**

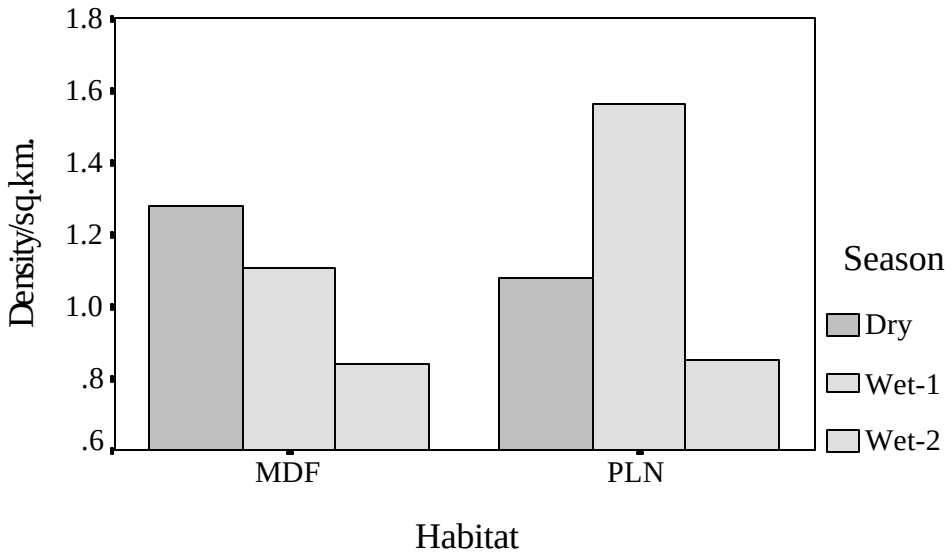
| Season | Area | Dung density/km$^2$ | % CV | 95 % CI Lower | 95 % CI Upper | Elephant density /km$^2$ |
|---|---|---|---|---|---|---|
| Dry | PLN | 946.55 | 16.72 | 678.69 | 1320.10 | 1.08 |
| | MDF | 1093.00 | 18.14 | 760.01 | 1572.00 | 1.25 |
| Wet-1 | PLN | 125.00 | 26.73 | 71.16 | 219.58 | 1.56 |
| | MDF | 89.29 | 44.72 | 29.79 | 267.64 | 1.11 |
| Wet-2 | PLN | 226.19 | 16.22 | 163.23 | 313.43 | 0.85 |
| | MDF | 223.21 | 20.00 | 148.44 | 335.66 | 0.84 |

MDF = Moist Deciduous Forests; PLN = Plantations

**Table 100. Density of elephants in different habitats in Central Ranges in 1996**

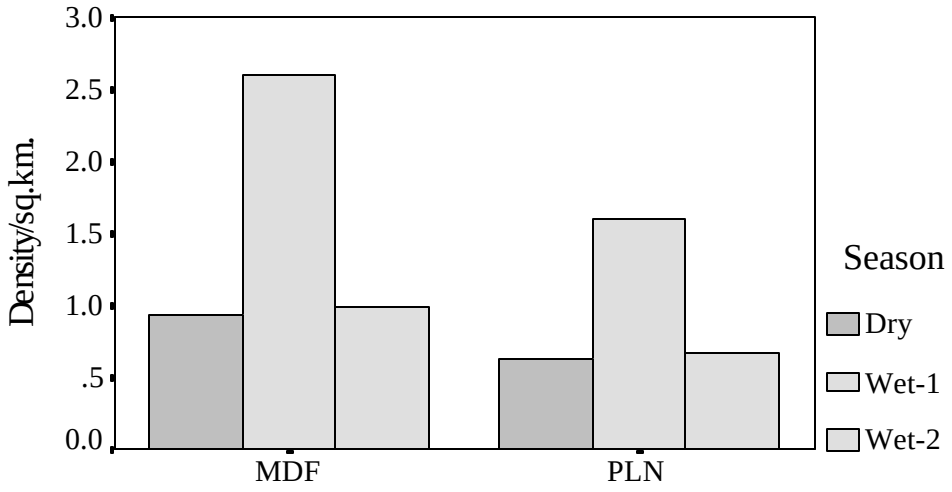
| Season | Area | Dung density /km$^2$ | % CV | 95 % CI | | Elephant density /km$^2$ |
|---|---|---|---|---|---|---|
| | | | | Lower | Upper | |
| Dry | PLN | 547.41 | 22.65 | 345.94 | 866.21 | 0.63 |
| | MDF | 808.42 | 31.85 | 426.16 | 1533.60 | 0.93 |
| Wet-1 | PLN | 128.57 | 33.33 | 61.70 | 267.93 | 1.60 |
| | MDF | 208.33 | 37.80 | 57.79 | 494.41 | 2.60 |
| Wet-2 | PLN | 263.05 | 27.71 | 147.79 | 468.18 | 0.99 |
| | MDF | 178.57 | 44.72 | 59.57 | 535.28 | 0.67 |

MDF = Moist Deciduous Forests; PLN = Plantations




MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 41. Density of elephants in different habitat types in 1995 –Central Ranges**




MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 42. Density of elephants in different habitat types in 1996 –Central Ranges**

**Seasonal distribution of gaur in different habitats**

**Southern Ranges**

The dung density of gaur in Southern Ranges in different vegetation types in 1995 and 1996 are given in Tables 101 and 102 and Figures 43 and 44.

Gaur dung density was higher in dry deciduous forest in all the seasons in 1995 and 1996.

**Table 101. Gaur dung density in different habitats in Southern Ranges in1995**

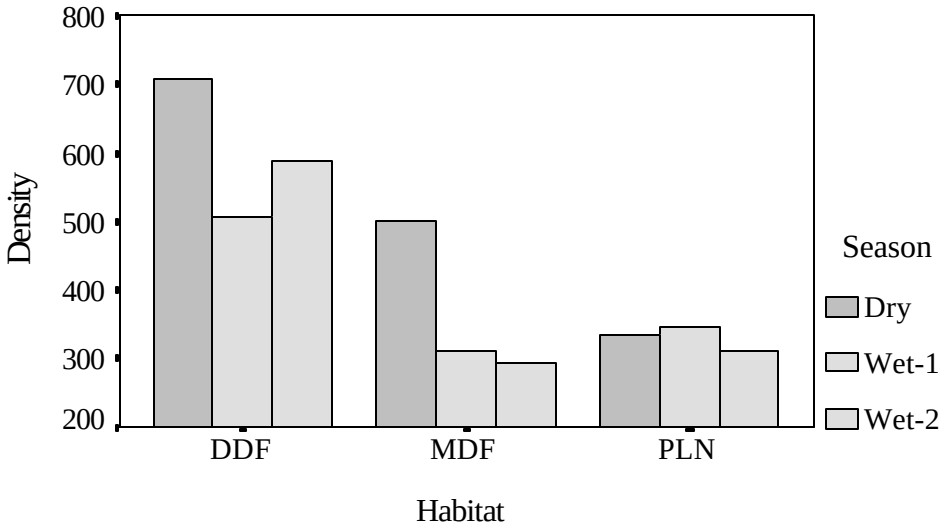
| Season | Area | Dung density/km$^2$ | % CV | 95 % CI Lower | Upper |
|---|---|---|---|---|---|
| Dry | DDF | 708.11 | 20.93 | 417.62 | 998.60 |
| | MDF | 502.70 | 22.16 | 284.36 | 721.04 |
| | PLN | 332.84 | 27.35 | 154.42 | 511.26 |
| Wet-1 | DDF | 508.19 | 24.99 | 259.28 | 757.10 |
| | MDF | 311.32 | 32.91 | 110.51 | 512.13 |
| | PLN | 345.54 | 25.90 | 170.13 | 520.95 |
| Wet-2 | DDF | 590.06 | 28.10 | 265.08 | 915.04 |
| | MDF | 294.40 | 25.94 | 144.72 | 444.08 |
| | PLN | 310.00 | 27.72 | 141.55 | 478.45 |

DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN = Plantations

**Table 102. Gaur dung density in different habitats in Southern Ranges in 1996**

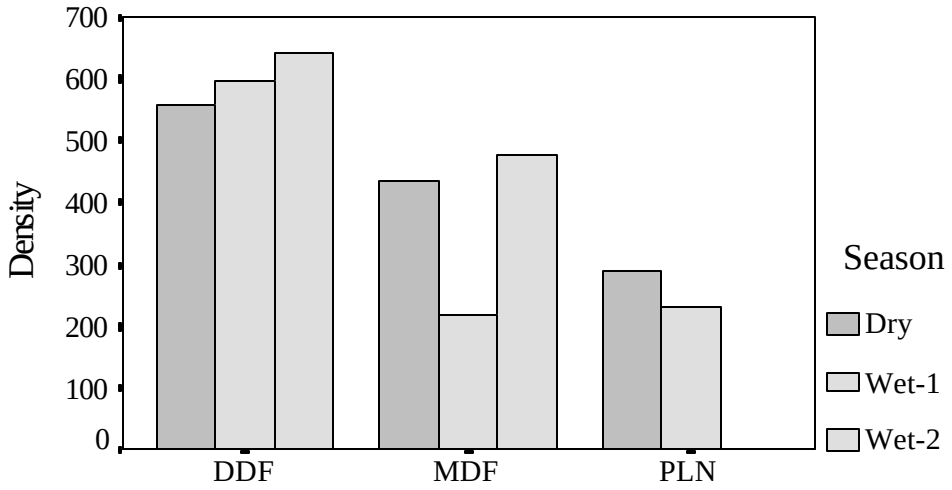
| Season | Area | Dung density/km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Dry | DDF | 556.35 | 20.43 | 333.57 | 779.13 |
| | MDF | 432.48 | 22.75 | 239.64 | 625.32 |
| | PLN | 291.10 | 28.93 | 126.04 | 456.16 |
| Wet-1 | DDF | 600.12 | 24.23 | 315.12 | 885.12 |
| | MDF | 216.28 | 26.27 | 104.92 | 327.64 |
| | PLN | 231.91 | 24.44 | 120.82 | 343.00 |
| Wet-2 | DDF | 644.99 | 25.89 | 378.43 | 1099.3 |
| | MDF | 478.01 | 26.40 | 277.65 | 822.98 |

DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN= Plantations.




DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN= Plantations.

**Fig 43. Density of gaur dung in different habitat types in1995 Southern Ranges**




DDF= Dry Deciduous Forest; MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 44. Density of gaur dung in different habitat types in 1996 - Southern Ranges**

**Northern Ranges**

The gaur dung density in Northern Ranges in different vegetation types in 1995 and 1996 are given in Table 103 and 104 and Figures 45 and 46.

Dung density of gaur was higher in moist deciduous forest in first wet and second wet seasons of 1995 and dry, first and second wet seasons of 1996.

**Table 103. Gaur dung density in different habitats in Northern Ranges in1995**

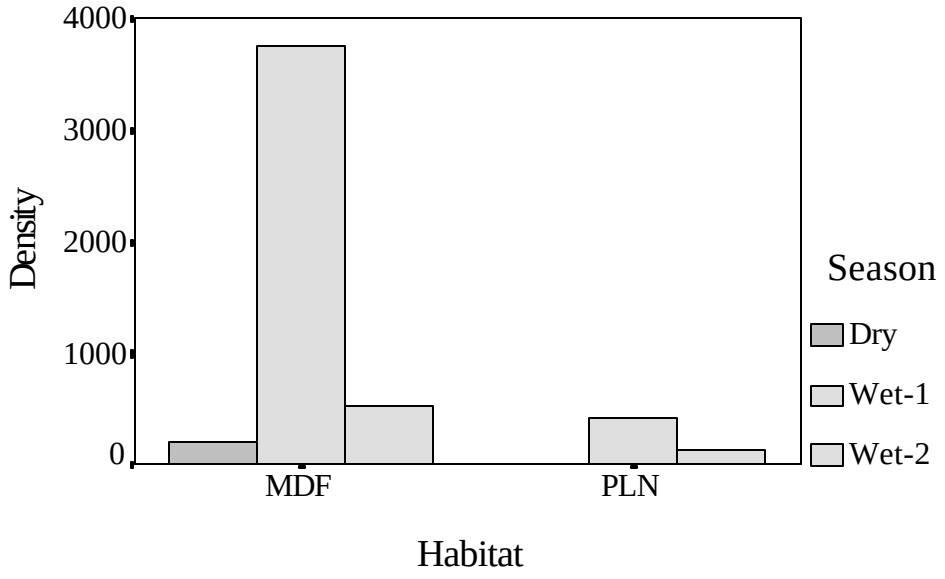
| Season | Area | Dung density /km$^2$ | % CV | 95 % CI Lower | Upper |
|---|---|---|---|---|---|
| Dry | MDF | 208.33 | 37.80 | 87.788 | 494.41 |
| | PLN | - | - | - | - |
| Wet-1 | MDF | 3764.3 | 83.50 | 372.05 | 38086.0 |
| | PLN | 423.22 | 53.86 | 135 | 1325.4 |
| Wet-2 | MDF | 542.09 | 49.51 | 187.98 | 1563.2 |
| | PLN | 133.93 | 57.74 | 24.303 | 738.04 |

MDF = Moist Deciduous Forests; PLN = Plantations

**Table 104. Gaur dung density in different habitats in Northern Ranges in1996**

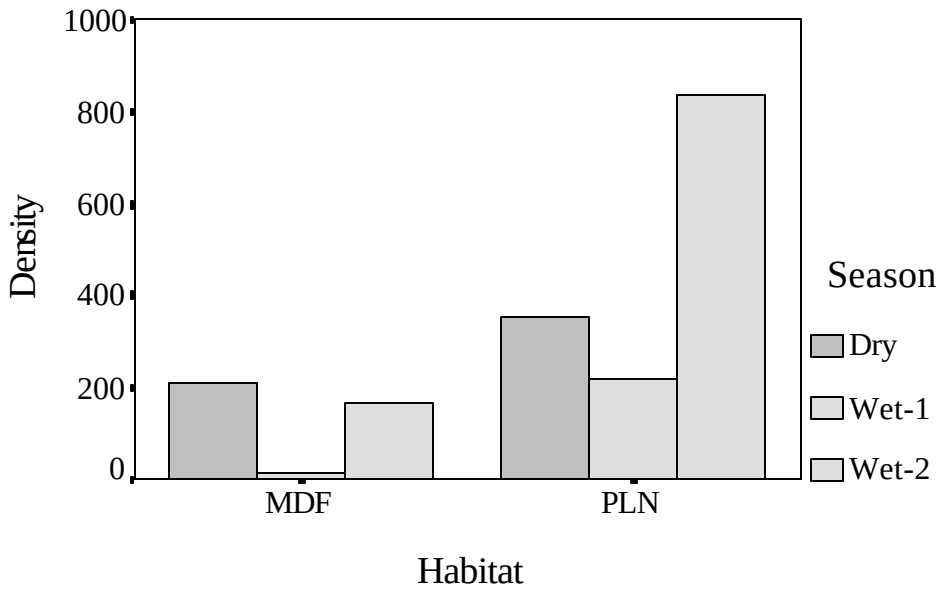
| Season | Area | Dung density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Dry | MDF | 211.27 | 35.12 | 98.816 | 451.70 |
| | PLN | 353.97 | 54.52 | 111.64 | 1122.3 |
| Wet-1 | MDF | 16.502 | 50.00 | 4.4466 | 61.239 |
| | PLN | 216.35 | 33.33 | 103.82 | 540.84 |
| Wet-2 | MDF | 167.21 | 67.08 | 24.038 | 1163.1 |
| | PLN | 833.58 | 32.95 | 418.66 | 1659.7 |

MDF = Moist Deciduous Forests; PLN = Plantations




MDF= Moist Deciduous Forest, PLN= Plantations

**Fig 45. Density of gaur in Northern Ranges in different habitat types in 1995**




MDF= Moist Deciduous Forest, PLN= Plantations

**Fig 46. Density of gaur in Northern Ranges in different habitat types in 1996**

**Density of sambar deer pellets in different habitats**

**Southern Ranges**

Pellet density of sambar deer in 1995 and 1996 in Southern ranges are given in Tables 105 and 106, and Figures 47 and 48. Higher density was recorded in dry deciduous forest in dry season and second wet season. Pellet density was comparatively higher in moist deciduous in first wet season in 1995.

Density of sambar deer was more in moist deciduous forest in all the seasons in 1996.

**Table 105. Sambar deer pellet density in different habitats in Southern Ranges in 1995**

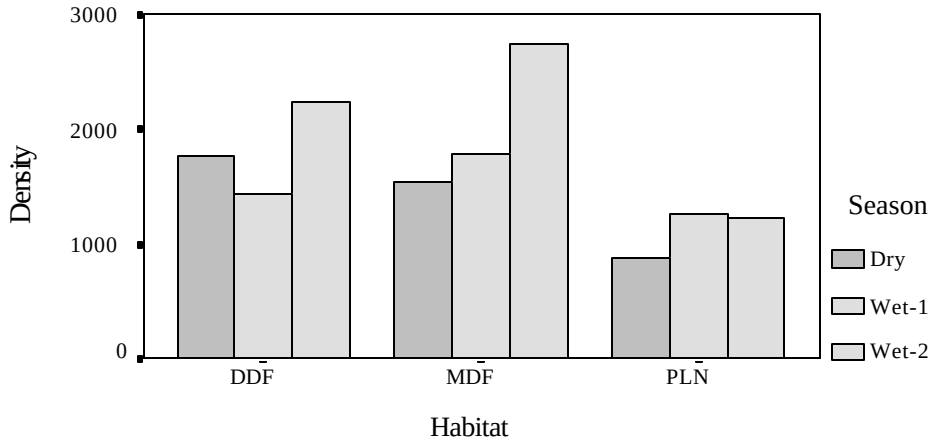
| Season | Area | Density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Dry | DDF | 1779.00 | 29.10 | 764.33 | 2793.67 |
| | MDF | 1549.00 | 37.20 | 419.59 | 2678.41 |
| | PLN | 895.20 | 25.30 | 451.29 | 1339.11 |
| Wet-1 | DDF | 1435.00 | 27.20 | 669.97 | 2200.03 |
| | MDF | 1789.00 | 18.20 | 1150.83 | 2427.17 |
| | PLN | 1255.00 | 21.90 | 716.30 | 1793.70 |
| Wet-2 | DDF | 2248.00 | 21.60 | 1296.29 | 3199.71 |
| | MDF | 2739.00 | 37.20 | 741.94 | 4736.06 |
| | PLN | 1230.00 | 39.60 | 275.32 | 2184.68 |

DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN = Plantations

**Table 106. Sambar deer pellet density in different habitats in Southern Ranges in 1996**

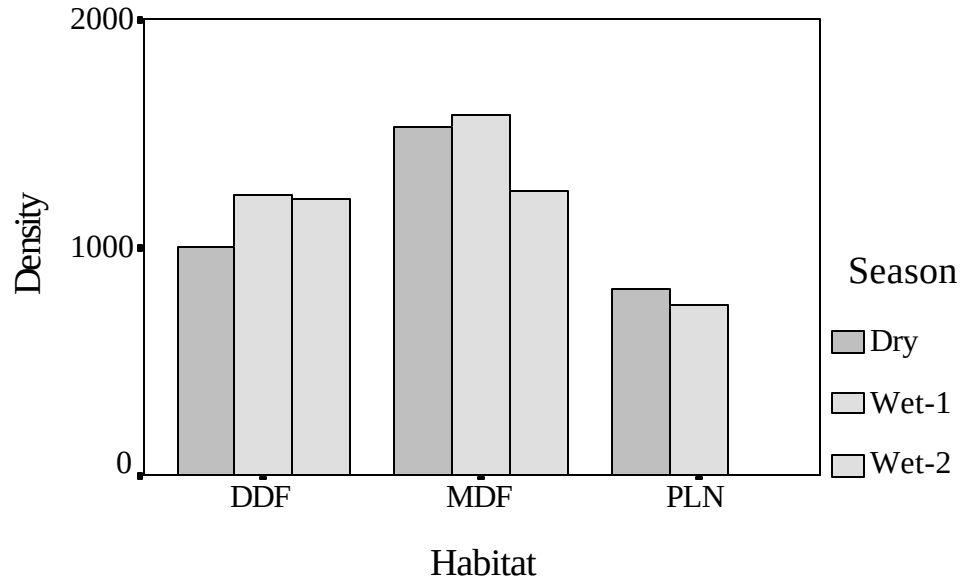
| Season | Area | Density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Dry | DDF | 1008.20 | 28.98 | 435.53 | 1580.87 |
| | MDF | 1521.00 | 29.20 | 650.50 | 2391.50 |
| | PLN | 813.90 | 28.15 | 364.84 | 1262.96 |
| Wet-1 | DDF | 1227.00 | 21.60 | 707.54 | 1746.46 |
| | MDF | 1581.06 | 23.00 | 868.32 | 2293.80 |
| | PLN | 747.90 | 46.40 | 67.73 | 1428.07 |
| Wet-2 | DDF | 1213.20 | 34.21 | 578.15 | 2545.70 |
| | MDF | 1246.40 | 27.09 | 714.11 | 2175.50 |

DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN = Plantations




DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 47. Density of sambar deer pellets in different habitat types in 1995 - Southern Ranges**




DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 48. Density of sambar deer pellets in different habit types in 1996 - Southern Ranges**

**Northern Ranges**

The pellet density of sambar in Northern Ranges in different vegetation types in 1995 and 1996 are given in Tables 107and 108, and Figures 49 and 50.

Pellet density of sambar was high in teak plantation in dry and first wet seasons of 1995 and dry, first and second wet seasons of 1996.

**Table 107. Sambar deer pellet density in different habitats in Northern Ranges in 1995**

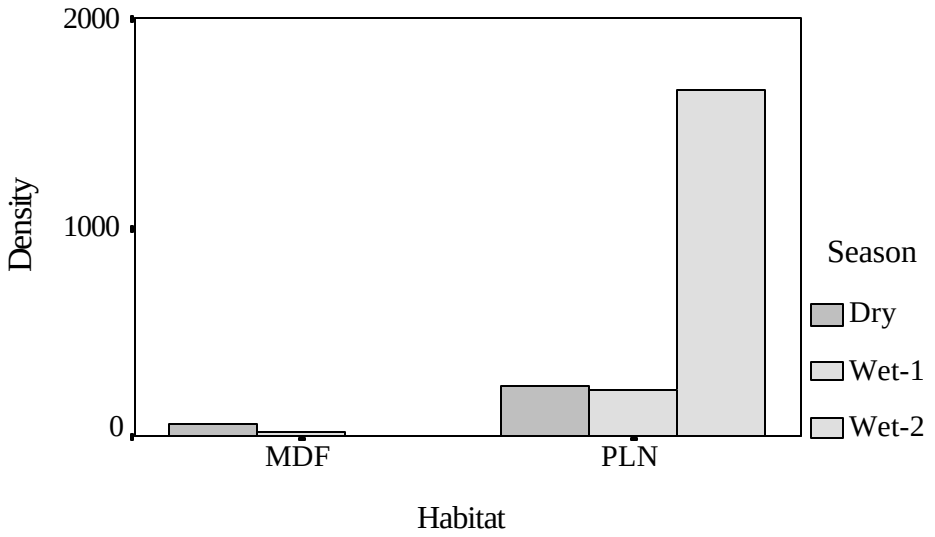
| Season | Area | Density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Dry | MDF | 62.500 | 57.74 | 11.342 | 344.42 |
| | PLN | 239.42 | 86.60 | 9.5761 | 5986.1 |
| Wet-1 | MDF | 20.833 | 100.00 | .53040E-03 | .81831E+06 |
| | PLN | 224.13 | 115.47 | .18669E-02 | .26909E+08 |
| Wet-2 | MDF | - | - | - | - |
| | PLN | 1662.3 | 141.42 | 213.06 | 1296.9.0 |

MDF = Moist Deciduous Forests; PLN = Plantations

**Table 108. Sambar deer pellet density in different habitats in Northern Ranges in 1996**

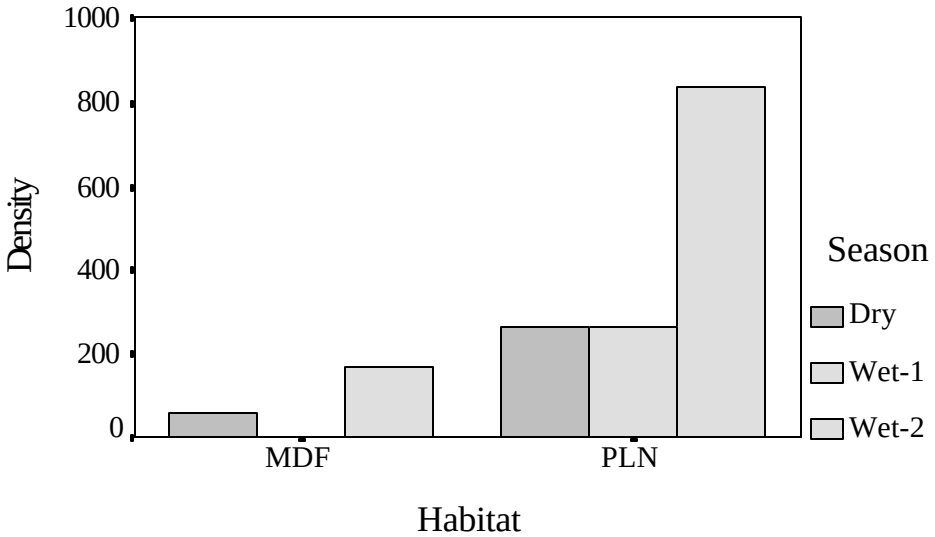
| Season | Area | Density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Dry | MDF | 62.500 | 57.74 | 11.342 | 344.42 |
| | PLN | 267.12 | 76.38 | 14.451 | 4937.6 |
| Wet-1 | MDF | - | - | - | - |
| | PLN | 267.12 | 76.38 | 14.451 | 4937.6 |
| Wet-2 | MDF | 167.21 | 67.08 | 24.038 | 1163.1 |
| | PLN | 833.58 | 32.95 | 418.66 | 1659.7 |

MDF = Moist Deciduous Forests; PLN = Plantations




MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 49. Density of sambar deer pellets in different habitat types in 1995 - Northern Ranges**




MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 50. Density of sambar deer pellets in different habitat types in 1996 - Northern Ranges**

**Spotted deer pellet density in different habitats**

**Southern Ranges**

The pellet density of spotted deer in Southern ranges in 1995 and 1996 are given in Tables 109 and 110, and Figures 51 and 52.

Moist deciduous forest was observed to have higher pellet density in dry season and dry deciduous in first wet and second wet seasons of 1995.

**Table 109. Spotted deer pellet density in different habitats in Southern Ranges in 1995**

| Season | Area | Density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Dry | DDF | 750.00 | 22.54 | 418.66 | 1081.34 |
| | MDF | 1300.00 | 30.60 | 520.31 | 2079.69 |
| | PLN | 295.60 | 29.10 | 127.00 | 464.20 |
| Wet-1 | DDF | 8866.00 | 33.00 | 3131.47 | 14600.53 |
| | MDF | 2284.00 | 38.80 | 547.06 | 4020.94 |
| | PLN | 3391.00 | 33.90 | 1137.88 | 5644.12 |
| Wet-2 | DDF | 1150.00 | 36.00 | 338.56 | 1961.44 |
| | MDF | 640.00 | 48.40 | 32.87 | 1247.13 |
| | PLN | 385.80 | 39.40 | 87.87 | 683.73 |

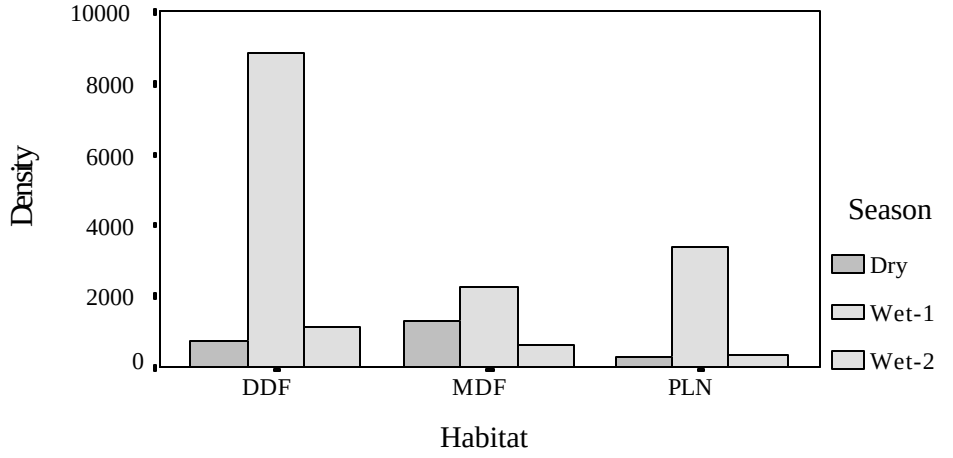
DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN = Plantations

In 1996, pellet density was higher in dry deciduous forest in dry and first wet seasons and moist deciduous in second wet season.

**Table 110. Spotted deer pellet density in different habitats in Southern Ranges in 1996**

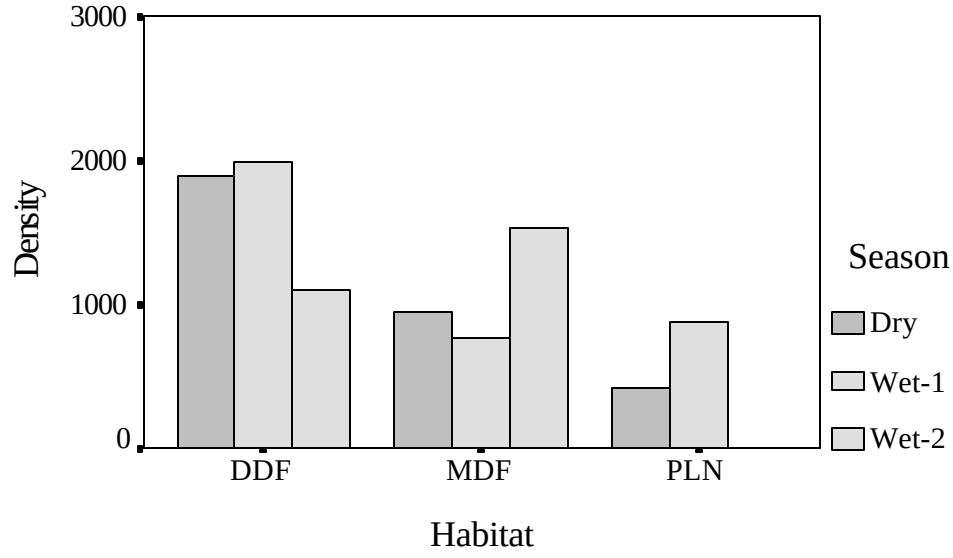
| Season | Area | Density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Dry | DDF | 1869.40 | 22.80 | 1034.00 | 2704.80 |
| | MDF | 945.87 | 34.82 | 300.34 | 1591.40 |
| | PLN | 425.07 | 30.64 | 169.80 | 680.34 |
| Wet-1 | DDF | 1986.80 | 12.40 | 1503.93 | 2469.67 |
| | MDF | 768.10 | 22.41 | 430.72 | 1105.48 |
| | PLN | 876.26 | 27.98 | 395.71 | 1356.81 |
| Wet-2 | DDF | 1097.20 | 42.06 | 451.30 | 2667.30 |
| | MDF | 1534.20 | 21.82 | 980.86 | 2399.70 |

DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN= Plantations.




DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN= Plantations.

**Fig 51. Density of spotted deer pellets in different habitat types in1995 - Southern Ranges**




DDF = Dry Deciduous Forests; MDF = Moist Deciduous Forests; PLN= Plantations.

**Fig 52. Density of spotted deer pellets in different habitat types in1996 - Southern Ranges**

**Northern Ranges**

The pellet density of spotted deer in Northern Ranges in different vegetation types in 1995 and 1996 are given in Tables 111 and 112, and Figures 53 and 54. The pellet density of spotted deer was high in Teak plantations in dry and second wet seasons of 1995, moist deciduous forest in dry season and plantation in first wet season of 1996.

**Table 111. Spotted deer pellet density in different habitats in Northern Ranges in 1995**

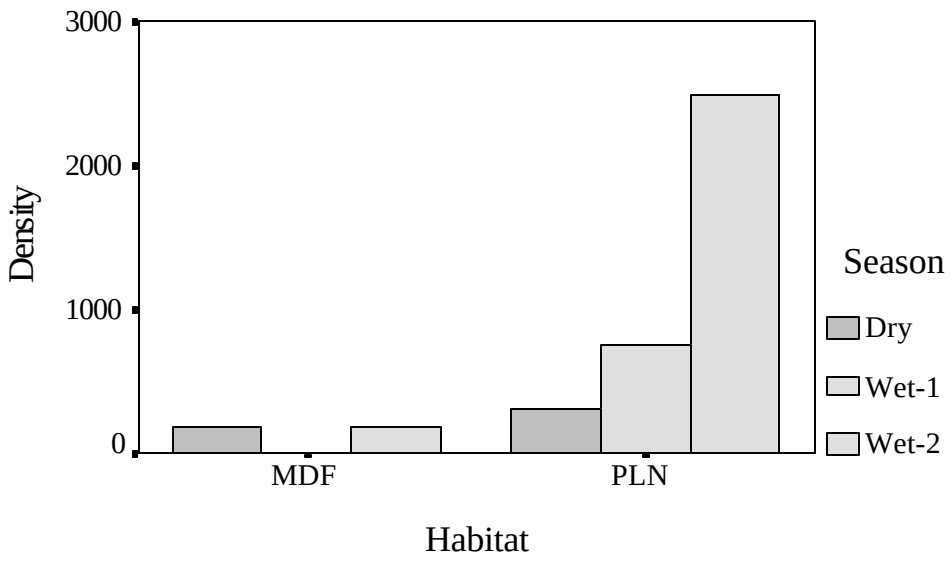
| Season | Area | Density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Dry | MDF | 179.27 | 82.19 | 8.1456 | 3945.3 |
| | PLN | 312.50 | 75.63 | 48.305 | 2021.7 |
| Wet-1 | MDF | - | - | - | - |
| | PLN | 753.93 | 49.74 | 255.09 | 2525.3 |
| Wet-2 | MDF | 190.95 | 127.02 | .74529E-03 | .48922E+08 |
| | PLN | 2493.4 | 141.42 | 319.59 | 19453.0 |

MDF = Moist Deciduous Forests; PLN = Plantations

**Table 112. Spotted deer pellet density in different habitats in Northern Ranges in 1996**

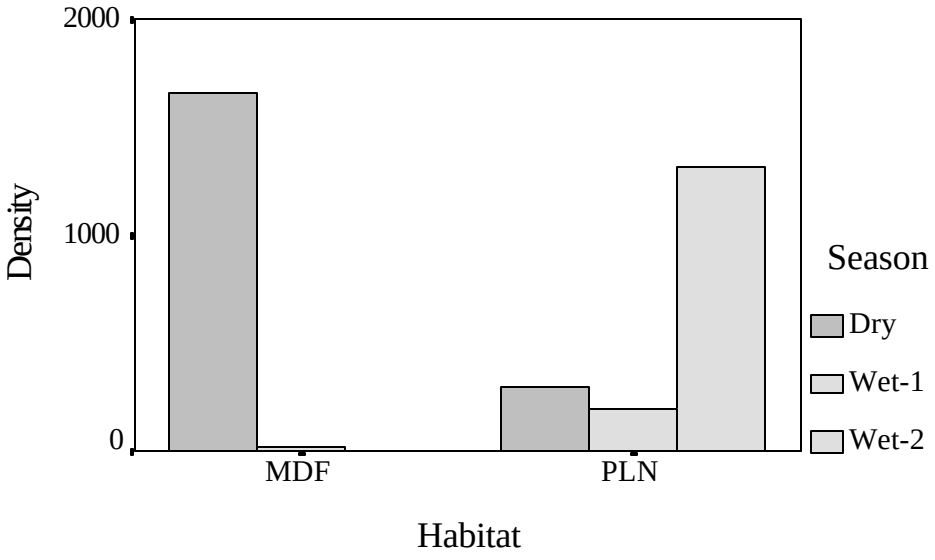
| Season | Area | Density /km$^2$ | % CV | 95 % CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Dry | MDF | 1662.3 | 141.42 | 213.06 | 12969.0 |
| | PLN | 299.99 | 91.29 | .15169E-01 | .59326E+07 |
| Wet-1 | MDF | 20.833 | 100.00 | .53040E-03 | .81831E+06 |
| | PLN | 205.15 | 102.23 | .44103E-02 | .95430E+07 |
| Wet-2 | MDF | - | - | - | - |
| | PLN | 1319.9 | 38.65 | 574.79 | 3030.7 |

MDF = Moist Deciduous Forests; PLN = Plantations




MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 53. Density of spotted deer pellets in different habitat types in 1995 - Northern Ranges**




MDF = Moist Deciduous Forests; PLN = Plantations

**Fig 54. Density of spotted deer pellets in different habitat types in 1996 - Northern Ranges**

**Food species of different animals in the study area**

The elephants in Wayanad were observed to feed and about 97 species of plants. The grasses dominate among them. About 92 plant species found to the food of sambar deer in the area and about 93 of spotted deer. Though gaur were observed on different location information of food species could not be collected.

**Table 113. List of plants fed by elephants in Wayanad**

| Sl.No. | Family | Species |
|---|---|---|
| 1 | **Cyperaceae** | *Cyperus compressus* |
| 2 | | *C. distans* |
| 3 | | *C. exaltatus* |
| 5 | | *C. pilosus* |
| 6 | | *Fimbristylis dichotoma* |
| 7 | | *F. littoralis* |
| 8 | | *Kyllinga monocephala* |
| 9 | | *Scleria laevis* |
| 10 | | *Rhyncospora sp.* |
| 11 | **Poaceae** | *Arthraxon lanceolatus* |
| 12 | | *Alloteropsis cimicina* |
| 13 | | *Apluda mutica* |
| 14 | | *Bambusa arundinacea* |
| 15 | | *Brachiaria miliiformis* |
| 16 | | *Capillipedium filiculmis* |
| 17 | | *Chrysopogon aciculatus* |
| 18 | | *Cymbopogon flexuosus* |
| 20 | | *Cynodon dactylon* |
| 21 | | *Cyrtococcum patens* |
| 22 | | *Dactyloctenium aegyptium* |
| 23 | | *Digitaria ciliaris* |
| 24 | | *D. longiflora* |

| | | |
|---|---|---|
| 25 | | *D. setigera* |
| 26 | | *Echinochloa colona* |
| 27 | | *Eleusine indica* |
| 28 | | *Eragrostis tenella* |
| 29 | | *E. tenuifolia* |
| 30 | | *E. unioloides* |
| 31 | | *Eriochloa procera* |
| 32 | | *Heteropogon contortus* |
| 33 | | *Imperata cylindrica* |
| 34 | | *Ischaemum indicum* |
| 35 | | *I. rangacharianum* |
| 36 | | *Oplismenus compositus* |
| 37 | | *Oryza meyeriana* ssp. *granulata* |
| 38 | | *Panicum notatum* |
| 39 | | *P. indicum* |
| 40 | | *P. maximum* |
| 41 | | *Paspalidium flavidum* |
| 42 | | *Paspalum punctatum* |
| 43 | | *P. conjugatum* |
| 44 | | *P. scrobiculatum* |
| 45 | | *Pennisetum hohenackeri* |
| 46 | | *Setaria palmifolia* |
| 47 | | *S. pumila* |
| 48 | | *S. intermedia* |
| 49 | | *Sporobolus indicus* |
| 50 | | *Themeda cymbaria* |
| 51 | | *T. triandra* |
| 52 | | *T. tremula* |
| 53 | **Scrophulariaceae** | *Scoparia dulcis* |
| 54 | **Hypoxidaceae** | *Curculigo orchioides* |
| 55 | **Asclepiadaceae** | *Hemidesmus indicus* |

| | | |
|---|---|---|
| 56 | **Euphorbiaceae** | *Phyllanthus urinaria* |
| 57 | **Malvaceae** | *Sida acuta* |
| 58 | | *Sida mysorensis* |
| 59 | | *S. rhombifolia* |
| 60 | | *Thespesia lampas* |
| 61 | | *Urena lobata* ssp. *sinuata* |
| 62 | | *U. lobata* ssp. *lobata* |
| 63 | **Mimosaceae** | *Mimosa pudica* |
| 64 | **Papilionaceae** | *Desmodium gangeticum* |
| 65 | | *D. triangulare* |
| 66 | **Rhamnaceae** | *Zizyphus xylopyrus* |
| 67 | **Sterculiaceae** | *Helicteres isora* |
| 68 | **Tiliaceae** | *Triumfetta rhomboidea* |
| 69 | | *Grewia hirsuta* |
| 70 | **Verbenaceae** | *Lantana camara* |
| 71 | **Zingiberaceae** | *Curcuma* sp. |
| 72 | | *Globba marantina* |
| 73 | **Anacardiaceae** | *Mangifera indica* |
| 74 | **Bignoniaceae** | *Stereospermum colais* |
| 75 | **Bombacaceae** | *Bombax ceiba* |
| 76 | **Caesalpiniaceae** | *Bauhinia racemosa* |
| 77 | **Combretaceae** | *Terminalia alata* |
| 78 | | *T. crenulata* |
| 79 | | *T. paniculata* |
| 80 | **Dipterocarpaceae** | *Shorea roxburghii* |
| 81 | **Ebenaceae** | *Diospyros montana* |
| 82 | **Euphorbiaceae** | *Bridelia retusa* |
| 83 | | *Emblica officinalis* |
| 84 | **Lecythidaceae** | *Careya arborea* |
| 85 | **Lythraceae** | *Lagerstroemia microcarpa* |
| 86 | **Malvaceae** | *Kydia calycina* |

| | | |
|---|---|---|
| 87 | **Moraceae** | *Ficus bengalensis* |
| 88 | **Myrtaceae** | *Syzygium cumini* |
| 89 | **Oleaceae** | *Schrebera swietenioides* |
| 90 | **Papilionaceae** | *Dalbergia latifolia* |
| 91 | | *Pterocarpus marsupium* |
| 92 | **Rubiaceae** | *Randia dumatorum* |
| 93 | **Sapindaceae** | *Schleichera oleosa* |
| 94 | **Sterculiaceae** | *Sterculia villosa* |
| 95 | **Tiliaceae** | *Grewia tiliaefolia* |
| 96 | **Verbenaceae** | *Gmelina arborea* |
| 97 | | *Tectona grandis* |

**Table 114. List of plants fed by sambar deer in Wayanad**

| Sl.No | Family | Species |
|---|---|---|
| 1 | **Poaceae** | *Alloteropsis cimicina* |
| 2 | | *Arthraxon lanceolatus* |
| 3 | | *Arundinella purpurea* |
| 4 | | *Axonopus compressus* |
| 5 | | *Bambusa arundinacea* |
| 6 | | *Brachiaria miliiformis* |
| 7 | | *Capillipedium filiculamis* |
| 8 | | *Centotheca lappacea* |
| 9 | | *Chloris dolichostachya* |
| 10 | | *Cynodon arcuatus* |
| 11 | | *Cyrtococcum patens* |
| 12 | | *Dactyloctenium aegyptium* |
| 13 | | *Echinocloa colona* |
| 14 | | *Eleusine indica* |
| 15 | | *Eragrostis tenella* |
| 16 | | *E. tenuifolia* |
| 17 | | *E. unioloides* |
| 18 | | *Eriochloa procera* |

| | | |
|---|---|---|
| 19 | | *Heteropogon contortus* |
| 20 | | *Imperata cylindrica* |
| 21 | | *Leersia hexandra* |
| 22 | | *Oplismenus compositus* |
| 23 | | *Oryza meyeriana* ssp. *granulata* |
| 24 | | *O. rufipogon* |
| 25 | | *Ottochloa nodosa* |
| 26 | | *Panicum maximum* |
| 27 | | *P. notatum* |
| 28 | | *P. trypheron* |
| 29 | | *Paspalidium flavidum* |
| 30 | | *P. conjugatum* |
| 31 | | *P. scrobiculatum* |
| 32 | | *Sacciolepis indica* |
| 33 | | *Setaria intermedia* |
| 34 | | *S. palmifolia* |
| 35 | | *S. pumila* |
| 36 | | *Sporobolus indicus* |
| 37 | | *Themeda cymbaria* |
| 38 | | *T. triandra* |
| 39 | **Acanthaceae** | *Justicia simplex* |
| 40 | **Amaranthaceae** | *Achyranthus aspera* |
| 41 | **Balasaminaceae** | *Impatiens lenta* |
| 42 | | *Impatiens sp.* |
| 43 | **Boraginaceae** | *Cynoglossum furcatum* |
| 44 | **Commelinaceae** | *Murdannia japonica* |
| 45 | | *Cyanotis fasciculata* |
| 46 | **Compositae** | *Spilanthes radicans* |
| 47 | | *Ageratum conyzoides* |
| 48 | | *Elephantopus scaber* |
| 49 | | *Emelia sonchifolia* |
| 50 | | *Synedrella nodiflora* |

| | | |
|---|---|---|
| 51 | | *Tridax procumbens* |
| 52 | | *Vernonia cinerea* |
| 53 | | *Conryza bonariensis* |
| 54 | | *Conyza stricta* |
| 55 | | *Spilanthes paniculata* |
| 56 | **Cyperaceae** | *Mariscus pictus* |
| 57 | | *Cyperus iria* |
| 58 | | *C. pilosus* |
| 59 | | *Fimbristylis dichotoma* |
| 60 | **Gentianaceae** | *Canscora diffusa* |
| 61 | **Hypoxidaceae** | *Curculigo orchioides* |
| 62 | **Malvaceae** | *Hibiscus lobatus* |
| 63 | | *Sida acuta* |
| 64 | | *S. alnifolia* |
| 65 | | *S. rhombifolia* |
| 66 | | *Thespesia lampas* |
| 67 | | *Urena lobata* ssp. *lobata* |
| 68 | | *U. lobata* ssp *sinuata* |
| 69 | **Mimosaceae** | *Mimosa pudica* |
| 70 | **Papilionaceae** | *Desmodium triflorum* |
| 71 | **Rubiaceae** | *Mitracarpus villosus* |
| 72 | **Hypoxidaceae** | *Curculigo orchioides* |
| 73 | **Papilionaceae** | *Desmodium triquetrum* |
| 74 | | *D. velutinum* |
| 75 | | *D. zonatum* |
| 76 | | *D. gangeticum* |
| 77 | | *D. triangulare* |
| 78 | **Rhamnaceae** | *Zizyphus oenoplea* |
| 79 | | *Z. rugosa* |
| 80 | **Sterculiaceae** | *Helicteres isora* |
| 81 | **Verbenaceae** | *Lantana camara* |
| 82 | **Anacardiaceae** | *Mangifera indica* |

| | | |
|---|---|---|
| 83 | **Combrctaceae** | *Terminalia paniculata* |
| 84 | | *T. tomentosa* |
| 85 | **Euphorbiaceae** | *Emblica officinalis* |
| 86 | **Lecythidaceae** | *Careya arborea* |
| 87 | **Myrtaceae** | *Syzygium cumini* |
| 88 | **Oleaceae** | *Olea dioica* |
| 89 | **Salicaceae** | *Salix tetrasperma* |
| 90 | **Verbenaceae** | *Gmelina arborea* |
| 91 | **Tiliaceae** | *Grewia tilifolia* |
| 92 | **Malvaceae** | *Kydia calycina* |

**Table 115. List of plants fed by spotted deer in Wayanad**

| Sl.No | Family | Species |
|---|---|---|
| 1 | **Poaceae** | *Alloteropsis cimicina* |
| 2 | | *Arthraxon lanceolatus* |
| 3 | | *Axonopus compressus* |
| 4 | | *Bambusa arundinacea* |
| 5 | | *Brachiria miliiformis* |
| 6 | | *Capillpedium filiculmis* |
| 7 | | *Chloris dolichostachya* |
| 8 | | *Cynodon arcuatus* |
| 9 | | *Digitaria ciliaris* |
| 10 | | *D. longiflora* |
| 11 | | *Echinochloa colona* |
| 12 | | *Eragrostis unioloides* |
| 13 | | *E. tenuifolia* |
| 14 | | *Eriochloa procera* |
| 15 | | *Leersia hexandra* |
| 16 | | *Oplismenus compositus* |
| 17 | | *Oryza meyeriana* ssp. *granulata* |
| 18 | | *O. rufipogon* |

| | | |
|---|---|---|
| 19 | | *Ottochloa nodosa* |
| ***20*** | | *Panicum maximum* |
| 21 | | *P. notatum* |
| 22 | | *Paspalum conjugatum* |
| 23 | | *P. scrobiculatum* |
| 24 | | *Sacciolepis indica* |
| 25 | | *Setaria intermedia* |
| 26 | | *S. pumila* |
| 27 | | *S. palmifolia* |
| 28 | | *Sporobolus indicus* |
| 29 | | *Themeda cymbaria* |
| 30 | | *T. triandra* |
| 31 | | *Arundinella purpurea* |
| 32 | | *Dactyloctenium aegyptium* |
| 33 | | *Digitaria setigera* |
| 34 | | *Eleusine indica* |
| 35 | | *Heteropogon contortus* |
| 36 | | *Paspalidium flavidum* |
| 37 | | *Cynodon dactylon* |
| 38 | **Acanthaceae** | *Justicia simplex* |
| 39 | **Amaranthaceae** | *Achyranthus aspera* |
| 40 | **Boraguiceae** | *Cynoglossum furcatum* |
| 41 | **Commelinaceae** | *Cyanotis fasciculata* |
| 42 | | *Murdannia japonica* |
| 43 | **Compositae** | *Conyza stricta* |
| 44 | | *C. ambigua* |
| 45 | | *Acanthospermum hispidum* |
| 46 | | *Ageratum conyzoides* |
| 47 | | *Elephantopus scaber* |
| 48 | | *Emilia sonchifolia* |
| 49 | | *Synedrella nodifora* |
| 50 | | *Tridax procumbens* |

| | | |
|---|---|---|
| 51 | | *Vernonia cinerea* |
| 52 | | *Spilanthes radicans* |
| 53 | | *S. paniculata* |
| 54 | **Cyperaceae** | *Mariscus paniceus* |
| 55 | | *M. pictus* |
| 56 | | *Cyperus iria* |
| 57 | | *Fimbristylis dichotoma* |
| 58 | **Hypoxidaceae** | *Curculigo orchioides* |
| 59 | **Malvaceae** | *Hibiscus lobatus* |
| 60 | | *Sida acuta* |
| 61 | | *S. alnifolia* |
| 62 | | *S. rhombifolia* |
| 63 | | *Thespesia lampas* |
| 64 | | *Urena lobata* ssp. *lobata* |
| 65 | | *U. lobata ssp. sinulata* |
| 66 | **Mimosaceae** | *Mimosa pudica* |
| 67 | | *Mitracarpus villosus* |
| 68 | **Acanthaceae** | *Phanlopsis imbricata* |
| 69 | **Rubiaceae** | *Mitracarpus villosus* |
| 70 | **Acanthaceae** | *Eranthemum montanum* |
| 71 | **Papilionaceae** | *Desmodium gangeticum* |
| 72 | | *D. motorium* |
| 73 | | *D. velutinum* |
| 74 | | *D. zonatum* |
| 75 | | *D. triquetrum* |
| 76 | | *D. triangulare* |
| 77 | | *D. triflorum* |
| 78 | **Rhamnaceae** | *Zizyphus rugosa* |
| 79 | | *Z. oenoplea* |
| 80 | **Sterculiaceae** | *Helicteres isora* |
| 81 | **Verbenaceae** | *Lantana camara* |
| 82 | **Anacardiaceae** | *Mangifera indica* |

| | | |
|---|---|---|
| 83 | **Combrctaceae** | *Terminalia paniculata* |
| 84 | | *T. tomentosa* |
| 85 | **Euphorbiaceae** | *Emblica officinalis* |
| 86 | **Lecythidaceae** | *Careya arborea* |
| 87 | **Myrtaceae** | *Syzygium cumini* |
| 88 | **Oleaceae** | *Olea dioica* |
| 89 | **Rutaceae** | *Murraya exotica* |
| 90 | **Salicaceae** | *Salix tetrasperma* |
| 91 | **Verbanaceae** | *Gmelina arborea* |
| 92 | **Tiliaceae** | *Grewia tilifolia* |
| 93 | **Malvaceae** | *Kydia calycina* |

**Food availability**

**Southern Ranges**

Table 116 shows the details of estimated of grass food biomass in different seasons. Seasonal grass food biomass varied irrespective of habitats in 1994. Food biomass was high during the first wet season (186g/$m^2$) and low during dry and second wet season. During 1995, the food biomass of grass in different seasons ranged between 120 gm/$m^2$ and 131 gm/$m^2$. Dry deciduous forest had the highest mean grass availability in 1994 and 1995 followed by moist deciduous and plantation.

**Table 116. Availability of grass food species (gm. dry weight/$m^2$) – Southern Ranges**

| Year | Habitat | Dry | % | Wet1 | % | Wet2 | % |
|---|---|---|---|---|---|---|---|
| 1994 | DDF | 255.21 | 71.65 | 284.45 | 50.99 | 182.58 | 47.37 |
| | MDF | 95.20 | 26.73 | 188.94 | 33.87 | 147.95 | 38.38 |
| | PLN | 5.76 | 1.62 | 84.45 | 15.14 | 54.92 | 14.25 |
| | Total | 118.72 | 27.40 | 185.95 | 42.92 | 128.48 | 29.66 |
| 1995 | DDF | 220.09 | 55.73 | 216.48 | 56.01 | 218.90 | 61.17 |
| | MDF | 158.42 | 40.11 | 103.04 | 26.66 | 100.49 | 28.08 |
| | PLN | 16.42 | 4.16 | 66.96 | 17.33 | 38.48 | 10.75 |
| | Total | 131.64 | 34.66 | 128.83 | 33.92 | 119.29 | 31.41 |

DDF= Dry deciduous forests; MDF= M0oist deciduous forests; PLN= Plantations

The mean food biomass of browse species in the study area is given in Table 117. The browse food biomass in dry deciduous forests was ranging between 285 gm/$m^2$ and 481 gm/$m^2$ during 1994 and 1995. In most deciduous forest, the total food biomass was higher compared to dry deciduous forest and ranged between 1350 gm/$m^2$ 1740 gm/$m^2$. The availability of browse species in plantation were almost equal to the availability in moist deciduous forest.

**Table 117. Availability of browse food species (gm. dry weight/$m^2$) - Southern Ranges**

| Year | Habitat | Dry | % | Wet1 | % | Wet2 | % |
|---|---|---|---|---|---|---|---|
| 1994 | DDF | 386.24 | 12.24 | 284.45 | 8.44 | 480.89 | 15.97 |
| | MDF | 1350.10 | 42.77 | 1740.89 | 51.64 | 1489.59 | 49.47 |
| | PLN | 1420.40 | 45.00 | 1345.97 | 39.92 | 1040.86 | 34.56 |
| | Total | 1052.25 | 19.38 | 3371.31 | 62.11 | 1003.78 | 18.49 |
| 1995 | DDF | 436.15 | 14.75 | 334.83 | 11.14 | 390.99 | 12.05 |
| | MDF | 1420.20 | 48.02 | 1348.56 | 44.88 | 1424.78 | 43.91 |
| | PLN | 1101.14 | 37.23 | 1321.26 | 43.97 | 1428.91 | 44.04 |
| | Total | 985.83 | 32.12 | 1001.55 | 32.63 | 1081.56 | 35.24 |

DDF= Dry deciduous forests; MDF= Moist deciduous forests; PLN= Plantations

**Northern Ranges**

The Table 118 shows the availability of grass food biomass in Northern Ranges. Total grass food biomass was more during the second wet season than the first wet season in 1994. In 1995 this was more in dry season followed by second wet and first wet seasons. In 1994 grass biomass was higher in moist deciduous forest in second wet season. This was higher in plantation in all the seasons. Dry season in 1996 also had higher grass food biomass in plantations.

The availability of browse food biomass is shown in Table 119. Browse food biomass was highest in second wet season of 1994 and in dry season of

1995. In 1994, the browse biomass was more in plantation in second wet season. In 1995, browse food biomass was more in moist deciduous in dry and first wet seasons and plantation in second wet season. In 1996 browse was more in plantation.

**Table 118 Availability of grass food species (gm. dry weight/$m^2$) - Northern Ranges**

| Year | Habitat | Dry | % | Wet1 | % | Wet2 | % |
|---|---|---|---|---|---|---|---|
| 1994 | MDF | - | - | - | - | 51.89 | 67.53 |
| | PLN | - | - | 14.47 | 100.00 | 24.95 | 32.47 |
| | Total | - | - | 14.47 | 27.36 | 38.42 | 72.64 |
| 1995 | MDF | 64.33 | 40.86 | 20.56 | 45.60 | 24.20 | 45.70 |
| | PLN | 93.11 | 59.14 | 24.53 | 54.40 | 28.75 | 54.30 |
| | Total | 78.72 | 61.62 | 22.55 | 17.65 | 26.48 | 20.73 |
| 1996 | MDF | 32.48 | 47.13 | - | - | - | - |
| | PLN | 36.43 | 52.87 | - | - | - | - |
| | Total | 34.46 | 100.00 | - | - | - | - |

MDF= Moist deciduous forests; PLN= Plantations

**Table 119. Availability of browse food species (gm. dry weight/$m^2$) - Northern Ranges**

| Year | Habitat | Dry | % | Wet1 | % | Wet2 | % |
|---|---|---|---|---|---|---|---|
| 1994 | MDF | - | - | - | | 8.80 | 45.22 |
| | PLN | - | - | 1.69 | 100.00 | 10.66 | 54.78 |
| | Total | - | - | 0.85 | 8.03 | 9.73 | 91.97 |
| 1995 | MDF | 11.29 | 57.34 | 3.56 | 48.11 | 5.38 | 37.75 |
| | PLN | 8.40 | 42.66 | 3.84 | 51.89 | 8.87 | 62.25 |
| | Total | 9.84 | 47.61 | 3.70 | 17.90 | 7.13 | 34.49 |
| 1996 | MDF | 14.66 | 42.88 | - | - | - | - |
| | PLN | 19.53 | 57.12 | - | - | - | - |
| | Total | 17.10 | 100.00 | - | - | - | - |

MDF= Moist deciduous forests; PLN= Plantations

**Central Range**

The Table 120 shows grass food biomass estimated for different habitat and season. Grass biomass was higher in the second wet season than the first wet season in 1994. In 1995, the grass biomass is high in first wet season and low during the second wet and dry seasons. In 1994, grass biomass was more in moist deciduous in first wet and plantation in second wet seasons. In 1995, It was more in plantation in dry and second wet seasons and moist deciduous forest in first wet season. It was high in moist deciduous in 1996.

**Table 120 Availability of grass food species (gm. dry weight/$m^2$) - Central Range**

| Year | Habitat | Dry | % | Wet1 | % | Wet2 | % |
|---|---|---|---|---|---|---|---|
| 1994 | MDF | - | - | 48.23 | 59.73 | 49.59 | 49.50 |
| | PLN | - | - | 32.51 | 40.27 | 50.60 | 50.50 |
| | Total | - | - | 40.37 | 44.63 | 50.09 | 55.37 |
| 1995 | MDF | 29.52 | 48.86 | 64.06 | 52.87 | 54.93 | 46.17 |
| | PLN | 30.90 | 51.14 | 57.10 | 47.13 | 64.05 | 53.83 |
| | Total | 30.21 | 20.10 | 60.58 | 40.31 | 59.49 | 39.59 |
| 1996 | MDF | 49.35 | 52.00 | - | - | - | - |
| | PLN | 45.55 | 48.00 | - | - | - | - |
| | Total | 47.45 | 100.00 | - | - | - | - |

MDF= Moist deciduous forests; PLN= Plantations

The Table 121 shows the estimated browse food biomass in Central Range. Browse biomass was more in second wet season than the first wet season in 1994. In 1995 the browse food biomass is more in second wet season followed by first wet and dry seasons. In 1994, the browse food biomass was more in moist deciduous in first wet and second wet seasons. In 1995, food biomass was more in plantations in dry and second wet seasons and moist deciduous in first wet season. In 1996 food biomass was more in plantation in dry season.

**Table 121. Availability of browse food species (gm. dry weight/$m^2$)**
**Central Range**

| Year | Habitat | Dry | % | Wet1 | % | Wet2 | % |
|---|---|---|---|---|---|---|---|
| 1994 | MDF | - | - | 7.39 | 62.68 | 10.70 | 66.63 |
| | PLN | - | - | 4.40 | 37.32 | 5.36 | 33.37 |
| | Total | - | - | 5.90 | 42.35 | 8.03 | 57.65 |
| 1995 | MDF | 10.95 | 36.16 | 38.42 | 69.24 | 24.69 | 42.70 |
| | PLN | 19.33 | 63.84 | 17.07 | 30.76 | 33.13 | 57.30 |
| | Total | 15.14 | 20.80 | 27.75 | 38.12 | 29.91 | 41.09 |
| 1996 | MDF | 20.91 | 48.79 | - | - | - | - |
| | PLN | 21.95 | 51.21 | - | - | - | - |
| | Total | 21.43 | 100.00 | - | - | - | - |

MDF= Moist deciduous forests; PLN= Plantations

**Discussion**

Mammals, especially the gregarious ones often respond to climatic changes and the resultant changes in the habitat by altering herd size and pattern of habitat utilization (McNaughton, 1985). Distribution pattern of large herbivores is influenced by resource availability such as food, shelter and water (Owen-Smith, 1988). Wild animals try to achieve the presumed goal of fitness maximisation by maintaining intake and avoiding environment stresses. This could be attained by selection of landscapes through migrations, home range placements or nomadism at behavioural frequencies of a few times in a year. Ranging behaviour of wild ungulates over wide geographical areas are normally in response to the temporal abundance and quality of forages (McNaughton, 1987). Watson and Moss (1970) have given examples to support that the dispersion of animals are related to food supply. Seasonal habitat selection has been reported in several species (Fuller, 1960; Shackleton, 1968; Shult, 1972; Dunckan, 1975; Owen-Smith, 1979; Krasinska *et al*., 1987). A number of studies on elephants in Africa (Buss and Savidge, 1966; Watson and Bell, 1969; Williamson, 1975; Tchamba, 1993; Dublin, 1996) and Asia (McKay, 1973;

Santiapillai *et al*., 1984; Sukumar, 1985; Easa, 1989a; Sivaganesan, 1991) have also reported changes in distributional pattern in response to environmental changes leading to a shift in water and food availability. Elephant distribution has also been reported to be influenced by external factors such as extreme weather condition (Corfield, 1973), human settlements and cultivation (Lamprey *et al.*, 1967; Western and Lindsay, 1984) and poaching activity (Dublin and Douglas-Hamilton, 1987). Change in habitat preference of bison have been reported (Jaczewski, 1958; Gill, 1967; Krasinski, 1978; Krasinski *et al*., 1987). Weigum (1972) and Conry (1981) suggested abundance of grass, forbs and seral browse species in agricultural estates as the most important factors influencing gaur distribution in Central Pahang. Similar observations have been made by Vairavel (1998) in the case of gaur in Parambikulam Dinerstain (1979), Studying the habitat-animal interaction in Nepal conducted that changes in plant distribution and phenology affected ungulate food habits, energy budget, movement and seasonal distribution. Chital responded to seasonal changes by shifting the relative time spend in different habitats (Dinerstein, 1987).

The present study in Wayanad clearly showed a seasonal pattern in the distribution of elephants in different areas and habitats. These changes in the seasonal distribution were associated with several factors especially the food and water availability. Higher concentration of elephants had been observed in the bordering areas where dry deciduous forest was utilised to the maximum. Food availability study also indicated higher grass biomass in dry deciduous forests in Southern Ranges throughout the year. Further, the perennial water sources in the Southern Ranges are restricted to the border areas. Though, a few perennial water sources do occur in the interior areas, these are not freely approachable due to the habitation and related human activities. However no correlation between food availability and seasonal distribution could be observed in other Ranges. Water seems to be not a limiting factor in the Northern and Central Ranges. But the area

available to elephants in the Central Ranges is too small that no pattern could be expected. The natural forest in the Northern Ranges cannot be considered as isolated and are seen in the midst of plantations also. This would explain the no-pattern observed in the area. Sukumar (1985) and Sivaganesan (1991) had also made similar shift in habitat utilisation in relation to food and water availability. Desai and Baskaran (1996) stressed the importance of water in the range use strategy of elephants in deciduous forest dominated areas.

The present study has shown the importance of grass in the diet of elephants. Though, the browse biomass was high in the interior areas of moist deciduous forests and plantations, the availability of water plays a crucial role in distribution of elephants in the Southern Ranges in Wayanad. The low crude protein but rich in forage biomass areas have been used by elephants in dry season in Amboseli (Western and Lindsay, 1984). Studies in Mara by Dublin (1996) have pointed out that the elephant density during dry season was largely determined by water availability followed by food availability.

The increased density in moist deciduous and plantation dominated interior areas of the Southern Ranges in the first wet season coincides with the fresh growth of grass and large scale water availability. The highly significant increase in the grass biomass in moist deciduous forest and plantation in the first and second wet seasons also supports the findings. The correlation coefficient shows a positive correlation between elephant density and bamboo young leaves its availability and soft textured grass during first wet season. A similar correlation was also observed between the elephant density and, grass and water availability in dry season, explaining largely the influence of these two factors in the density distribution of elephants in the study area.

Fire seems to play a major role in the distribution of elephants along with food and water availability. Density of elephants in 1995 was the highest in the

Southern Ranges during the study period. The dry season density of 2.78/km2 in dry deciduous forests during 1995 was quite unusual than expected. The extensive fire in the adjacent Mudumalai and Bandipur could have triggered a mass movement of elephant to the study area where fire, though occurred, were only in patches during the late dry and early first wet seasons. A decrease was observed in the density of elephants from the dry to first wet season throughout the study period. However, the reduction in 1995 was drastic (1.90/km2 to 0.44/km2). The fresh grass growth subsequent to the fire in the adjacent area would have definitely attracted a part of elephants leaving the rest to move to the interior of the study area. The impact of fire in the adjacent area and the resultant high density has also led to a comparatively higher density in the inside area also in 1995.

Habitats surrounding the settlements are degraded as shown from the low grass biomass throughout as a result of cattle grazing, though the rainfall was higher in these moist deciduous dominated areas compared to dry deciduous forest. Desai and Baskaran (1996) have discussed the dual impact of human settlements on elephant habitats. It could be due to habitat loss through conversion for human use or avoidance of human use areas by elephants in the normal home range. Moist deciduous and plantation areas in the interior of the Southern Ranges had been increasingly used in first wet season followed by a decrease in second wet season. The trend in the border areas in Southern Ranges where dry deciduous forest is dominant, was just the reverse. This seasonal movement could be explained by the optimal foraging theory developed to explain movements of foraging animals (Pyke, 1983). The higher density during dry season forced the animal to go for quantity compromising the quality. In the following wet seasons, the strategy seemed to be changing to attain higher quality food intake. Changes in density within wet seasons could be due to a decreasing rate of food intake as a result of depletion in quantity or decline in quality because

of continuous use of the patches as explained in the marginal value theorem of Charonav (1976). Gaur, sambar deer and spotted deer though show seasonal differences in habitat utilization do not seem to follow a pattern.

The elephants in the study area showed seasonal movement and shift in habitat utilisation in relation to food and water availability, an also the occurrence of fire in the adjacent areas. The Southern Ranges of Wayanad thus is a dry season refuge for the elephants. However, the Northern Ranges have comparatively higher density during first wet season.

The density distribution of sambar deer in Wayanad, as evident from the density of pellets in different ranges does not seem to follow any type of pattern. However, there is a general tendency for increased concentration in the first wet and second wet season in the Southern Ranges. The habitat requirements of the species vary considerably. The availability of food plants, places for resting, wallowing and drinking differs in abundance and distribution pattern according to the climatic changes. The types of variation are clearly evident in tropical dry deciduous forest. Moreover, cervids in general are reported to be highly sensitive to water deprivation (Berwick, 1974). The density distribution has also been observed to be influenced by environmental factors in Parambikulam (Easa unpublished information). Observations in Wayanad though do not agree completely with the reports from elsewhere, seem to indicate a pattern where the environmental factors also play a role.

# CHAPTER 8
# CROP RAIDING

## Introduction

Declaration of protected areas and the subsequent regulation led to the denial of access to the resources to the local people. Fragmentation and depredation resulting from the dependence by the people in enclosures and fringes have contributed to the increased incidence of human-wildlife conflict. Information on various aspects of crop raiding would help in formulating suitable mitigative measures and policy decisions. Information on various aspects of crop raiding *viz.*, the extent, animals involved effectiveness of protection methods and economic implications were collected from Wayanad.

## Methods

### Settlement selection for studying crop raiding

The study area has sixty-nine enclosures and forty seven settlements in periphery. These are of different legal status such as revenue, leased, patta and forest lands. The surrounding vegetation types and protection methods employed differ according to the location. The types of crops cultivated also vary depending on the area.

### Protection methods

Crop protection methods employed in the field during the study period were recorded and classified as follows:

**1. Ordinary Fencing and Guarding (OF+GU)**: The fields were fenced using different materials like bamboo, barbed wires, thorns, hedgerows, *etc*. This type of protection

includes guarding at night by people from machans (platforms on trees) or guard sheds on ground with fire and sound making devices like tins, drums, etc.

**2. Special Protection (SP)**: This is similar to the ordinary fencing but used along with several other elephant scaring devices. Trip wires with explosive crackers are the special protection devices used in most of the places. . This method is employed only during the reproductive phase of paddy. Guarding at night is avoided.

**3. Electric Fencing (EF)**: Electric fences were installed by the Forest Department around some of the settlements in the study area using energizers which generate very short pulses of high voltage current and the animal coming in contact with such wires get a strong shock but are not harmed. Some of these were maintained properly by the people themselves and some were not maintained, hence the effect varied.

**4. Trenches (TR):** Trenches were dug around some of the settlements by the Forest Department. These trenches are maintained annually.

Twenty nine settlements were selected in the study area based on the surrounding vegetation types, location of the settlement and types of protection method employed (Fig. 55). These settlements were distributed in six Forest Ranges *viz*., Tholpetty, Begur, Chedleth, Kurichiat, SulthanBattery and Muthanga. The details of selected settlements are given in Table 122. Data on crop raiding were collected from twenty nine settlements over a period of three years during 1994-1996

**Cultivation in selected settlements**

About 66.5% of the total land in the selected settlements were under seasonal crops and the remaining under perennial crops (referred as wet and dry lands respectively).

**Table 122. Details of settlements selected for crop raiding studies**

| Sl. No | Settlement | Protection method | Major crops cultivated |
|---|---|---|---|
| 1 | Alathur | OF+GU | Coffee, Paddy, Tapioca, Plantain |
| 2 | Appapara | EF+GU | Paddy, Ginger, Pepper, Coconut, Plantain |
| 3 | Arakunji | OF+GU | Ginger, Coffee, Paddy |
| 4 | Begur river side | EF+GU | Ginger, Paddy, Rubber, Tapioca |
| 5 | Begur Range office side | EF+GU | Paddy, Tapioca, Ginger, Coffee |
| 6 | Chetti alathur | OF+GU | Ginger, Paddy, Tapioca, Plantain, Pepper |
| 7 | Chekadi | EF+TR | Coconut, Ginger, Jack fruit tree, Paddy, Plantain |
| 8 | Cheriyamala | OR+GU | Arecanut, Paddy, Pepper, Plantain, Coffee |
| 9 | Chullikad | CR+GU | Arecanut, Coconut, Ginger, Paddy, Plantain |
| 10 | Emmady | EF+GU | Coconut, Plantain, Tapioca, Paddy, Ginger |
| 11 | Kallumukku | EF | Coffee, Ginger, Paddy |
| 12 | Konduvady | CR+GU | Coconut, Paddy, Pepper, Rubber |
| 13 | Kottavayal | CR+GU | Paddy, Ginger, Plantain |
| 14 | Kumizhi | EF | Coffee, Ginger, Paddy, Tapioca |
| 15 | Kuppadi | EF | Coffee, Plantain, Ginger, Tapioca |
| 16 | Kurichiat | EF | Paddy, Tapioca, Ginger |
| 17 | Mathalampatta | CR+GU | Coconut, Ginger, Paddy, Pepper, Plantain, Arecanut |
| 18 | Nedumthana | TR | Ginger, Plantain, Pepper |
| 19 | Narimundakolly | EF+GU | Paddy, Ginger, Plantain |
| 20 | Nulpuzha | OF+GU | Coffee, Ginger, Paddy, Pepper, Plantain |
| 21 | Polanna | CR+GU | Paddy, Plantain, Rubber |
| 22 | Ponkuzhy | OF+GU | Ginger, Paddy, Plantain, Tapioca |
| 23 | Puthiyoor | EF+GU | Ginger, Paddy, Tapioca |
| 24 | Puthussery | CR+GU | Paddy, Plantain, Ginger, Tapioca |
| 25 | Punchavayal | CR+GU | Ginger, Coffee, Paddy |
| 26 | Thirulakunnu | EF+GU | Paddy, Tapioca, Ginger |
| 27 | Vakeri | CR+GU | Paddy, Ginger, Plantain |
| 28 | Vattathur | CR+GU | Paddy, Ginger, Plantain |
| 29 | Veluvalli | CR+GU | Coconut, Paddy, Ginger, Plantain |

**Seasonal crops**

The study area had the maximum rainfall during southwest monsoon and planting of seasonal crops began at the onset of monsoon in May and harvest was completed by November or December. Among the seasonal crops, paddy (*Oryza sativa*), the staple food crop of the people was grown to a larger extent in all the selected settlements. Paddy was sown during the middle of May or first week of June depending on the pre-monsoon rains and the onset of monsoon. By mid or late September, paddy comes to flowering stage and the harvest was between November and December, and sometimes it may be extended to first and second week of January, depending on the planting season.

Ginger (*Zingiber officinale*) and plantains (*Musa paradisiaca*) constituted the other seasonal crops. These were cultivated in the wet lands. Tapioca (*Manihot utilisima*) was cultivated only to a lesser extent in the study area.

**Perennial crops**

Dry land constituted about 33.5% of the total in the selected settlements in the Southern Ranges and 41.89% in Central Range. The cash crops such as coffee (*Coffea arabica*) and pepper (*Piper nigrum*) were the dry perennial crops cultivated throughout the study area. Along with coffee and pepper, coconut (*Cocos nucifera*) and arecanut (*Areca catechu*) (referred as mixed crops) were also cultivated by farmers.

Coffee, pepper, coconut and arecanut were cultivated in the dry land mostly in mixed cultivation. Mono-cultivation of coffee, pepper and arecanut constituted only a small portion in the settlements.

Tapioca was planted during May and harvested during December. Plantain was available evenly in all the months round the year. Paddy constituted a larger proportion of the edible crops (>90%). Availability of paddy during May was only below 10% and increased to 87% in June. During the harvest season, the availability decreased to less than 5%.

**Crop damage**

The selected settlements were visited twice in a month and visually checked for signs of damage. Information was collected on crop damaged, the animal species involved, the pheno-phase and height of the crop. The total area damaged (in $m^2$, based on the length and breadth of the damaged area) was also recorded.

Percentage of damage due to feeding and trampling was recorded separately by laying a number of $1m^2$ plots for paddy and ginger, and by actual count for other crops. Plots of same size were laid in undamaged areas also for comparison and estimation of the quantum of damage. An area was considered damaged due to trampling if it occurred while the elephant was moving through the crop field without feeding or just walking across the field in the course of their movement between different feeding points or while being driven away by the people from the crop field before feeding. The area trampled by elephants while moving was considered as damage due to feeding if there was any sign of feeding.

Phenology of crops, especially of paddy was noted as vegetative (before flowering) and reproductive (in flower/fruits/grains).

Secondary data were also collected from the villagers during each visit for information on date of raiding, time, animal species involved and number of individuals. Information on the sex of the animal, identification (if possible) and number of individuals were also collected during the visit. If tracks of calves or juveniles were found in the

field, the raiding was considered as that of a herd. The fresh tracks were followed and the elephants observed for information on the sex, age group, number and identification marks.

Crop raiding and spatial pattern of habitual crop raiders (only males) were studied during 1995 in Southern Ranges. The identified bulls were monitored regularly and information collected on the location, frequency of crop raiding in each settlement and distance between the habitual crop raiders. The nearby settlements were also visited subsequently for collecting information on the damages caused by these.

**Analysis**

**Economic loss**

In the case of plantation crops such as coffee, pepper, plantain, tapioca, coconut and arecanut, the actual number of plants damaged and their age were collected based on the method suggested by Sukumar (1985). The number of years of yield lost to the farmer is the same as the age at which the tree was damaged as he has to plant another sapling in its place and nurture it to the same stage. Hence, the age of the plant was multiplied with the expected total annual yield of the damaged plant to calculate the economic loss. This was added to the establishment cost such as planting and other maintenance charges.

The extent of damage to paddy and ginger was calculated using the total area damaged. These were converted into per unit area (ha.). The crop lost per acre of damage was calculated in terms of potential expected yield. The potential yield was arrived at from the yield obtained from the crops left undamaged in the same field or from the surrounding field.

**Quantity Damaged**

The actual quantity of paddy damaged/day/elephant was calculated as suggested by Sukumar (1985) as shown below:

$$q_i = \frac{a_d \times Y}{e}$$

Where $a_d$ = areas of the field damaged

Y = expected potential yield in terms of quintal

e = number of elephant raiding crops

For each settlement, the quantity of crops damaged was calculated using the following formula.

$$E \times F \times Q$$

Where E = mean raiding group size of elephants

F = frequency of raiding

Q = weighted mean quantity damaged / day / elephant in a village

The market value of the crops collected from State agency or/and wholesale dealers did not differ significantly between years. Hence, an average was taken for the years and tabulated for the purpose of calculation (Table 123).

The cost for seeds, ploughing, fertilizers, pesticides, fencing, guarding at night, labour, irrigation etc. for paddy and ginger cultivation alone were computed and was about 20 % of the total yield. This was added to the total loss.

**Table 123. Density, Yield and value of crops cultivated in the study area**

| Crop | Density/ha. | Average Yield/ha | Value (Rs) |
|---|---|---|---|
| Paddy | 523640 | 39.5 q. | 500/q. |
| Ginger | 79040 | 395.2 q. | 1000/q. |
| Plantains | 741 | Rs.40/plant | 29640/ha. |

| | | | |
|---|---|---|---|
| Tapioca | 2470 | 123.5 q. | 200/q. |
| Coconut | 124 | 6200.0 Nos. | 4/ No. |
| Coffee (Alone) | 865 | 18.5 q. | 4000/q. |
| Coffee (Mixed) | 494 | 9.9 q. | 4000/q. |
| Pepper (Alone) | 988 | 24.7 q. | 7000/q. |
| Pepper (Mixed) | 618 | 14.8 q. | 7000/q. |
| Arecanut | 1235 | Rs.30/plant | 37050/ha. |

**Manslaughter by elephants in the study area**

Information on manslaughter by elephants in the study area was collected with the details such as name, sex and age of the persons killed, the place of encounter, the activity of the victim and those accompanying, circumstances of the encounter, sex of the elephant and the nature of injury.

All the analyses were done using SPSS for Windows Release 6.0 (Anonymous, 1987).

**Results**

**Crop damage**

Elephant, wild boar, gaur, sambar deer, spotted deer and bonnet macaque were the major crop raiders in the area. Among these, elephants were responsible for 75.85% of the crop raiding (Fig 56). The damage was mostly by feeding and trampling. The extent of damage by wild boar (10.40%), gaur (9.79%), sambar (1.83%) barking deer (0.61%), bonnet macaque (0.92%) and spotted deer (0.61%) were comparatively negligible. The differences in the frequency of raiding between animals were significant ($\chi^2 = 842.63$, $df = 5$, $P < 0.000$).

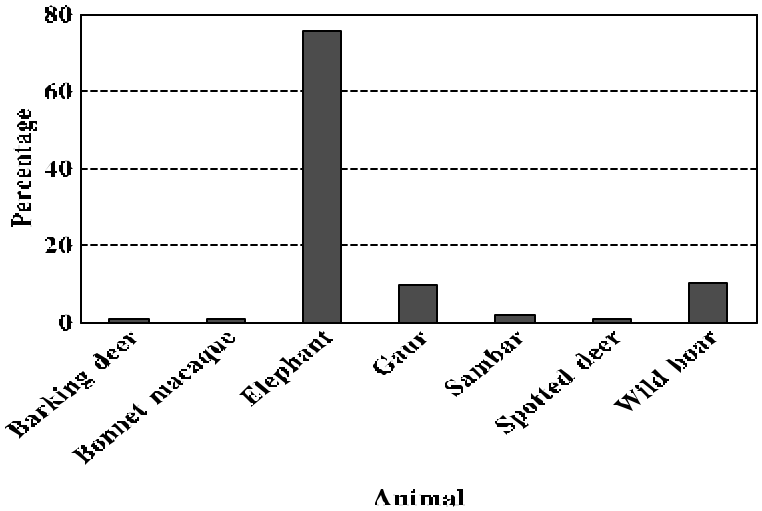



**Fig 56. Percentage frequency of crop raiding in Wayanad by animals**

The analyses for the crops damaged by different animals indicate that paddy was the most vulnerable among the crops (73.39%) followed by ginger (7.65%), coconut (4.59%), tapioca (4.28%), plantain (3.67%), arecanut (0.61%), coffee (3.36%), jack tree (0.31%), pepper (1.53%) and rubber (0.61%) (Fig 57). The percentage frequency of crop damage on paddy by elephant was about 70%. Most of these were due to trampling followed by feeding. Ginger (8.47%), coconut (6.05%), tapioca (3.23%), plantain (4.84%), arecanut (0.81%), coffee (3.63%), jack tree (0.4%), pepper (1.61%) and rubber (0.4%) were also damaged by elephant (Fig 58).

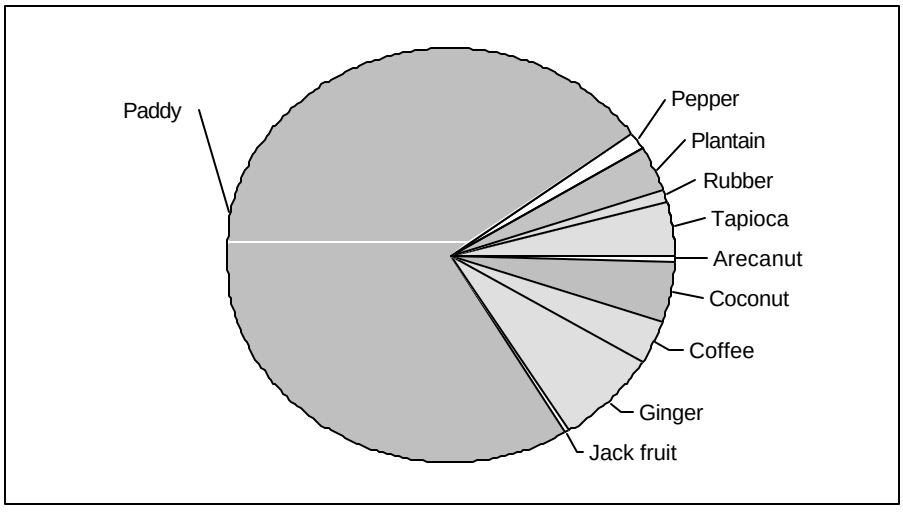


**Fig. 57. Percentage frequency of crops raided by animals in Wayanad**

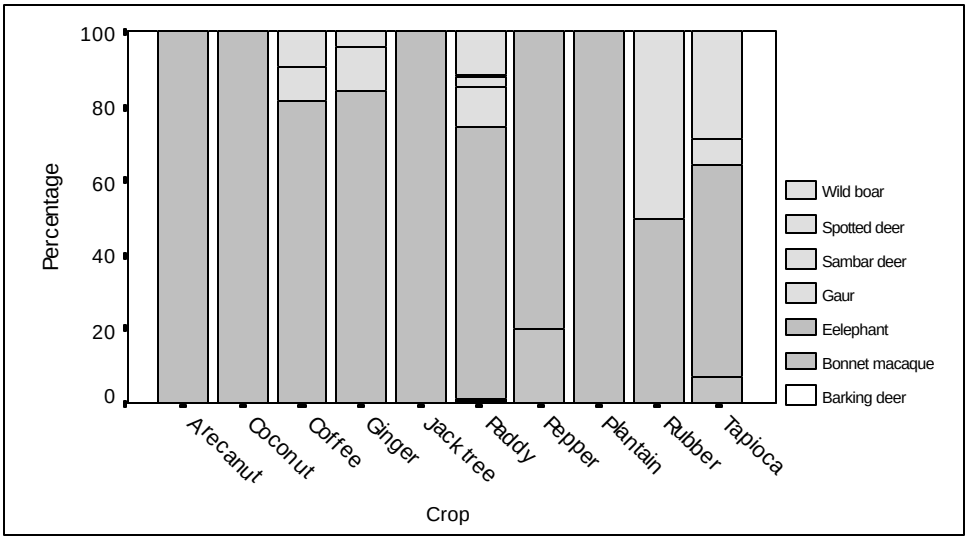



**Fig 58. Percentage frequency of raiding different crops by animals**

An analysis for seasonal incidences of crop raiding indicates that 86.54% of crop raiding was during the rainy season and the rest (13.46%) in summer (Fig 59). The difference was highly significant ($\chi^2$ = 174.68, *df* = 1, P < 0.000). Incidence of crop raiding by elephant was also high in rainy season (86.29%). Animals had an increased tendency to raid the crops in the reproductive phase compared to the vegetative phase (Fig. 60). However, there were significant variations depending on the crop. The Chi-square test indicates that the variation is statistically significant. Crop raiding incidences were higher (99.08%) in enclosures compared to the settlements in periphery (0.92%). Analyses for monthly distribution of raids indicate that the frequency of raiding was more in October and November (Fig. 61). The monthly variation in crop raiding is statistically significant. ($\chi^2$ = 353.01, *df* = 10, P < 0.000).

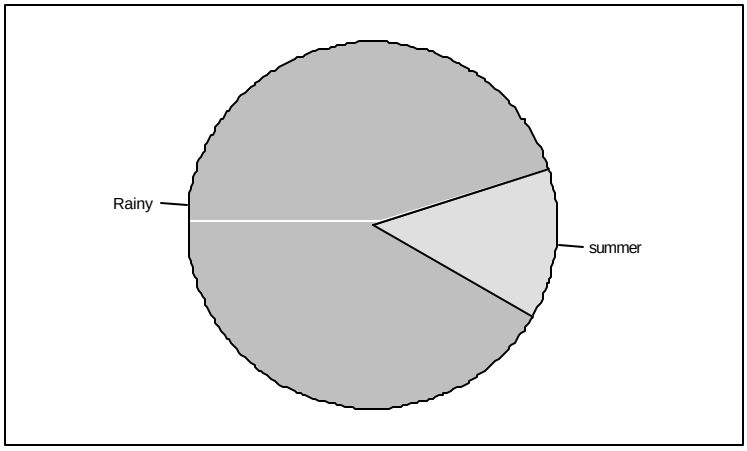



**Fig 59. Percentage of crop damage in different seasons**

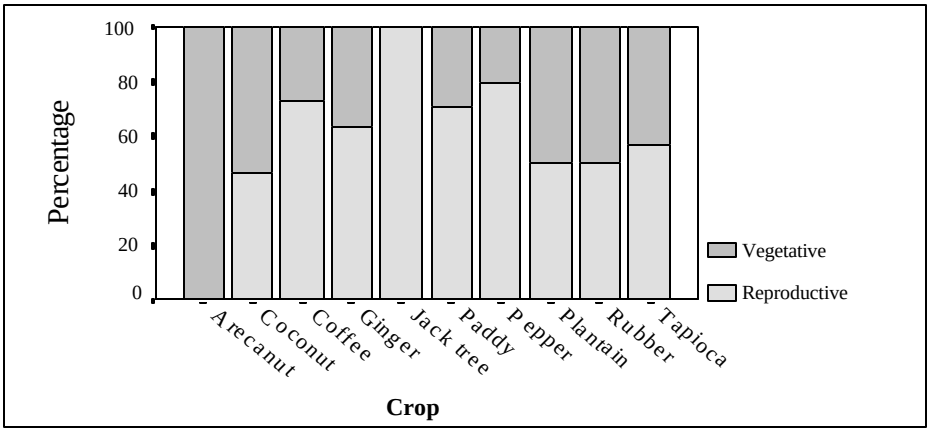



**Fig. 60. Crop damage in different phenological stages**

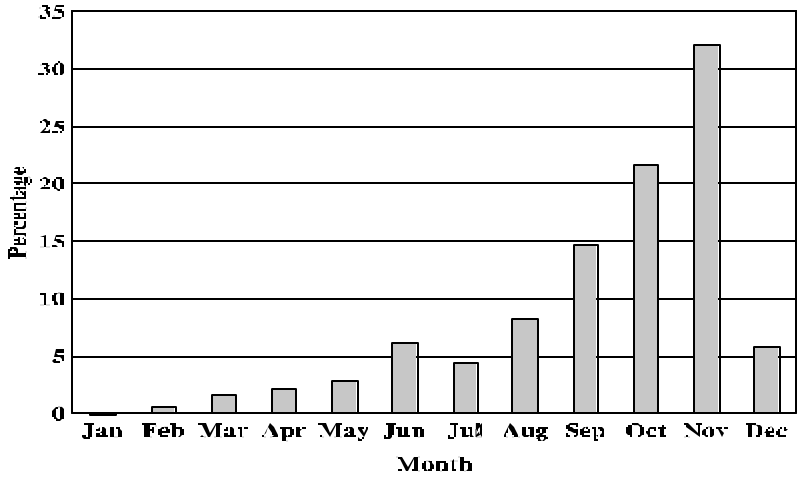



**Fig.61. Crop damage by animals in different months**

The settlements surrounded by moist deciduous plus teak plantations were subjected more to crop raiding (Table 124). The difference in crop-raiding incidence between settlements surrounded by different habitats was significant. ($\chi^2$ = 205.82, *df* = 5, P < 0.000).

**Table 124. Crop damage in settlements based on the nature of the surrounding habitat**

| Sl. No. | Habitat | Total | Percentage |
|---|---|---|---|
| 1 | EP | 22 | 6.73 |
| 2 | EP+TP | 30 | 9.17 |
| 3 | MD | 103 | 31.50 |
| 4 | MD+TP | 121 | 37.00 |
| 5 | SE | 2 | 0.61 |
| 6 | TP | 49 | 14.98 |

EP= Eucalyptus plantation, MD= Moist deciduous forest,
SE= Semi evergreen, TP= Teak plantation

**Protection methods Vs crop raiding**

There is a significant difference in the number of crop raiding incidences in different protection methods ($\chi^2$ = 133.31, *df* = 5, P = < 0.000). Trench was observed to be more effective to prevent the animals from crop raiding. The frequency of raiding was more in the areas where ordinary fencing, or crackers and guarding were used (Table 125).

**Table 125. Percent frequency of crop raiding in Wayanad under different protection methods by animals**

| Sl. No. | Protection methods | Incidence of crop raiding | Percentage |
|---|---|---|---|
| 1 | CR+GU | 108 | 33.03 |
| 2 | EF | 50 | 15.29 |
| 3 | EF+GU | 47 | 14.37 |
| 4 | EF+TR | 31 | 9.48 |
| 5 | OF+GU | 88 | 26.91 |
| 6 | TR | 3 | 0.92 |

CR= Crackers, GU= Guarding, EF= Electric fencing, Of= Ordinary fencing, TR= Trench

In the case of elephant, trench was observed to be more effective to prevent or control crop raiding. The frequency of raiding was more in the areas where ordinary fencing or crackers and guarding were employed (Table 126).

**Table 126. Percentage frequency of crop raiding by elephants in areas under different protection methods**

| Sl. No. | Protection | Total | Percentage |
|---|---|---|---|
| 1 | CR+GU | 85 | 34.27 |
| 2 | EF | 37 | 14.92 |
| 3 | EF+GU | 37 | 14.92 |
| 4 | EF+TR | 30 | 12.10 |
| 5 | OF+GU | 56 | 22.58 |
| 6 | TR | 3 | 1.21 |

CR= Crackers, GU= Guarding, EF= Electric fencing,
OF= Ordinary fencing, TR= Trench

Herds were raiding more in the settlements having trenches. Even though the trenches and electric fencing together found to be effective, it is not found to deter the solitary elephants. (Fig 62)

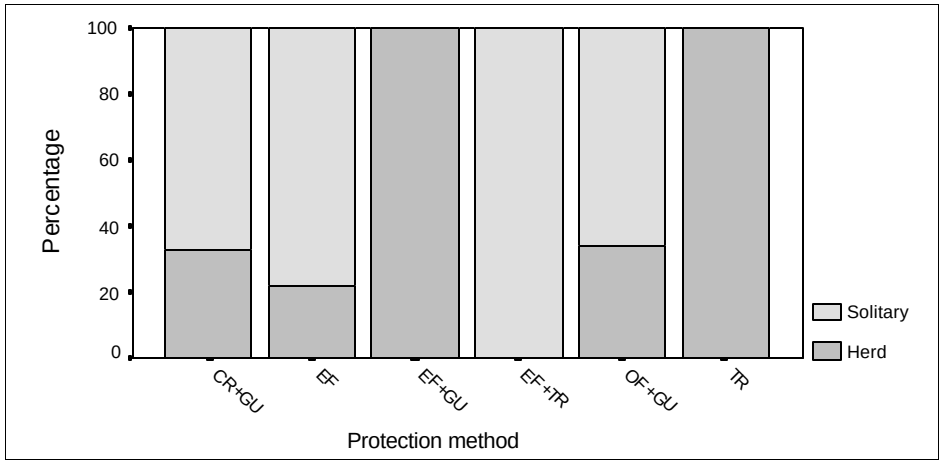



**Fig 62. Percentage of raids by herds and solitary elephant in areas under different protection methods**

Crop raiding incidences were high in Southern Ranges than Central and Northern Ranges. However, analysis for incidence show that crop raiding was more in Chedleth Range, followed by Muthanga, Tholpetty and Sulthan Bathery. Crop damage was comparatively less in Kurichiat and Begur Ranges (Fig 63.).

**Fig. 63. Percentage frequency of crop raiding in different Ranges**

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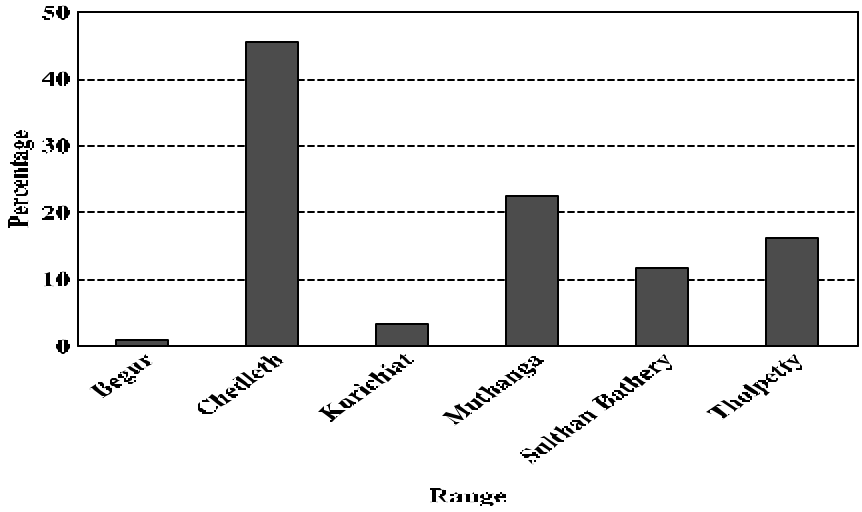
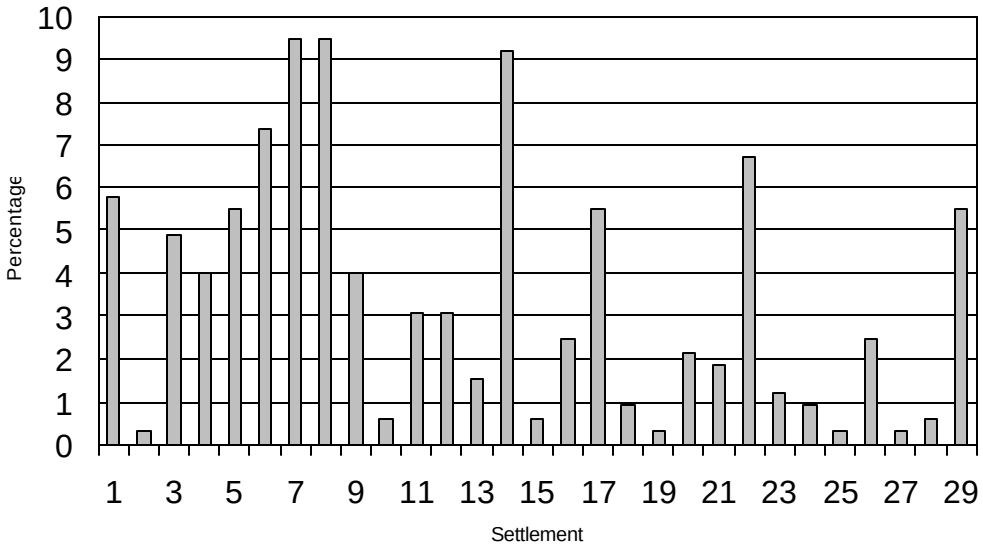



Among the settlements selected for the study, the frequency of raids were more in Chegadi, Cheriyamala, Kumizhi, Chettiyalathur and Ponkuzhi (Fig 64). The difference was highly significant ($\chi^2$ = 238.78, *df* = 16, P < 0.000).

**Fig. 64. Percentage frequency of crop raiding in different settlements**



**1**= Alathur, **2**= Appapara, **3**= Arakunchi, **4**= Begur river side, **5**= Begur Range office side, **6**= Chetti alathur, **7**= Chekadi, **8**= Cheriyamala, **9**= Chullikkad, **10**= Emmaddy, **11**= Kallumukku, **12**= Konduvadi, **13**= Kottavayal, **14**= Kumizhi, **15**= Kuppadi, **16**= Kurichiat, **17**= Mathalampatta, **18**= Nedumthana, **19**= Narimundakolli, **20**= Noolpuzha, **21**= Polanna, **22**= Ponkuzhy, **23**= Puthiyoor, **24**= Puthusserry, **25**= Punchavayal, **26**= Thirulakunnu, **27**= Vakeri, **28**= Vattathur, **29**= Veluvalli

**Economic loss**

During the study period, a total area of 45.03 ha. of paddy and 6.11 ha of ginger was damaged by different animals. A large proportion of the economic loss was due to the damage of paddy and ginger by different animals (Table 127). This is true in the case of elephants also. A total economic loss of Rs. 42,43,203.47 was estimated due to crop damage by different animals. Of this 88.89% of economic loss was due to the damage by elephants alone.

**Table 127. Economic loss due to animals for three years (1994-1996)**

| Crop | Area damage | Average yield /ha. (100 kg) | Loss of production (100 kg) | Economic loss (Rs) | Loss/ hectare |
|---|---|---|---|---|---|
| Paddy | 45.03 ha | 39.5 | 1778 | 1067368.00 | 23703.49 |
| Ginger | 6.11 ha | 395.2 | 2414.67 | 2897606.00 | 474239.93 |
| Plantain | 168 Nos | - | - | 8064.00 | 35568.00 |
| Tapioca | 0.115 ha | 123.5 | 14.20 | 3408.10 | 29635.65 |
| Coconut | 218 Nos | - | - | 52320.00 | 29760.00 |
| Coffee | 1.68 ha | 18.5 | 31 | 149184.00 | 88800.00 |
| Arecanut | 54 Nos | - | - | 1994.00 | 45596.20 |
| Pepper | 0.26 ha | 14.8 | 6.60 | 55459.37 | 213305.00 |
| Rubber | 26 Nos | - | - | 7800.00 | 90000.00 |
| | | | | 42,43,203.47 | |

**Discussion**

Analysis of the data in Wayanad indicates that elephants were involved in about 75% of the crop raiding and paddy was the most affected crop. The crop raiding was higher in rainy seasons especially in the reproductive phase of the crops. Settlements surrounded by moist deciduous forests and those with teak plantations were more prone to crop raiding.

A number of factors seem to influence the crop raiding behaviour of elephants. Sukumar (1989), Balasubramanian *et al*., (1995) and Kumar and Sathyanarayana (1995) have dealt with these factors while studying crop raiding elephants. Sukumar (1989) listed the factors as those related to movement pattern, availability of water and food, reduction, fragmentation and degradation of habitat, and the difference in the palatability and nutritive value of crops compared to the natural food species.

Elephants' far ranging behaviour and larger requirement of the resources often lead them into contact with cultivation in the fragmented forests (Sukumar, 1988). Increased elephant population and local over abundance resulting in habitat degradation were also reported to lead to crop raiding (Desai, 1997). The pattern of density distribution was evident in the Southern and Northern Ranges in the study area. Elephant in the study area showed a distinct pattern of movement with increased density in the peripheral region during dry season. The interior areas, where the settlements are located have an almost equal density during the first and second wet seasons. The density figure in the Southern Ranges of Wayanad was higher compared to similar elephant ranges.

Straying of elephants has also been observed in Wayanad. On one occasion, four elephants strayed out from the forest in Padri Range into Panamaram area through coffee plantations. This was ultimately driven back by the forest officials. In another

incidence an adult tusker followed the same route, surrounded by moist deciduous forests, killed a person and ultimately was shot dead by police. It is possible that these areas had been the usual elephant paths much before the conversion and settlements started. Further, the areas surrounding the settlements are degraded to a greater extent because of the dependence of the people on the surrounding forest for cattle grazing, fire wood collection and similar activities (Chapter 5).

Analyses of the food availability data from areas surrounding the settlements have also indicated the impact of these activities on the habitat. Food availability study also indicated low grass biomass in areas surrounding the settlements. The conversions of natural forest into plantations have also contributed to the degradation considerably. This is clearly evident in the eucalypts plantation, where the under growth is dominated or fully occupied by *Lantana sp*. and *Eupatorium sp*. The increased rate of crop raiding in the settlements surrounded by natural forest mixed with plantation especially of teak indicate the degradation of habitat as a possible causative factor for crop raiding. Degradation of habitats has been reported to lead to a futile search for non-existent food sources ending up in crop raiding (Desai, 1997).

The elephant habitat in the study area, though not fragmented in the strict sense of the term, is disturbed due to the scattered nature of the settlements. Movements of the people during daytime force the elephants to confine themselves to smaller undisturbed patches and put them under stress and strain. The situation is severe in the Central Range where the area available for elephant is comparatively low and these are almost fragmented due to the settlements all along Kabini, the connecting link with the adjacent area.

Among the wet land crops, paddy was the dominant one extensively cultivated in all the settlements selected for the study. Paddy was also the crop, which was

damaged most by the elephants and other animals. The damage to ginger and dry crops except coconut were mostly due to trampling, more often while going for paddy. The damage of paddy by elephant during vegetative phase was almost exclusively due to trampling. The paddy in reproductive phase were fed and thus damaged. Sukumar (1985) has mentioned the high nutrient value and digestibility coupled with less toxins as the possible reasons for preference for paddy.

Palatability of paddy was also high compared to the matured grasses in second wet season. The crude protein content of paddy in inflorescence was higher than the short grass available in the moist deciduous forests surrounding the settlements. Sukumar (1989 & 1990) has also reported higher calcium and sodium content in the mature paddy. The present observation of high intensity of raiding during the reproductive phase could also be due to the sudden increase of sucrose and aminoacids in the developing grains of paddy. Observations in Southern Ranges have revealed that habitual crop raider spent less time for feeding in the wild (Balasubramanian, 1998). This also indicates the possibility of meeting the nutritional requirements within the short period of raiding from the highly nutritious crops.

In the study area, the frequency of crop raiding by males was higher than those by the herds. The success in the attempts were also more in the case of males. Similar observations have been made by Sukumar (1989) and Kumar and Sathyanarayana (1995). Males due to their solitary nature can very well stay over days together in the areas surrounding settlements compared to the herds with juveniles and calves.

Balasubramanian (1998) observed no significant difference in the herd size of elephants in the natural and crop raiding herds. Sukumar (1985) observed herd formation even among the bulls while raiding crops. Datye and Bhagawat (1995a) observed an increased mean herd size among the elephant raiding crops. It may be

probable that the herds in the study area do not go purposefully for crop raiding and more often raid once coming into contact with the cultivated area. The present observation in the study area also indicated a positive correlation between the size of settlement and frequency of crop raiding because of the increased perimeter available in the larger settlement

Considering all the factors discussed above, the habit of the animal seems to play an important role in crop raiding behaviour in the study area. In one incidence, an adult bull in the company of another adult bull tried to break open a live wire fence but retreated on getting the shock. But the other adult bull broke the fence and both raided the field. The bull, which failed, was later reported to be raiding crops all alone even in the electric fenced settlements. The habitual crop raiders stay around the settlements and continuously raid irrespective of the protection methods employed. These elephants even follow a spacing pattern among themselves and once chased move to the next settlement to repeat the process. These observations indicate the possibility of acquiring the crop raiding habit through learning process and possibly act in combination with all the proximate factors discussed earlier.

Sukumar (1985) estimated a loss of Rs. 1.9 lakhs during 1981-82 in nine settlements and the per hectare loss was Rs. 59. The per hectare loss incurred in Dharmapuri Forest Division of Tamil Nadu was between Rs. 134.11 and Rs. 145.54. The per hectare economic loss in Wayanad is comparatively more than other areas studied. A much higher loss has been reported from Malaysia by Blair *et al*. (1979) and Blair (1980) where the damage has been on perennial crops such as oil palm, coconut or rubber. The damage of cash crops in the study area could be one of the reasons for the higher rate of economic bss. But, estimation without cash crops also show a higher economic loss compared to other crop raiding areas. A preliminary

comparison made with the compensation paid by the authorities point out that most of the raids go unreported and loss unclaimed due to several reasons.

Electric fencing was found to be the most efficient protection method, if properly maintained. But the habitual crop raiders break open electric fences and raid the crops. Properly maintained electric fencing coupled with guarding was found to be more effective against habitual crop raiders. Most of the settlements, where electric fencing were erected in the middle of the study showed a decrease in crop raiding incidences.

The human deaths due to elephants in the study area were less compared to Dalma in Bihar (Datye and Bhagawat, 1995c) or NorthEast (Lahiri-Choudhury, 1980). The attitude of the people seems to contribute a lot while projecting the problem of crop raiding in Wayanad. Francis (1994) has mentioned crop raiding as a common phenomenon in the erstwhile Wayanad where swamps were under cultivation. He has described the innumerable number of *'machans'* raised by the tribal communities as one of the characteristic features of Wayanad. Intrusions of the area by the settlers who are unused to wildlife and intolerant to the ways of wildlife have also influenced the attitude of the tribals. The whole change in the vegetation of the area as a result of increased settlements, cultivation and relationships between communities have also contributed to the socio-economic changes which have not been proved to be too good for wildlife especially elephants.

## Recommendations

1. The present study revealed that elephants were responsible for most of the crop depredation in Wayanad. Regular monitoring of habitual crop raiders would help in studying their behavioural ecology
2. The scattered settlements within the forest are hindrances to the free movement of wildlife. Majority of the settlers within the Sanctuary have expressed their willingness to be resettled. Measures may be taken for resettling the interior enclosures thereby consolidating areas ensuring free movement of wildlife.
3. The importance of browse species including bamboo as food species of herbivores has been revealed in the present study. Measures may be taken to protect the existing browse species and enhance their availability in the habitat. This would mean reconsideration of the existing practice of bamboo extraction and action plans for enrichment of habitat.
4. The existing vayals (marshy areas) should be maintained through appropriate technique to ensure growth of palatable grass.
5. The number of live stock within the forest should be reduced.
6. Eco-development programmes may be taken up for alternate source to the people depending on the forest that would reduce their impact on the habitat to a great extent.
7. Electric fencing was found to be the most economic and effective control measures if maintained properly. Trenches though effective would cost more for maintenance.
8. Compensation for damage due to wildlife is not a permenant solution to the problem. However, tomely action for compensating th loss due to crop raiding would help in building up a good rapport with the perople.

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