

**HABITAT UTILIZATION AND DISTRIBUTION PATTERN  
OF INDIAN WILD PIG (*Sus scrofa cristatus*)  
IN SARISKA TIGER RESERVE, RAJASTHAN**

**DISSERTATION SUBMITTED TO THE SAURASHTRA UNIVERSITY,  
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DEGREE IN WILDLIFE SCIENCE (1991)**

**BY**

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The Indian Wild Fig (*Sus scrofa cristatus*) at water source.

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## CERTIFICATE

This is to certify that Shri D.D. Bhujanga Rao has carried out an original piece of research in partial fulfillment of his Master's Degree in Wildlife Science of Saurashtra University, Rajkot. The topic of Dissertation is 'Habitat Utilization and Distribution Pattern of Indian Wild pig (*Sus scrofa cristatus*) in Sariska National Park'. The investigations were carried out at the Wildlife Institute of India, Dehra Dun under my supervision from November 1990 to April 1991. I hereby certify that this work has not been submitted for any degree of any University.

  
[G.S. Rawat] 3/7/1991

Assistant Professor

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# CONTENTS

	Page No.
Certificate of Originality	
Acknowledgements.....	ii
Table of Contents.....	iii
List of Tables, Figures, Plates and Appendix.....	v
Summary.....	vii
1. Introduction.....	1
1.1 Natural history of wild pig.....	1
1.1.1 Digging and derooting.....	2
1.1.2 Wallowing.....	3
1.1.3 Nesting and resting sites.....	4
1.1.4 Scavenging.....	5
1.2 Review of literature.....	5
1.3 Objectives.....	7
2. Study area.....	9
2.1 Geographical location.....	9
2.2 Legal status.....	9
2.3 Climate.....	9
2.4 Terrain.....	10
2.5 Geology and soil.....	11
2.6 The vegetation.....	11
2.7 Fauna.....	15
2.8 Distribution of water.....	15
2.9 Disturbances in the park.....	16
3. Methods.....	17
3.1 Quantification of habitat parameters.....	17
3.2 Density estimation of wild pigs.....	20
3.3 Availability-utilization technique.....	21
3.4 Data analysis	

4.	Results.....	27
4.1	Quantification of habitat variables.....	27
4.1.1	The vegetation.....	27
4.1.2	Terrain availability.....	28
4.1.3	Water availability.....	28
4.1.4	Phenology of important food plant....	29
4.2	Habitat utilization.....	29
4.2.1	Density estimates.....	29
4.2.2	Availability-utilization test.....	30
4.2.3	Terrain use.....	30
4.2.4	Midnoon activity.....	31
4.2.5	Digging and derooting.....	31
4.2.6	Waterhole use.....	31
4.2.7	Dung analysis.....	32
5.	Discussion.....	41
5.1	Habitat use between seasons.....	41
5.1.1	Habitat use during winter.....	42
5.1.2	Habitat use during summer.....	45
5.1.3	Dung analysis.....	46
5.1.4	Observations at waterhole.....	46
5.2	Management implications.....	46
5.3	Conclusion.....	47
	Literature cited .....	48

## List of Tables, Figures, Plates and Appendices:

Tables:	Page No.
1. Particulars of foot and cycle transects.....	25
2. Wild pig food plants identification in Sariska Valley.....	26
3. Overall Tree and shrub densities with average grass volume in the four habitats in Sariska valley.....	33
4. Densities of individual trees, shrubs in the four habitats in Sariska valley.....	34
5. Terrain availability-utilization over two seasons.....	35
6. Phenology of <i>Z. mauritiana</i> in the four habitats during Winter (1991).....	35
7. Diet composition of Wild pigs in two seasons.....	36
8. Green forage Volume available to wild pig during pinch period.....	36
9. Morning and evening densities of over two Seasons.....	37
10. Density estimates of wild pig based on Cycle transects...	37
11. Wild pig digging in four habitats over 2 seasons.....	38
12. Intensities of wild pig digging in 4 habitats.....	38
13. Density estimation based on midnight transects.....	39
14. Major dietary components identified in dung.....	39
15. Distribution of wild pig in 4 habitats over 2 seasons....	40
16. Dominant grasses and herbs in 4 habitats.....	40

**Figures:**

1. Map of Sariska Tiger Reserve showing the location of intensive study area.
2. Vegetation map of study area showing location of water holes and transects.

**Plates:**

- |       |                              |
|-------|------------------------------|
| 1.a   | Winter resting site          |
| b.    | Latrine area                 |
| 2.a   | Digging (High intensity)     |
| b     | Digging (Low intensity)      |
| 3 a   | Wallowing                    |
| b     | Solitary male at waterhole   |
| 4 a,b | Disturbances in the park     |
| 5 a   | Scrub habitat                |
| b     | <i>Butea-Zizyphus</i> mix    |
| 6 a   | <i>Zizyphus</i> woodland     |
| b     | Wildpig feeding association. |

**Appendices:**

- I: Analysis of Habitat availability-utilization of wild pig  
II: Analysis of Terrain availability-utilization of wild pig.

## SUMMARY

Habitat utilization and distribution pattern of wild pig (*Sus scrofa cristatus*) was studied in Core I of Sariska Tiger Reserve, Rajasthan over winter and early summer. Habitat was stratified into scrubland, mixed woodland, *Zizyphus* woodland, and *Anogeissus* Forest, and important parameters such as vegetation, phenology of important plants, topography, water and disturbance were quantified. Four foot transects (two in plains and two in hills) and three cycle transects covering 188 km and 688 km respectively over two seasons gave a total sighting of 206 wild pigs. Of these 117 were in scrub 35 in Mixed woodland 51 in *Zizyphus* woodland, and 3 in *Anogeissus* forest. It was found that wild pigs utilized *Zizyphus* woodland in winter (density=32.97) and scrubland in summer (density=17.29) more than availability. This shows that there is a definite shift in the habitat use from winter to summer.

The distribution pattern of wild pigs in various habitats and availability of important food plants during summer (pinch period) are analysed. The data from dung analysis and indirect evidences from digging show their omnivorous food habit, and a definite seasonality in food intake.

The results are discussed along with the management implications.

## CHAPTER 1. INTRODUCTION

The inter-relationships between herbivores and their habitats are complex, and are influenced by the morphology and the behaviour of the animals as well as ecological responses of vegetation and other habitat parameters. The study of habitat utilization and distribution pattern of species gives valuable information on the preference and avoidance of habitats by the species over time and space (Neu *et al.* 1974, Marcum & Loftsgaarden 1980, Ben-Shahar & Skinner, 1988). Usually habitat features such as vegetation its phenophases, terrain and water are also analysed in such studies and the knowledge obtained, are crucial for the management of the species concerned and its habitat.

Studies on the habitat utilization by wild ungulates in India include Green (1985), Johnsingh (1983), Karanth (1988), Rice (1984), and Schaller (1967). But wild pig (*Sus scrofa cristatus*), a widely distributed and an important prey species for large carnivores in India, has not been the subject for an intensive study so far.

The present study aims at finding out the spatio-temporal use of habitat by wild pig and its distribution pattern in the Sariska valley in the Sariska Tiger Reserve (STR).

### 1.1. Natural History of Wild Pig:

The wild pig (*Sus scrofa cristatus*) belongs to family suidae of the sub order Suinae (the pigs, peccaries and hippos). Th

Suidae is an old world family with a very wide distribution which includes wild, domestic and feral pigs (Graves, 1984). Whereas peccaries, and hippos are limited to north America and Africa respectively, pigs (Suidae) are the only representative of the Suinae in India, with two sub-genera viz. *Sus*, the wild boar and *Porcula*, the pygmy hog (Prater, 1980).

The wild pig is present in almost all biogeographic regions of India excepting the alpine zone, deserts and trans-Himalayas (Prater 1980). It's high degree of adaptability has led to this wide distribution.

Wild pig is a generalist species and is admirably adapted to range of habitats such as forests, secondary thickets, woodlands and grasslands in which they roam in small bands (sounder) of three to 30 animals. The dominant males are generally solitary and join the sounder during breeding season (Graves, 1984). The sows in a group usually come in the estrous simultaneously a phenomenon known as estrous synchronization (Eisenberg and Lockhart 1972). The size of the sounder seems to be a function of carrying capacity of the habitat (Pine and Gerdes 1973). Wild pigs throughout their distribution ranges in the world are omnivorous and opportunistic feeders (Fradrich, 1971; Martin 1974).

Wild pig exhibits some of the activities which are very specific to its suborder. These are as follows:

#### 1.1.1. Digging and Derooting:

The pigs are characterized by derooting behavior which is

facilitated by their associated cranial features including an elaborated rhinarium, elongated snout and hypertrophy of the nuchal muscles and areas of attachment (Grave, 1980). The roots, tubers, and rhizomes thus dug out supplement their dietary requirements and also make them naturally more fit to survive in a habitat which is shared by sympatric herbivorous species to whom these underground vegetal matter is unavailable. Derooting can be of various intensity and also depends on the experience of the animal (Pate 2-A & B). It has been observed during this study that intensity of digging by sub-adult and young ones are more intense and narrow than that of adults which more or less graze through a wide area and dig only after sensing potential food. This behavior is attributed to the experience of the adult boar in finding out the hidden food as compared to the young ones who are inexperienced and probably rely on trial and error basis. This habit can lead to damage and death of potential food plants, or may cause a shift in plant succession influencing the regeneration of certain plant species and changing the habitat conditions for itself as well as other resident herbivores (Everitt and Alaniz, 1980).

#### 1.1.2. Wallowing:

Pigs lack sweat glands and have sparse haircoat. They do not tolerate a wide range of temperature. Therefore, thermoregulation is a major component of their ethogram (Dellmeir and Friend, 1991).

Wild pigs may wallow for a short time or just long enough to plaster the skin with mud as a protection against flies (Eisenberg

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and Lockhart, 1972) or to get rid of the ectoparasites (Conley et al, 1972) or for thermoregulation during the hot dry season (Eisenberg and Lockhart, 1972; Graves, 1984). Wallowing is not restricted to any one sex amongst wild pigs (Plate 3-A). Usually, immediately after the wallowing they rub their sides, snout or the anal portion probably to get rid of parasites sticking to skin even after wallowing and, this therefore is a comfort behavior (Graves, 1984).

### 1.1.3. Nesting and Resting Sites:

Wild pigs spend most of their inactive daylight hours in characteristic day beds (Graves 1984, Fradrich, 1971). They construct temporary sleeping nests of considerable size or use burrows dug by other mammals (Fradrich, 1971). The beds are often made at the base of a tree beside a log or other protected areas on an exposure where the pigs can warm up (Conley et al 1972) (Plate-1.A). Dens are not used during winter but in hot weather, more elaborate beds are made in cool and shady places (Stegeman, 1938, Conley et al 1972, Graves, 1984). Resting places are normally occupied by more than one individual because pigs, unlike most of other *Artiodactyles*, (except the hippos) belong to the 'Contact type' (Fradrich, 1971, Conley et al 1972).

Nest building is the most overt behavioral indication of farrowing. Excavating shallow oblong areas, slightly larger than their bodies by rooting, and filling up this bed with grass, leaves, stems and other plant material gathered by mouth and

carried to the nest site is the common method of nest building (Covacevich, 1972). It was observed in domestic swine that nest building behavior is primarily instinctive and can be observed in sows with no previous farrowing experience in an environment enabling nest construction (Dellmeir and Friend 1991).

#### 1.1.4. Scavenging:

Johnsingh (1978) has observed wild pigs feeding on the kill remains of dholes five times; three times in the presence of the pack itself. Nevertheless, wild pigs are ecologically separated from other scavengers by their mode of feeding on other herbaceous material such as grass, roots, tubers, fruits, etc. (Conley *et al* 1972).

#### 1.2 Review of literature:

Except a few natural history observations e.g. Schaller (1967) and a few studies on the abundance and distribution pattern (Ahmed & Jaisamant 1991, Karanth 1988), most of the literature on wild pig in India comes from outside the country. Wild pigs have been best studied in Europe because of its pest status (Howe *et al* 1981, Lewis, 1966), and as a game animal (Pine & Gerdes, 1973).

The studies on home range and habitat use of wild pig showed that seasonal home ranges of males are greater than those of females (Singer *et al*, 1981 Kurz and Marchinton 1972). Feral hog movements and habitat use were studied by Wood and Breeneusen (1980) in coastal South Carolina and they also have recorded

greater average home ranges for the hogs (221 ha) as compared to sows (181 ha). Brenneman (1980), Wood & Roark (1980), and Vuren (1984) studied the seasonal variation in food selection and impact of wild pig feeding on the vegetation.

Studies on activity pattern of wild pig by Blasetti *et al* (1988) showed that adults and piglets differed in their time activity budgets. Though this study was conducted in a closed enclosure (Rome Zoo), there was significant difference in use of exhibit areas (influenced by temperature) between the adults and piglets. The relationship between the wild pig population and the hunting pressure was shown by Pine & Gerdes (1983). Graves (1984) studied the detailed behavior and ecology of wild and feral swine and showed that boars are mostly solitary and seen roaming in 'sounders' only during breeding season. This was also observed by Eisenberg & Lockhart (1972) during a 12 month study in Wilpattu, Sri Lanka. The observations on group sizes of wild boar by Conely *et al* (1972) reveal that 80-85% of solitary individuals sighted are either adult or subadult males. The sightings of solitary boars are quite high (74%) by Seidensticker (1976) in Chitawan than those by Eisenberg & Lockhart (38 %) in Wilpattu. Johnsingh (1983) found 53% of his wild pig sightings (n=155) were of lone males. Pigs have a short gestation period varying from 114 to 130 days. They are truly multiparous ungulates with litter size consisting of 3 or more.

Studies on diet, feeding and habitat utilization by African bush pig (*Potamochoerus porcus* Linnaeus) by Breytenbach & Skinner

(1981) reveal that their ecological requirements are similar to those of Indian wild pig. The phenomenon of using 'latrine areas' was also observed in the present study (Plate 1-B).

The distinction between the domestic, feral and wild pigs is not easily drawn (Hanson and Karstad 1959). There is mixing up of domestic and wild boar genes to produce feral ones and thus the genetic purity is fast disappearing in South Eastern U.S.A. Even the wild pigs in Sariska are said to be a hybrid between domestic and wild, as one of the Kings is said to have introduced domestic pigs when the wild pig population went low for sustained hunting.

### 1.3 Objectives:

Following are the objectives of the present study:

1. To quantify the important habitat parameters that govern the distribution of wild pigs in the study area.
2. To quantify the habitat utilization by wild pig in the study area over two seasons
3. To observe group size, and composition in different habitats.

To fulfill the objectives, following main hypotheses were formulated:

1. There was no shift in habitat utilization of the wild pig between the two seasons.
2. The use of different habitats in a season was not in proportions of their availability.

The introduction is followed by study area description (Chapter.2), Methodology (Chapter. 3), Results (Chapter. 4) and Discussion (Chapter.5). Summary precedes Chapter-1 and Appendices along with literature cited are given at the end.



Plate 1a: Typical winter resting site. Note the low canopy cover (field assistant in picture).



Plate 1b: Latrine area observed 3m away from resting site.



Plate 2a: Wild pig digging; class III (note the high intensity of digging).



Plate 2b: Low intensity digging; class I.



Plate 3a: Note that water holes are good wallowing grounds.

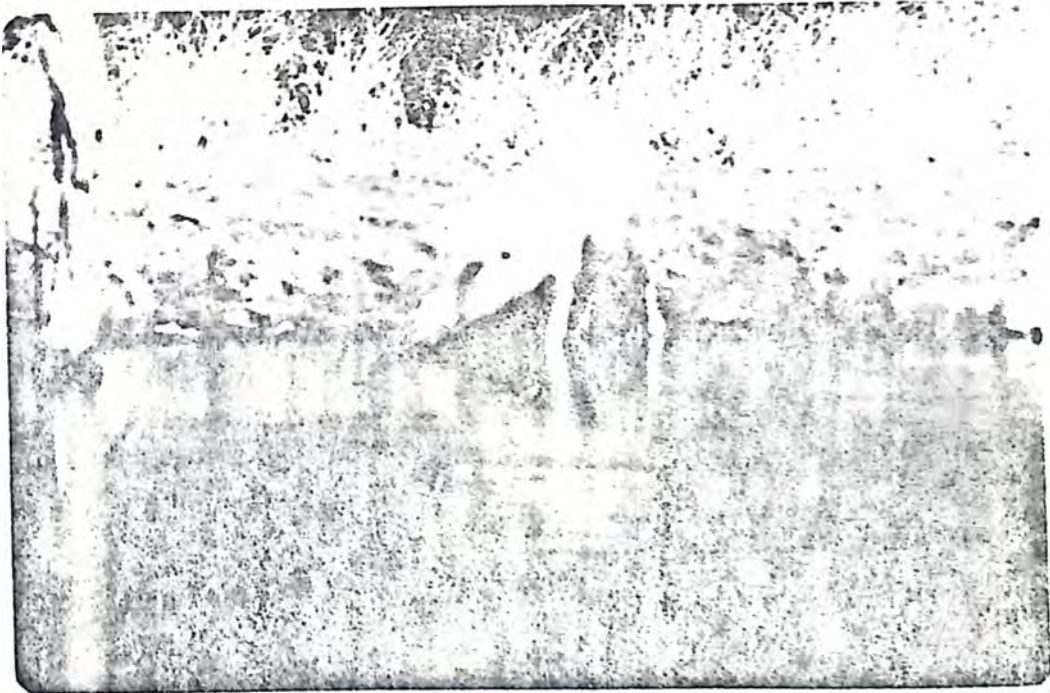


Plate 3b: Boars are mostly solitary both at water hole and habitat.

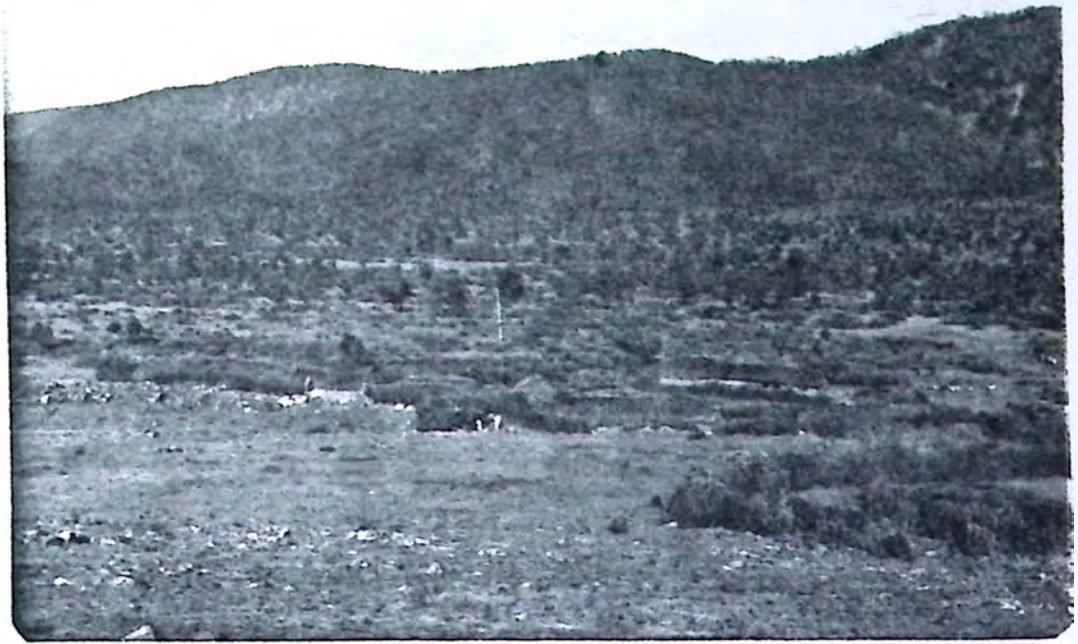


Plate 4a: Settlements in the park is a perpetual source of disturbance.



Plate 4b: Illegal grazing in the park boundaries.

## CHAPTER 2. STUDY AREA

The study was conducted in Sariska Tiger Reserve (STR) from November 1990 to April 1991 covering two seasons i.e. winter and early summer. The total area of reserve is approximately 800 sq. km. including 480 sq. km. of core area and 320 sq.km of buffer. The core is distributed in three distinct areas viz. core I, Core II and Core III. The present study was done in Core I i.e. main valley of Sariska around the study area is around 30 sq.km (Map.1)

### 2.1. Geographical Location:

STR lies between 27'20'N latitude and 76'25'E longitude, in Alwar district of Rajasthan. The altitude of the study area varies from 290m to 680m (Management Plan, 1990).

### 2.2. Legal Status:

STR is a proposed sanctuary but its legal status is a Reserve forest. Infact, the core-I was proposed as a National Park (Management Plan, 1990). Much depends on the relocation and resettlement of the local tribals (Gujjars and Meenas) outside the park for any further improvement in its legal status.

### 2.3. Climate:

The region is typically semi-arid with subtropical climate consisting of 3 distinct seasons. The hot dry summer, a short and monsoon dependent rainy and a col. winter. The summer begins in

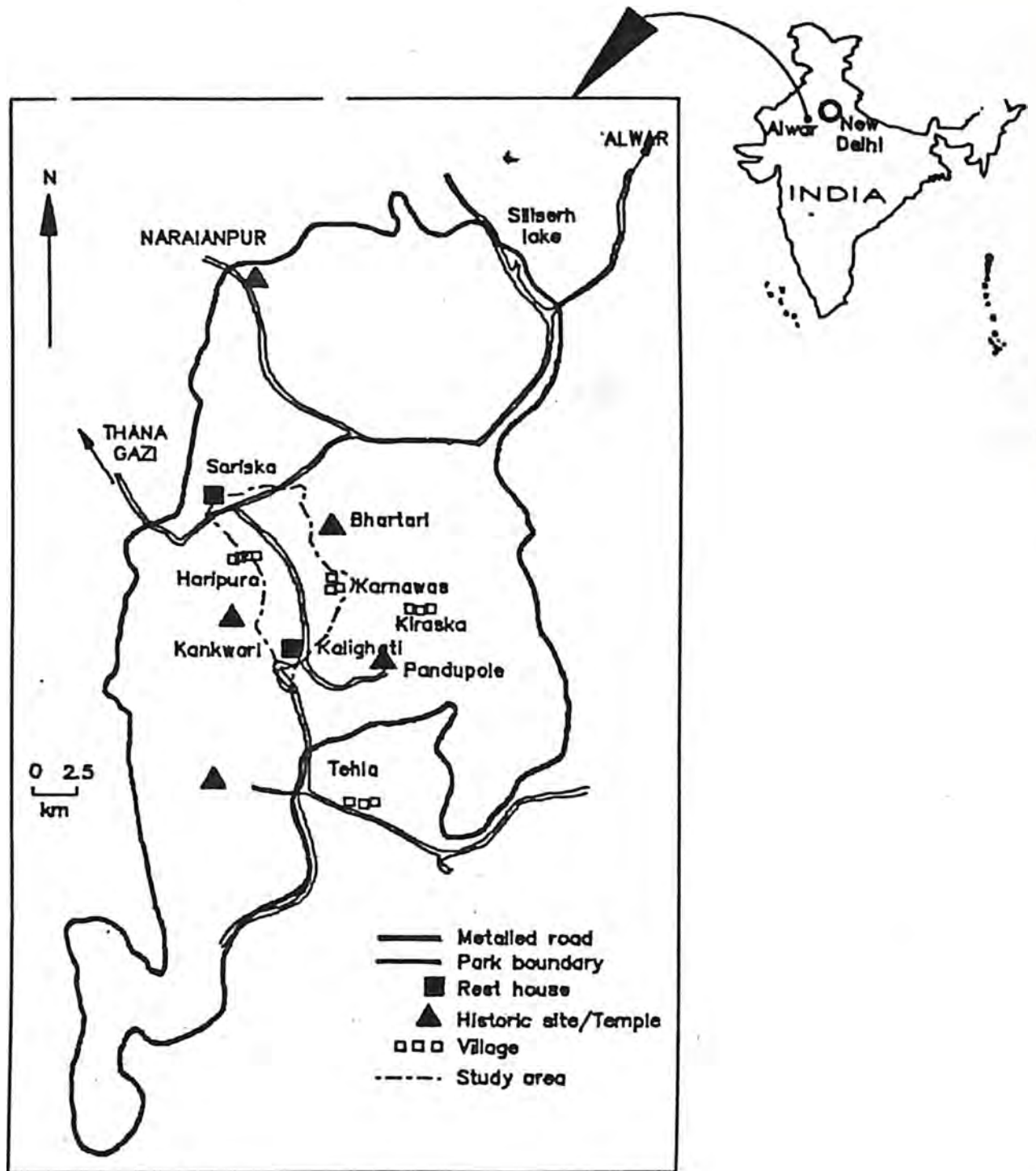


Fig.1 Location of study area in Sariska Tiger Reserve, Rajasthan

later part of February and extends till June. The winter is from November to February. December and January are the coldest months. The rainy season is short and starts from late June with the onset of south-west monsoon to the middle of October. The climate is generally dry.

April, May and June are extremely hot, May being the hottest month with temperatures soaring as high as 45°C. During this period, the humidity is relatively low and is characterised by hot westerly winds (loo) blowing through the entire stretch of the region.

The variation in annual rainfall and number of rainy days differ from year to year. The average number of rainy days is about 30 and average annual rainfall is 650 mm.

The winters are extremely pleasant with day temperatures not exceeding more than 35°C. Nights are very cold and the mercury drops down as low as 0°C.

#### 2.4. Terrain, Topography and Physical Features:

The tract is basically hilly and has two big plateaus i.e. Kankwari and Kiraska. The valleys are numerous amongst which Kalighati, Pandupole and Raika are important. The present study was done in the Sariska valley which is wide and extends from Baran Tal gate to Thana gazi. The striking feature of the hills are their homogenetic regularity of height, level summits and uniform appearance (Parmar, 1985) which stretch from north-east to south-west in more or less parallel lines. The slopes are steeper o

their southern aspect, as compared to other directions.

The terrain is broadly divided into 4 categories :

1. Flat terrain found in valley (0 to 10° ).
2. Gentle slope along the ascending phases of the hills (10-30°).
3. Steep slopes, along the descending phases (generally southern aspect) (> 30° )
4. Plateaus (Kankwari and Kiraska).

#### 2.5. Geology and Soil:

Majority of the area is occupied by rocks of Delhi and Aravalli system comprising of quartzities, conglomerates, gneisses, limestones, phyllites, granites and schists (Parmar, 1985; Management Plan, 1990). The soil is mainly red-sandy in the study area. However, it differs from site to site depending upon underlying rock.

#### 2.6. The Vegetation:

The vegetation of the STR comes under Tropical Dry Deciduous and Tropical Thorn Forest (Champion and Seth, 1968). The upper stratum is characterized by trees growing upto a height of 10-15 m. The canopy cover of trees vary from one community to other, and generally it is not continuous except along the nallas. The second stratum forms the shrub layer with heights varying from 1 to 5 m. The third stratum is the ground layer consisting of grasses and herbs.

Depending on the species dominance, composition and terrain

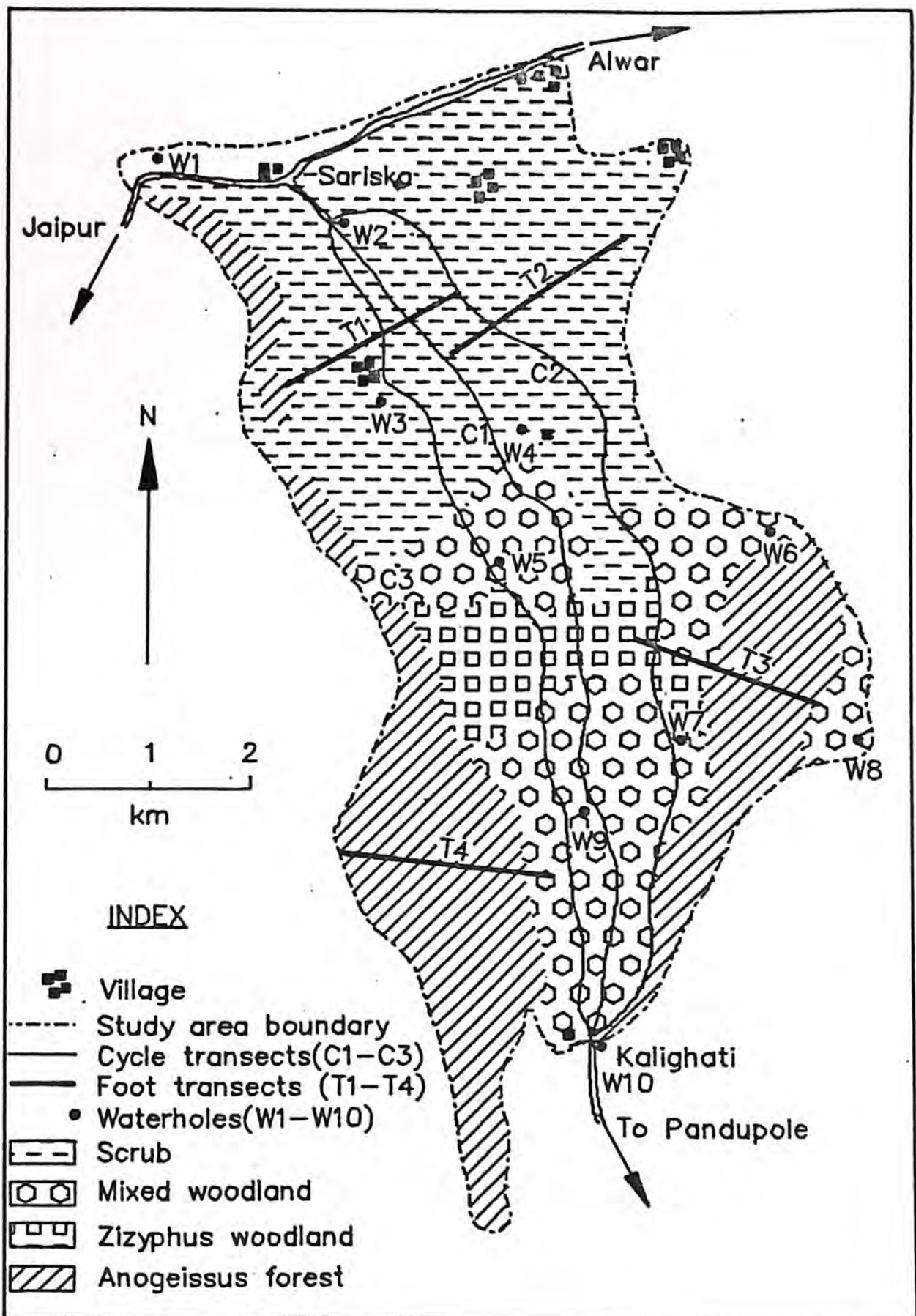


Fig.2 Details of transects, waterholes and broad vegetation types in the study area.

the vegetation in the study area is classified into 4 broad categories :

1. Scrubland
2. Mixed woodland
3. *Zizyphus* woodland
4. *Anogeissus* forest

#### 2.6.1. Scrubland:

This type of habit is restricted only to the valleys and encompasses most parts of the study area (Plate 5-A) The most common trees found here are *Acacia catechu*, *A. leucophloea*, *A. senegal*, *Balanites aegyptiaca*, *Capparis decidua*, *Phoenix sylvestris* and *Zizyphus mauritiana*. Shrub seen are *C. decidua*, *C. sepiara*, *Flacourtia indica*, *Z. mauritiana*. Weeds like *Adathoda vasica*, *Cassia tora*, *Achyranthes aspera*, *A. bidentata* are common. Stragglers like *Ipomea pes-tigridis* are abundant. Among herbs *Boerhavia diffusa*, *Indigofera linifolia*, and *Desmodium* sp. are present. Common grasses include *Aristida* sp, *Apluda mutica*, *Heteropogon contortus*, *Chloris dolichostachyia*, *C. barbata*, *Cynodon dactylon*, *Chrysopogon fulvus*, *Cenchrus* spp. and *Brachiaria ramosa*.

#### 2.6.2. Mixed woodland:

In this vegetation type various tree species are found associated to various degrees. This can be further sub-divided into following three sub-types:

a) *Butea-Zizyphus* mix

This type of woodland is dominated by *B.monosperma* found mainly in the valleys especially near the base of the hills (plate 5-B). Other trees found in the area include *A. senegal*, *B. aegyptica*, *A.leucophloea*, *A.catechu* and *C. decidua*. The prominent shrubs encountered were *C.sepiara*, *Z. nummularia*, *A. vasica* and *G. flauvescence*. Herbs like *I.pes-tigridis*, *B. diffusa* and weeds like *Cassia tora*, *Sida spp.*, *Abutilon indicum*, *A. aspera*, *A. bidentata* are common. *C. dolichostachyia*, *Digitaria spp.* and *H.contortus* are common grasses.

b) *Acacia-Zizyphus* mix

*A. catechu*, *A. leucophloea* and *A. senegal* are observed to be present along with *Z. mauritiana* trees in this type. The tree density is high and shrubs are less in number. *C. sepiara* and *C.decidua* shrubs with Grasses such as *Aristida spp.*, *H. contortus* and *C. dolichostachyia*. This type of woodland is distributed mostly in the valleys and in the foot hills.

c) *Anogeissus* mix woodland

In association with *A. pendula*, species like *Z. mauritiana*, *A. catechu*, *A. leucophloea* and *B. monosperma* are seen. This type of forest is distributed near the base of hills on the gentle slopes and on the ridge tops. On the middle slopes and summit of hills, *A. pendula* is found in association with *Boswellia serrata*, *Diospyros melanoxylon* and *Ficus racemosa*. Shrubs such as

*C. sepiaria* and *G. flavescens* are common. The most important fodder plant available in this forest is *Dendrocalamus strictus*, which is restricted to the shady valley bottoms and slopes. Weeds like *C. tora*, *A. aspera*, *A. vasica* are frequently encountered. The grass community is mostly dominated by *C. dolichostachya* and is found in association with other species like *Digitaria ramosa* and *H. contortus*.

#### 2.6.3. *Zizyphus* Woodlands:

In this type dominant tree is *Z. mauritiana* and is found mostly in the valleys. The distribution and abundance of *Zizyphus* trees govern the habitat use, movement and activity pattern of many ungulates amongst which wild pig is the topic of interest. Common trees associated with *Z. mauritiana* are *A. catechu*, *B. aegyptiaca*, *P. silvestris* and *A. leucophloea*. The shrubs present are *C. sepiara*, *G. flavescens*. In the entire study area pure stands of *Zizyphus* do not cover more than 3.25 sq.km. area (Plate 6-A). Common grass spp. are *C. dolichostachya*, *Digitaria* spp. and *H. contortus*.

#### 2.6.4. *Anogeissus pendula* Forest

*A. pendula* is the principal species in this type and its distribution is restricted to the hills. It covers over 90% of the hilly areas and is often found in association with other trees *B. serrata*, *A. catechu*, *D. melanoxylon*, *Soymuda fabrifuga*, *Sterculia urens*, *Anogeissus latifolia*, *Wrightia tinctoria* and *Z. mauritiana*.

The shrubs generally encountered are *C. sepiara*, *G. flavescens* and *Mallotus philippinensis*. Common grasses are *C. dolichostachya*, *Digitaria ramosa*, *Aristida* spp. and *Brachiaria* spp. Climber *Mucuna pruriens* was also seen.

## 2.7. Fauna:

Besides wild pig (*Sus scrofa cristatus*), the fauna of this park include Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Jungle cat (*Felis chaus*), Caracal (*Felis caracal*), Palm civet (*Paradoxurus hermaphrodites*), Striped hyena (*Hyena hyena*), Jackal (*Canis aureus*), Nilgai (*Boselephas tragocamelus*), Chausingha (*Tetracerus quadricornis*), Sambar (*Cervus unicolor*), Chital (*Axis axis*), Black naped hare (*Lepus nigricollis nigricollis*), Rufous tailed hare (*Lepus nigricollis ruficaudatus*) and Porcupine (*Hystrix indica*). The primates are represented by common langur (*Presbytes entellus*) and rhesus macaque (*Macaca mullata*) are the primates. About 250 species of birds are reported from this park (Sankar, WII pers. com.).

## 2.8. Distribution of Water:

Important management activity in the park is the waterhole maintenance. This can be divided into two phases : Prior to 1987 and after 1987. Prior to 1987 there were more waterholes along roadside and which were filled by tankers. Presently only few waterholes are retained which are fed by an underground pipeline system. The number of water holes was reduced to prevent the

congregation of ungulates and over exploitation of the resources in the valley. This was done after the post-drought mortality which claimed the lives of the over 300 wild ungulates in the valley (Sankar, pers.comm.). It is believed that the existing dispersed, and fewer waterholes would enable the ungulates to use the resources evenly.

#### 2.9. Disturbances in the Park:

There are 17 villages situated in and around the park which are constant source of disturbance (Plate 4-A). Illegal practices like grazing, cutting, lopping and firewood and MFP collection are common (Plate 4-B). Added to these, there is disturbance due to the location of a temple in the core area I. The park is open twice a week for the visiting pilgrims. All these cause considerable amount disturbance.

## CHAPTER 3. METHODS

Ecological studies of a free ranging species involve two important components, one related to the habitat and the other use of habitats by the species.

The present study on habitat utilization and distribution pattern of wild pig in STR deals with both the above components and the following three broad methods were used to get relevant data.

- a) Quantification of habitat parameters by surveys, transects, plotless method and circular plots.
- b) Density estimates of wild pigs as a relative measure for comparing the habitat use as described by Moshby (1963) i.e. King's method.
- c) The habitat availability - utilization technique as described in Neu *et al* (1974) and subsequently modified by Marcum and Loftsgaarden (1980) to study animal use/avoidance of particular habitat.

### 3.1. Quantification of Habitat Parameters:

This had two phases. One was extensive surveys during which the vegetation and the water holes were mapped and the other was intensive studies along the four foot transects and three cycle transects.

The survey indicated that the study area can be broadly stratified into hills and plains with different vegetation types occurring in these strata. The four vegetation types identified

were 1. Scrubland, 2. Mixed woodland, 3. *Zizyphus* woodland and 4. *Anogeissus pendula* forests.

Of the four foot transects, two went across the plains and the other over the hills. Both the foot transects in the plains were in the scrub which forms the bulk of the vegetation in the study area. These two transects also gave opportunity to quantify biotic disturbances from the adjacent villages. The hill transects went through the vegetation dominated by *A. pendula*. The cycle transects went along the main road from Sariska gate to Kalighati check post (10 km) and along the right and left loop roads 11.25 and 11.75 km respectively.

Availability of the habitat parameters were quantified by sampling vegetation and topography at the intervals of 200 m along the foot transects and 250 m along the cycle transects. The sampling stations represented 90 points for the scrub, 58 for Mixed, 13 for *Zizyphus* woodland and 31 for *Anogeissus* forests. All the three strata of vegetation viz. tree, shrub and ground layer were quantified.

#### (A) Quantification of vegetation

Plotless sampling technique (Mueller-Dombois & Ellenberg 1974) was used to quantify the density of trees. The twentieth and 21st tree were identified and the average distance of these two trees from the sampling point was taken as radius of the circle to calculate the density of the trees.

Density estimates of all the stations for a particular vegetation type were pooled together and multiplied by 10,000 to

get tree densities per hectare.

Shrub density was estimated by counting all the shrub species in a 5 m radii circular plots at each sampling station. Ground layer (grass, herb and stragglers) were recorded at each sampling station using 1 m circular plots.

#### (B) Phenology of important fruiting trees

Existing information shows that wild pigs intensively feed on fruits of *Zizyphus mauritiana* and *Zizyphus nummularia*. Therefore, phenological studies on these two plant species were conducted every fortnight. Ten trees for each species in each vegetation type were marked on random basis and data on flowering and fruiting were quantified.

#### (C) Distribution of key food plants

Though wild pigs are omnivorous, herbaceous matter constitute significant portion of their diet (Graves 1987). Food plants were identified by the following two methods: by direct observations and by indirect evidences such as left over plant parts after feeding and digging and derooting signs where the remains of underground and subterranean food (root or stem) could be identified.

Based on both the methods a checklist of important food plants for wild boar was prepared (Table 2) and a survey was done for quantifying the distribution of these plants in the four major vegetation types. The relative densities of herbaceous food plants in various habitat gave an index of their availability. For the

pinch period (summer) criteria such as grass species, percent greenness of grass, average height upto which greenness is present and presence of important tuber yielding herbs such as *I. pestigridis* and *B. diffusa* were quantified in various vegetation types.

These quantifications were done in a 1 m radius circular plots and distance between the two sampling points was 1 m. The number of plots quantified per vegetation type was in proportion to its occurrence.

Biotic disturbance is considered an important factor effecting distribution of key food plants and hence the sampling was done in the disturbed and undisturbed areas of the above mentioned vegetation types to get a relative picture of abundance of these key food plants.

### 3.2. Density Estimation of Wild Pigs:

Density estimates by King's method gives reliable figures independent of the heterogeneity in the habitat (Riney 1982). The relative estimates gives a logical explanation to the pattern in which the animals are distributed in different patches of a habitat. For the present study this method was found suitable as the study area is very heterogeneous with four distinct vegetation types. Since the basic objective of this study was to see the pattern of habitat use by wild pigs over two seasons the densities obtained for different habitats can be useful in understanding seasonal variations in the habitat use. If other habitat parameters

are correlated to the density estimates it can give a meaningful idea regarding the used and avoided habitats of the species studied.

Along the foot and cycle transects the following parameters were recorded.

- (1) Time and the vegetation type in which the animal was seen,
- (2) Kilometer and segment number for each sighting. Later this was used to understand the variations in the micro habitat used,
- (3) Terrain,
- (4) Sighting angle and sighting distance,
- (5) Group size and age and sex composition.

Also, along the transects indirect evidences such as digging signs and dung along the visible range were also quantified.

### 3.3. Availability-Utilization Technique (Neu *et al* 1974):

In order to see the usage and avoidance of the different habitats over two seasons, this technique was adopted with a few modifications to suit the requirements. The main reasoning behind this method is the fact that utilization of the habitat (occupance or avoidance) by an animal cannot be quantified unless a relative measure of the total areas of different habitats and their distribution pattern is taken into consideration.

The method of availability data collected by Neu *et al* (1974) is based on mapping of the study area and calculating the areas of well defined plant communities using a planimeter (See Marcum and Loftsgaarden, 1980).



As there are problems associated with the availability-utilization technique of Neu et al (1974), the data for availability of habitat parameters were collected with some modifications of Marcum and Loftsgaarden's (1980) standard technique of gridding the entire study area and selecting some random points for collecting availability data. In the present study availability of different habitat categories were collected along the transects at an interval of every 200m on foot and 250 m on cycle transects. The utilization data was also collected on these transects in the form of animal sightings in different habitat categories. The data thus collected were analyzed using the program 'PREFER' (Prasad 1991) based on Neu et al (1974).

Further data on habitat utilization was collected by observations at waterholes and by quantifying digging signs. Wild pigs require water for drinking and wallowing. Observations at water holes from dawn to dusk (06.00-18.00 hrs) gives a picture of how the pigs use water hole in terms of frequency and time. Observations at water holes were made from a two-men tent pitched sufficiently away from the waterhole and well camouflaged to minimize the disturbance to the animals. This data was collected on 11 days : 6 during winter and 5 during summer. When the pigs came to the waterhole parameters such as time of arrival and leaving and age and sex composition of the groups were recorded.

Wild pigs unlike other ungulates have special devices to dig out and reach the lower most strata of vegetation (roots, tubers, rhizomes and bulb). The derooting habit makes it a distinct user of

habitat and a quantification of these diggings can give an idea the relative use of different habitats, if not the actual number of wild boars using the habitat. Digging signs along foot and cycle transects were quantified within a width of 2 m on either side and those on the line of transect. Depending on the intensity of the site dug out, these digging signs were classified subjectively as low intensity diggings over a small area, medium intensity diggings and heavy intensity diggings.

In order to look at the seasonal variation in dietary components of wild pig and supplement it to their habitat use, 100 wild boar dung were collected in every season from all the habitat types. Equal amount of time in each habitat was spent in searching. Food plants eaten were identified by dung analysis.

#### 3.4. Data Analysis:

Data were analysed to test the Null hypothesis ( $H_0$ ) that there is no preference for any particular habitat. In other words, utilization of each habitat category was in proportion to its occurrence in the study area. Chi-square ( $\chi^2$ ) tests were done to test the significance.

It is desirable to examine several comparisons between estimated and expected occurrence in order to detect preference or avoidance of individual habitat or forage species which are creating statistical significance in the Chi-square statistic. For this purpose, individual confidence intervals are constructed for each theoretical proportion of occurrence  $P_i$  of the multinomial distribution in order to determine whether expected values  $P_j$  lies

within the magnitude of significant effects. The one necessary adjustment concerns the level of significance of the intervals. When estimating a single parameter, the probability of obtaining an incorrect interval estimate is controlled at a level of significance 'L'. The resulting interval estimate is termed a (1-x) 100 percent confidence interval.

In estimating several parameters simultaneously, as long as the number of parameters is small, the appropriate tabulated statistic to use in constructing each interval estimate is

$Z(1-\alpha/2k)$  where  $K$  = number of simultaneous estimates being made.

These are bonferroni normal statistics (Miller 1966) as quoted in Neu et al 1974). At 'L' level of significance, the resulting confidence intervals will slightly wider for each of the multiple estimates than for an estimate of only one parameter. The form of confidence interval will be :

$$P_i - Z(1-\alpha/2k)$$

$$\leq P_i + z(1-\alpha/2k)$$

Where  $P_i$  = Proportion of animal sighted in the  $i$ th habitat category.

$n$  = sample size i.e. no. of animals sighted.

Most of the analysis was done manually using a Cassio f(x) 120 calculator. Siegel and Castellan (1956) has been used for nonparametric tests and Sokal & Rohlf (1981) for parametric tests.

Table 1: Particulars of foot and cycle transects in the study area.

Sl. No.	Name of Transect	No. of times run in month			Distance in different habitats (in km)				Type of disturbance
		Morning	Mid moon	Evening	Scrub-land	Mix WL	Sisyphus WL	Anogeisus	
<b>FOOT</b>									
1.	Naripura (PT-1)	2	-	2	1.8	-	-	0.2	Grazing, wood and grass cutting
2.	Bhartari (PT-2)	2	-	2	2.0	-	-	-	Grazing, wood and grass cutting
3.	Kiraska (PT-3)	2	-	-	0.4	0.2	-	2.0	Grazing, wood and grass cutting
4.	Kankwari (PT-4)	2	-	-	-	0.4	-	2.4	Grass cutting and tourism
<b>CYCLE</b>									
5.	Main Road (CT-1)	2	2	2	4	5.25	0.75	-	Tourism
6.	Left Loope (CT-2)	2	-	2	6	4	0.75	1.0	Tourism
7.	Right Loope (CT-3)	2	-	2	5.25	4.25	1.75	-	Tourism

Table-2: Checklist of wild pig food plants identified in Sariska valley

Sl.No.	Species	Distribution in study area	Part eaten	Mode of obtaining edible part	Based on
<u>Trees:</u>					
1.	<i>Zizyphus mauritiana</i>	Plains	Fruit	feeding fallen fruits	Observation
2.	<i>Prosopis juliflora</i>	Plains	Pods	feeding	Dung analysis
3.	<i>Butea monosperma</i>	Plains	Seedling roots tubers	Digging	Digging signs
<u>Shrubs spp:</u>					
4.	<i>Capparis decidua</i>	Plains & hills	Fruit	feeding fallen	Dung analysis
5.	<i>Zizyphus nummularia</i>	Plains	Fruit	feeding fallen fruit	Observation
6.	<i>Grewia damine</i>	Plains	Fruit	feeding fallen fruits	Dung analysis
<u>Grasses:</u>					
7.	<i>Cynodon dactylon</i>	Plains & hills	Leaves, stem and root	Grazing/digging	Observation
8.	<i>Brachira ramosa</i>	Plains & hills	Leaves, stem & root	Grazing/digging	Observation Dung analysis.
9.	<i>Chrysopogon fulvus</i>	Plains	Leaves, stem and root	Grazing/digging	Digging signs
10.	<i>Cenchrus ciliaris</i>	Plains	Root	Digging	Digging signs
11.	<i>Chloris barbata</i>	Plains & hills	Root	Digging	Digging signs.
<u>Herbs:</u>					
12.	<i>Ipomea pes-tigridis</i>	Plains & hills	Root	Digging	Observation
13.	<i>Boerhavia diffusa</i>	Plains & hills	Root	Digging	Digging sign
14.	<i>Indigofera tinifolia</i>	Plains	Root	Digging	Digging signs.

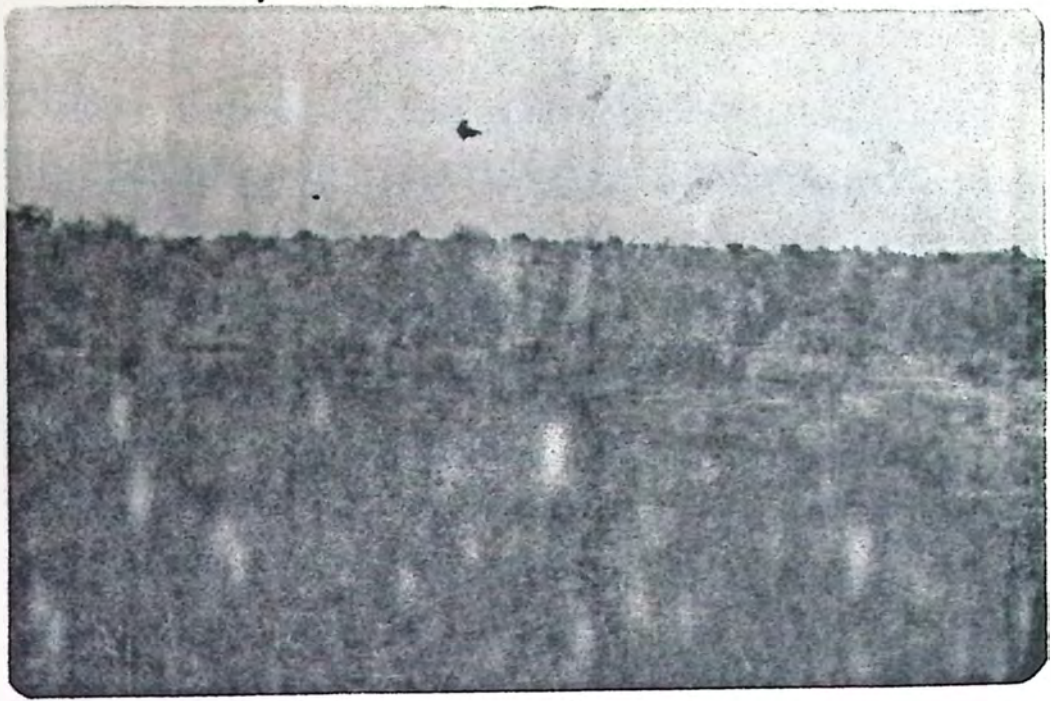


Plate 5a: Typical scrub habitat - note the sparse tree distribution.



Plate 5b: *Eutea* - mix forest. Note the mettle road in the fore ground.

## CHAPTER 4. RESULTS

Findings of this study are presented under two sections: Quantification of the habitat variables and habitat utilization.

### 4.1. Quantification of the Habitat Variables:

Data on various habitat parameters viz vegetation, terrain, water and phenology of important fruit trees are analysed and presented below:

#### 4.1.1. The Vegetation:

Results of tree, shrub and grass layer quantification is presented in table 3. The mean density figures with standard error of the mean (SEM) are given in per hectare units.

##### Scrubland:

The tree density in scrubland is low ( $201.07 \pm 38.39$ ) with shrubs dominating over trees ( $2216.5 \pm 376.8$ ). Among the dominant trees which provide cover are *A. leucophloea* ( $664.8 \pm 24.7$ ) *A. catechu* ( $26.09 \pm 6.22$ ) and *Balanites aegyptiaca* ( $46.5 \pm 10.8$ ).

The fruit bearing trees in the scrub land are *Z. mauritiana* ( $19.51 \pm 9.93$ ) and *Prosopis juliflora* ( $4.27 \pm 10.5$ ). The shade giving shrubs are *C. decidua* ( $345.15 \pm 155.1$ ) and *C. sepiara* ( $727.2 \pm 74.52$ ) which constitute 47.2% of total shrubs present. A list of tree, shrub species are given in Table 4.

#### Mixed Woodland:

The tree density in mixed woodland is greater ( $322.61 \pm 96.13$ ) than in scrub (Table-3). *Z. mauritiana* is the dominant tree ( $123.54 \pm 28.47$ ) followed by *A. pendula* ( $111.5 \pm 38.2$ ).

#### Zizyphus woodland:

Pure stands of *Z. mauritiana* were seen in this habitat ( $310.01 \pm 48.89$ ). The shrub layer was very low ( $758 \pm 72.19$ ). Dominant grasses were *C. dolichostachya* and *Digitaria* spp. The herb layer was almost missing (Table 16).

#### Anogeissus forest:

*A. pendula* was the dominant tree ( $270.5 \pm 64.88$ ). Very few *Z. mauritiana* were found ( $12.72 \pm 16.67$ ).

#### 4.1.2. Terrain:

The terrain is mostly flat. Of the total study area 71% is flat, 26% is gentle slope and 3% steep (Table 5).

#### 4.1.3. Water Availability:

The water holes in the study area are unevenly distributed with plains having all the waterholes and the hills none. *Zizyphus* woodland had the highest density of water holes (1.4/sq.km) which is followed by scrub (0.84/sq.km) and mixed woodland (0.41/sq.km).

#### 4.1.4. Phenology and Important Food Plants:

The phenology of *Z. mauritiana* was observed over two seasons (Table 6) along with grass layer which form the basic diet of wild pig during winter (Table-7 & 14). Fruit abundance estimate for *Z. mauritiana* is calculated from proportionate densities (PD) of *Z. mauritiana* obtained from different habitats and the percent ripe fruits therein as given in Table-6. The percentage of ripe fruits decreased with the onset of summer. The fruit abundance was more in the *Zizyphus* woodland than in other habitats. The important food plants and the methods based on which they were identified are given in Table-2.

The sampling in different disturbed and undisturbed habitats for estimating green forage volume showed that scrub had many palatable grass species and perennial herbs with a palatable green forage volume (155.41 cc). Though the mixed woodland has the highest green forage volume (339.79 cc), the grass species present these were mostly unpalatable (Table 8).

#### 4.2. Habitat Utilization:

Habitat utilization was analysed using several methods such as density in different habitat types, availability-utilization test and indirect evidences.

##### 4.2.1. Density Estimates:

Both in winter and summer wild pigs were seen in the foot transects only in the plains (scrub) where the density estimates

were  $18.7 \pm 12.3$  and  $26 \pm 15.9$  respectively. Density estimate for summer was significantly greater (t-test, one tailed at  $p = 0.025$ ). Data on morning and evening cycle transects over two seasons are given in Table 9. Morning density estimate was significantly different from evening. (Wilcoxon matched pair test,  $p = 0.05$ ).

Table 10 gives the density estimation for different habitat types for both the seasons by cycle transect. Winter density in *Zizyphus* was greater than summer in contrast summer density in scrub was greater than in winter.

#### 4.2.2. Availability-Utilization Test:

Avoidance/occupance was estimated using the software PREFER (Prasad 1991). The major findings summarised below are given in table 11.

- (1) In winter *Zizyphus* woodland was used more than scrub which was used in proportion to its availability.
- (2) Mixed woodland and *Anogeissus* forests were avoided in both the seasons.
- (3) In summer, scrub was used more than its availability while *Zizyphus* woodland was used in proportion to its availability. *Anogeissus* forests and mixed woodlands were avoided.

#### 4.2.3. Terrain Use:

Of the available terrain types, preference/avoidance rating was done (Prasad,1991) to see the pattern in which they are used over two seasons. The major findings listed below are given in Table 12.

- (1) Flat terrain (0-10 ) was more used during winter when compared to gentle and steep slope which were avoided
- (2) Steep slopes were avoided.
- (3) In summer, flat terrain as well as gentle slopes were used in proportion to their availability (Appendix-II).

#### 4.2.4. Midnight Activity:

Density estimation based on midnight transects also show (Table 13) that there was congregation of wild pig in the *Zizyphus* woodland in winter as compared to the summer high density in the scrub. Less number of wild pigs were sighted during summer as the day temperatures were very high (mean temp=39°).

#### 4.2.5. Digging and Derooting:

Digging signs were quantified in each habitat (Table 11). More diggings were observed in the scrub. This was significant ( $X^2 = 66.5$  at  $p = .05$  level). More diggings were observed in the winter as there were occasional winter showers which could favoured more digging. In summer less diggings were observed as there were more palatable grass species available in the scrub. A Chi-square test was also done to check whether there was any significant variation in intensity of digging over the two seasons. The results show that there is no significant variation in digging intensities over two seasons (Table 12).

#### 4.2.6. Waterhole Use:

The major funding at the waterhole was the following.

Wild pigs used the waterhole (Kalighati) more in winter (41

sightings of groups and loners) and the sightings were only two in summer. This was attributed to the availability of food (*Zizyphus* fruits) in winter in *Zizyphus* woodland where the waterhole was situated. In summer palatable green forage available was less as the dominant grass in *Zizyphus* woodland is *C. dolichostachya* which in summer is highly unpalatable.

#### 4.2.7. Dung Analysis:

The results of dung analysis are given in Table 7 and 14.

The major findings are:

- (i) *Zizyphus mauritiana* seeds were found mostly from the samples collected from *Zizyphus* woodland largely in winter.
- (ii) There was significant difference in consumption of plant to animal matter.
- (iii) Plant material constituted the bulk of the diet (Table-7).

**Table-3: Overall Tree & Shrub densities and with average grass volume in four habitats in Sariska valley**

Habitat	Tree density (M±SEM)	shrub density (M±SEM)	Average grass volume (M±SEM)
Scrubland	201.07±38.39	2216.51 ± 376.8	5830 ± 215.05
Mixed wl	322.61±96.13	1114.75±306.2	23742.2±19182.7
Zizyphus	382.6±18.98	758±72.19	11383.3±1935.2
Anogeissus forest	387.38±91.8	887±122.6	5251±1162.3

Table 4. Densities of important trees, and shrubs in various habitats.

Species	Density (per ha)			
	Scrub	Mixed WL	Zizyphus WL	Anogeissus For.
<b>A. Trees</b>				
1. <u>Aca. catechu</u>	26.09 +6.2	46.1 +5.3	-	-
2. <u>A. leucophloea</u>	64.8 +2.7	26.1 +9.2	13.4 +7.5	-
3. <u>A. senegal</u>	8.3 +3.4	-	-	-
4. <u>Ano. pendula</u>	-	111.5 +38.2	55.3 +30.7	270.5 +64.8
5. <u>Bal. aegyptica</u>	46.5 +10.8	-	-	-
6. <u>Ros. serrata</u>	-	-	-	118.8 +18.7
6. <u>But. monosperma</u>	-	23.95 +8.7	-	-
7. <u>Cap. decidua</u>	25.5 +7.2	-	-	-
8. <u>Pho. sylvestris</u>	6.5 +2.8	-	-	-
9. <u>Pros. juliflora</u>	4.2 +1.5	-	-	-
10. <u>Z. mauritiana</u>	19.5 +9.9	123.5 +28.4	310.01 +48.8	12.79 +16.6
<b>B. Shrubs</b>				
1. <u>Adh. vasica</u>	124.1 +42.97	39.0 +10.6	474.3 +22.9	-
2. <u>Cap. decidua</u>	345.1 +155.1	-	-	-
3. <u>C. sepiaria</u>	727.2 +74.5	718.6 +67.2	-	613.6 +34.4
4. <u>Gre. flavescens</u>	436.4 +110.7	01.2 +12.83	333.2 +24.7	417.5 +130.3
5. <u>Z. nummularia</u>	797.2 +106.5	14.8 +32.3	-	-

Table 5. Terrain-availability utilization by wild pig in two seasons.

Type	prop. available	winter use (n=140)	summer use (n=66)
Flat	.71	126	52
G.slope	.26	13	14
S.slope	.03	1	0

Table-6: Phenology of *Zizyphus mauritiana* in the four habitats in Sariska Valley in winter 1991

Habitat	Density (M ± SEM)	% ripe	Fruit (*PD x % ripe)
Scrub	19.51 ± 9.93	33.33	1.21
Mixed	123.54 ± 28.47	53.33	12.27
Zizyphus	310.01 ± 48.89	73.33	42.52
Anogeissus	82.79 ± 16.67	30	4.64

\*PD = Proportional density.

Table 7 : Diet Composition of wild pig

Season	Scrubland			Mixed WL			Sizyphus WL			Anogeissus forest		
	% Plant	% Animal	Unknown	% Plant	% Animal	Unknown	% Plant	% Animal	Unknown	% Plant	% Animal	Unknown
Winter	74.65	16.1	9.25	77.07	3.12	19.8	73.3	8.75	17.8	-	-	-
Summer	75.6	4.3	19.8	81.8	0.1	18.1	87.6	10.3	1.9	-	-	-

Table 8 : Green forage volume available to wild pig in pinch period (summer) in Sariska Valley.

Habitat	Disturbed			Undisturbed		
	Common grass species	Grass volume (in C.B.)	Herbs	Grass sp	Green forage volume (in C.C.)	Herbs
Scrubland	C.fulvus	2.73	-	C.dactylon	39.79	B.diffusa
	C.dactylon	4.3	-	C.barbatus	25.00	I.pes-tigridis
				C.fulvus	90.62	
Sizyphus butea mixed	C.dactylon	4.02	-	C.dolichostachya	47.27	
	C.dolichostachya	111.44	-	D.bipinnata	292.52	
	H.contortus	14.71				
Riverine in mixed	C.dolichostachya	6.0	-	C.dolichostachya	31.5	I.pes-tigridis
				C.dactylon	8.5	
				C.fulvus	16.53	B.diffusa
Anogeissus	C.dolichostachya	2.5	-	C.dolichostachya	63.08	
	Aristida sp.	2.0				
	C.dactylon	13.3				

Table-9. Comparision of morning(M) & evening(E) densities over two seasons

Season	habitat	M	E
Winter	Scrub	6.4	6.3
	mix	5.3	5.2
	Z.wl	36.8	35.4
	Anog	9.4	0
Summer	Scrub	20.9	12
	mix	1.2	.3
	Z.wl	2.3	2.9
	Anog	0	0

Table-10: Densities estimation based on cycle transects.

Habitat	Winter(M±SD)	Summer(M±SD)	t-cal
Scrub	5.75±3.6	17.29±4.5	4.06*
Mixed	5.25±1.6	.47±.53	3.64*
Zizy.WL	32.97±21.5	2.56±2.6	2.54 *
Anog.	0.92±1.66	0	1.42

\* =significant

Table-11: Percent fresh digging sites observed in different habitats over two seasons

Habitat	Season		Calculated $\chi^2$
	Winter (n=244)	Summer (n=112)	
Scrubland	43.03	68.75	
Mixed woodland	25.41	21.42	
Zizyphus woodland	20.49	6.25	66.76*
Anogeissus forest	11.06	3.5	

(\* significant at  $p \leq 0.05$ )

Table-12: Digging intensities in 2 seasons

Intensity	% intensity of digging		Calculated $\chi^2$
	Winter	Summer	
Low	43.03	58.03	
Medium	37.7	30.35	5.46*
High	19.26	10.71	

(\* Not significant at  $df(2) p \leq 0.05$ )

Table-13: Densities of wild boar from Midnoon Transects

Habitat	Winter	Summer
Scrubland	5.24	1.59
Mixed woodland	1.84	0
Zizyphus woodland	25.66	0
Anogeissus forest	0	0

Table 14 : Percent occurrence of major dietary component in wild pig dung.

Habitat	Zizy.seed		Moncot leaf		Stem		Root	
	W	S	W	S	W	S	W	S
Scrub	40	0	90	80	80	90	40	100
Mixed	40	0	70	80	60	75	40	70
Z.WL	100	5	40	60	25	60	50	80
A.p.	-	-	-	-	-	-	-	-

Table 15: Distribution of wild boar sightings in different habitats during study period (based on transects).

Month	Scrub-land	Mixed woodland	Zizyphus woodland	Anogeissus forest
December	18	12	29	1
January	16	7	17	2
February	23	12	3	-
March	27	4	2	-
April	33	-	-	-

Table-16: Dominant grasses and herbs in four habitats

Habitat	Grass species	Herbs encountered	% Occurrence	Common weeds
Scrubland	<i>C.dactylon</i>	<i>I. pestogradis</i>	60%	<i>C. tora</i>
	<i>Bracheira</i> sp.	<i>B. diffusa</i>	30%	<i>Sida</i> sp.
	<i>C.fulvus</i>			<i>A. aspera</i>
	<i>C.dolichostachia</i>			
Mixed woodland	<i>C.dolichostachia</i>	<i>I. pestogradis</i>	30%	<i>A.bidenta</i>
	<i>Digitaria</i> sp.	<i>B. diffusa</i>	40%	<i>C. tora</i>
	<i>H.contortus</i>			
Zizyphus woodland	<i>C.dolichostachia</i>	-	0	<i>C. tora</i>
	<i>Digitaria</i> sp.			
Anogeissus forest	<i>C.dolichostachia</i>	-	0	<i>C. tora</i>
	<i>Celotia</i> spp.			
	<i>Digitaria</i> spp.			



Plate 6a: *Zizyphus woodiana* - note the sparse ground cover.



Plate 6b: Wild pig langoor association (note the hanging tail).

## CHAPTER. 5 DISCUSSION

The frequency of encountering wild ungulates in different habitat types indicates trends in their habitat utilization (Seidensticker 1976). Indirect evidences such as tracks, dung, and feeding signs could also give an index of habitat use by different ungulate species. Results obtained based on both the direct sightings and indirect evidences of wild pig are discussed here. The discussion revolves around the following three basic questions:

- 1) Is there any shift in use of habitat over seasons?
- 2) Are the habitats used in proportion to their availability ?
- 3) What are the key factors which govern the distribution of wild pigs in STR ?

### 5.1. Habitat Use Between Seasons:

The data obtained from foot and cycle transects show that the density of the wild pig during the winter was higher in the *Zizyphus* woodland (32.97) than the scrubland (5.75) and mixed woodland (5.25). *Anogeissus* forest had the lowest density. (0.19). The trends were completely different during summer (Table 10). The density in the Scrub was highest (17.29) followed by *Zizyphus* woodland (2.56), and mixed woodland (0.6). *Anogeissus* forests were totally avoided. This indicates that with onset of summer wild pigs probably shifted their activities from *Zizyphus* and mixed woodland to scrubland.

### 5.1.1. Habitat Use During Winter:

Like most other omnivores, wild pig are opportunistic and utilize seasonally abundant food sources. In STR *Zizyphus mauritiana* is an important food tree for pigs during winter. The fruits of this species fall down either after ripening or when common langur feed upon them in the trees. The fallen fruits attract not only wild pigs but also other ungulates such as chital, sambar and nilgai. Though much of the wild pigs' nourishment may come from underground plant parts, and kills, considerable amount of nutrition may be obtained from the *Z.mauritiana* fruits.

The distribution of *Z.mauritiana* in the study area is very uneven (Table. 6). They occur in low densities in scrubland ( $19.5 \pm 9.9$ ) and in *Anogeissus* forests ( $82.79 \pm 16.6$ ) when compared to the other two types. *Zizyphus* woodland has the highest densities of *Zizyphus* trees ( $310 \pm 48.8$ ). This plays an important role in the habitat utilization of the pigs in winter as evident from their distribution pattern. Other studies on habitat utilization, and movement by wild pigs also suggest that habitats with abundant food and water are utilized more (Wood and Roark, 1971, Singer et al 1981, Vuren 1984).

Interestingly, during winter there was very little use of hills by wild pigs. This again could be correlated to the rarity of the *Z.mauritiana* in the hills (Table 6). The grass cover in the hills is largely of *C.dolichostachya* (Table 8) and it is not a good forage species. This also may have influenced the habitat use of th pigs (Table.9). The scrubland which is relatively poor in *Z.*

*mauritiana* and hence, in fruit abundance (Table.6) had lower density of pigs as compared to the *Zizyphus* woodland during winter. Though the proportional area of the scrub is relatively higher than all the habitat types (Appendix I) the available habitat was not used in proportion during winter.

The mixed woodland was not used in proportion to its availability as fruit availability is not that high as compared to the *Zizyphus* woodland (Table.6). But this habitat has a good grass cover and volume (Table 8). In spite of this, use of this vegetation type by wild pigs is less than expected. Waterhole density in the *Zizyphus* woodland was higher (1.4/sq.km) than in other vegetation types and this coupled with fruit abundance made this habitat attractive to pigs during winter. Similar observations have been made by Wood and Roark (1980) who showed that feral hogs in South Carolina fed in Oak stands in fall and summer as long as acorns were available. When acorns were not available, the hogs fed on roots and tubers in the margins of marshes and swamps, indicating shift in habitat use and diet.

#### Indirect evidences of habitat use in winter:

The number of digging sites observed in different habitats do not really suggest the number of animals using the habitat, though a rough index can be obtained. The data on digging sites during winter show that scrubland is more dug than other habitats (Table 11). If one goes by assessing habitat use just by looking at the digging sites, it may not give a correct picture of how different

habitats are used. During winter, more digging was seen in scrub probably because of less *Zizyphus* fruits and more palatable grasses e.g. *C. dactylon*, *C. fulvus*, and herbs such as *J. pes-tigrides* and *B. diffusa* (Table.8). Also, due to winter showers, soil may have become suitable for digging in scrubland. The intensities of digging in various habitats are given in (Table 12). which shows that intensity of digging were not significant in winter and summer. In *Zizyphus* woodland, the number of diggings were less, as the grass associated with this habitat is mostly *C. dolichostachya* and *Digitaria* sp. (Table 8).

#### Winter resting sites:

Wild pigs dig out a small area so that a depression could be formed in the substratum, which maintains a constant micro-climate. These winter resting sites were usually dug in a open area, preferably under a tree or shrub, with less canopy cover, so that they are exposed to early morning sun light, as well as they can scan over a large distance during night to avoid predators (Plate 6-B). Of the 15 resting sites observed in the study area, 12 were located in the scrub 2 in the mixed woodland and 1 in *Zizyphus* woodland.

One possible reason for finding such an uneven distribution of resting sites could be due to the variation in the visibility in different habitats while doing the transects. The visibility was more (Ca. 40m) in scrub than in other habitats and this would have enabled me to locate more resting sites.

### Dung analysis:

Dung collected from all habitats in winter had *Zizyphus* seeds (Table 14), suggesting that *Zizyphus* fruits were utilised to the maximum extent available. It was also observed that dung collected from scrub had less *Zizyphus* seeds, reflecting lower availability.

### 5.1.2. Habitat Use in Summer:

The density of wild pig during summer in scrub was much higher (17.29) than in other habitats (Table 10), suggesting that there could have been a possible shift in habitat use from woodlands to scrub, where non-temporal food resources such as palatable grasses and herbs are available. The grass species diversity was also high in scrub than in woodlands. The scrubland adjoins a stream, and soil is alluvial, which contribute to the availability of green forage.

The other important factor which could have helped in more use of scrub during summer, is presence of large number of cover giving shrubs such as *C. decidua* and *C. sepiara* which gives the shade necessary for the pigs in the summer (Table 4). Less intensity of digging in this area may be due to hard substratum and availability of green forage. It is expected that during late summer digging and derooting intensity would go up as green forage will be scarce.

### 5.1.3. Dung Analysis:

Dung collected from all habitats in summer had more root and monocot leaf fragments (Table 14) suggesting that wild boars utilised more underground parts of plants during summer. In mixed woodland, more monocot leaves are consumed than in other habitats, though this was in proportion to green herbaceous matter available there.

### 5.1.4. Observations at Waterhole :

In all the 5 sittings at (Kalighati) waterhole on five different days in summer there were only 2 sightings. This waterhole is surrounded by *Zizyphus* woodland, which had no fruits during summer. In winter when fruits were abundant in *Zizyphus* woodland there were in total 41 sight of pigs. This implies that a waterhole may be neglected if it is situated in an area without the pig's favourite food.

### 5.2. Management Implication:

In order to maintain and improve the population of wild pig in STR, management action is urgently needed to promote the regeneration of *Z.mauritiana* trees throughout the reserve. Presently, the population structure of this species quantified (Sankar WII pers comm) shows that there is total lack of regeneration. This trend needs to be arrested otherwise when the mature trees die out there will be very scarcity of energy rich *Zizyphus* fruits for the wild pigs and other ungulates in STR.

### 5.3. Conclusion:

It is evident from the density figures (Table 10) obtained during winter that there was a High density of wild pigs in the relatively less available *Zizyphus* woodland habitat. The scrubland which represents a large proportion of study area (0.48) had only 57 sightings (Table 15). This habitat was thus used in proportion to its availability. The mixed woodland which represented 36% of the total study area was not used in its proportions of availability and thus it was avoided. The *Anogeissus* habitat which represented 7.6% of the total study area, was avoided, as there were only 3 sightings during the entire season. It is concluded that the availability of *Zizyphus* fruits governed the distribution of pigs during winter. The results of availability-utilization technique also confirm this.

In summer the utilization of scrub was more when compared to other habitats as it had a variety of perineal food resources, in the ground layer (Table 2 & 3). The *Zizyphus* woodland is used in proportion to its availability, as it represented a small area (8.1%) of the total study area. Mixed woodland was avoided as the availability of green herbaceous matter was low (Table 8). The *Anogeissus* forests were totally avoided as they were mostly restricted to hills, with no water and little forage availability.

In a nutshell it is concluded that *Zizyphus* fruits in winter, perennial food resources in the ground layer and cover in summer influence the distribution of wild pig in Sariska Valley. Water, without forage around has a low habitat suitability value for wild pigs.

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(\* Original not seen)

Appendix I: Habitat availability - utilization data as analyzed  
by PREFER (Neu et al 1974).  
[ \* = Avoided ; \*\* = Preferred ]

Winter

Z= 2.499999523162842

S.NO	Hab.cat	Tot.Area	Rel.area	Exp. usage	Obs. Usage
1	Scrubland	0.00	0.480	67.200	57
2	Mixed WL	0.00	0.360	50.400	31
3	Zizyphus WL	0.00	0.081	11.340	49
4	Anogeissus	0.00	0.076	10.640	3
	Exp prop usage	Lower Confidence limit	Upper Confidence limit		
1	0.480	0.303	0.511		
2	0.360	0.134	0.309 *		
3	0.081	0.249	0.451 **		
4	0.076	0.000	0.052 *		

SUMMER

Z= 2.499999523162842

S.NO	Hab.cat	Tot.Area	Rel.area	Exp. usage	Obs. Usage
1	Scrubland	0.00	0.480	31.680	60
2	Mixed WL	0.00	0.360	23.760	4
3	Zizyphus WL	0.00	0.081	5.346	2
4	Anogeissus	0.00	0.076	5.016	0
	Exp prop usage	Lower Confidence limit	Upper Confidence limit		
1	0.480	0.821	0.998 **		
2	0.360	0.000	0.134 *		
3	0.081	0.000	0.083		
4	0.076	0.000	0.000 *		

Appendix II: Terrain availability - utilization data as analyzed  
 by PREFER (Neu et al 1974).  
 [ \* = Avoided ; \*\* = Preferred ]

Winter

Z= 2.389999628067017

S.NO	Hab.cat	Tot.Area	Rel.area	Exp. usage	Obs. Usage
1	Flat	0.00	0.710	99.400	126
2	Gentle slope	0.00	0.260	36.400	13
3	Steep slope	0.00	0.030	4.200	1
	Exp prop usage	Lower Confidence limit	Upper Confidence limit		
1	0.710	0.839	0.961 **		
2	0.260	0.034	0.151 *		
3	0.030	0.000	0.024 *		

SUMMER

Z= 2.389999628067017

S.NO	Hab.cat	Tot.Area	Rel.area	Exp. usage	Obs. Usage
1	Flat	0.00	0.710	46.860	52
2	Gentle slope	0.00	0.260	17.160	14
3	Steep slope	0.00	0.030	1.980	0
	Exp prop usage	Lower Confidence limit	Upper Confidence limit		
1	0.710	0.668	0.908		
2	0.260	0.092	0.332		
3	0.030	0.000	0.000 *		