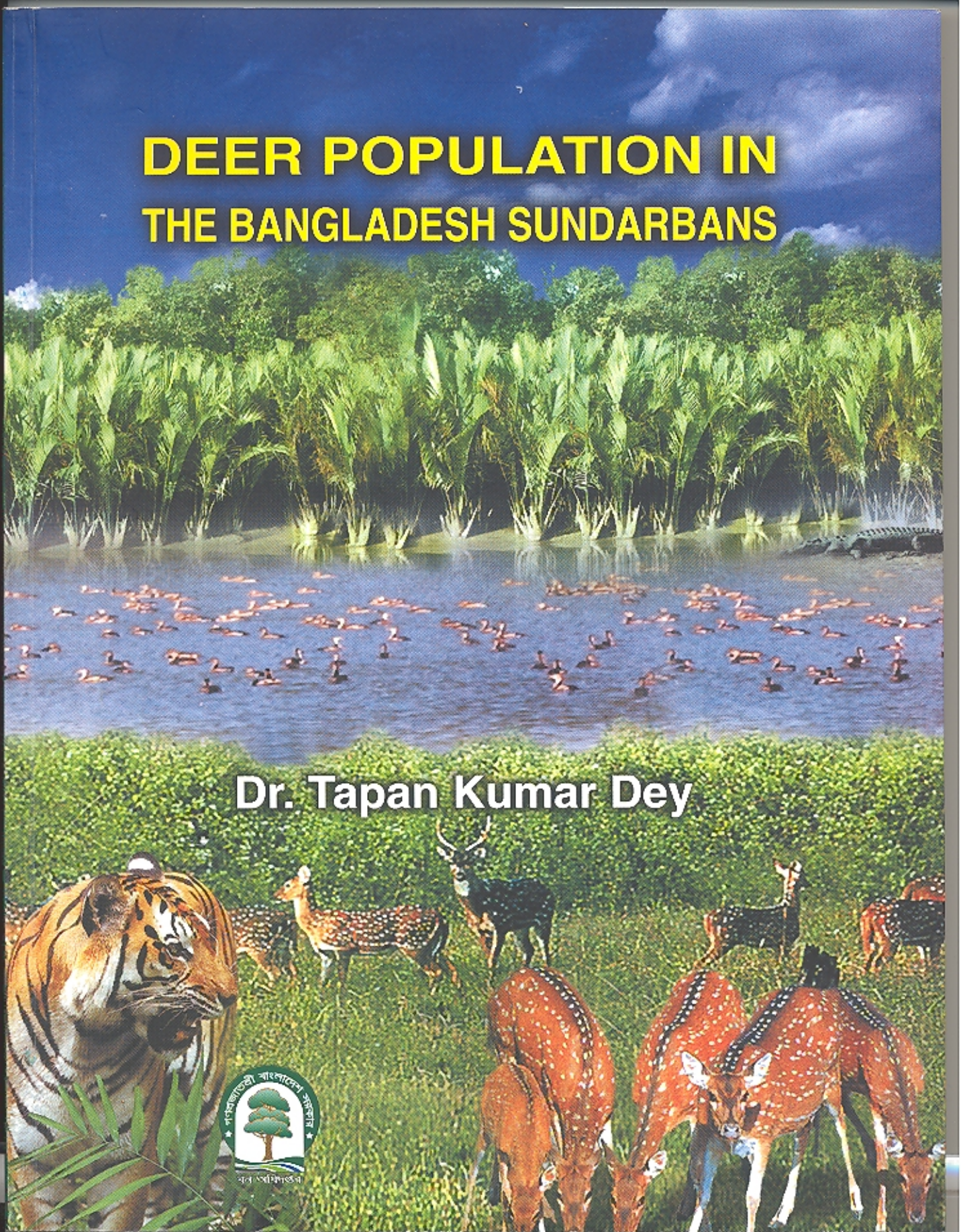
DEER POPULATION IN THE BANGLADESH SUNDARBANS



Dr. Tapan Kumar Dey

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2007

The views expressed in this publication is the outcome of the Ph.D. research study of Dr. Tapan Kumar Dey

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Abbreviation

C.C : Complete Counting
CITES : Convention on Internatiional Trade in Endangered Species of Woil Fauna and Flora
ESRI : Environmental System Research Institute
GPS : Ground Position Survey
HMM : Harmonic Mean Measure
IUCN : International Union of Conservation of Nature and National Resources
IWM : Institute of Water Modelling
LTC : Line Transect Counting
MCP : Minimum Convex Polygon
ODA : Overseas Development Authority
PGC : Pellet Group Counting
RTHR : Radio Tacking Home Range
RIMS : Rasources and Information Management Services
SRF : Sundarban Reserve Forests
SWMC : Surface Water Modelling Centre
UNDP : United Nations Development Progra mme
WBC : Wildlife Breeding Centre
WSC : Wildlife Sanctuary Centre

FOREWARD

It is an honor and a pleasure to be asked by Dr. Tapan Kumar Dey to write a foreward to his book. A great detail has been published both in text and pictures about the population ecology of Spotted Deer and Barking Deer in the Sundarbans. The Sundarbans mangrove forests are quite rich in terrestrial, aquatic and avian faunal species. The forest waterways provide unique habitats, breeding areas and refuge for a wide variety of species.

Bangladesh has adopted the flagship species approach for wildlife and biodiversity conservation using fabulous majestic animal such as the Bengal Tiger (*Panthera tigris*) as an umbrella species, to preserve the intact assemblages of large mammal and their habitats. In recent year the status of the prey species of tiger have caused grave concern among the conservationists due to negative impact caused due to illegal hunting, poaching and degradation of habitats. The status of prey population of tiger is almost unknown due to the lack of scientific basetine information and regular monitoring of deer in the Sundarbans.

The biodiversity of the wildlife of Bangladesh Sundarbans and the complexity of the conservation issues make it extremely difficult to write a comprehensive and up-to-date account of fauna. But the author made a desperate efforts for the estimation of the major wildlife population of Sundarbans though the wildlife population estimation in a situation like Sundarbans is a very difficult task.

The population density, status, distribution and home range of the Barking Deer (*Muntiacus muntjak*) and Spotted Deer (*Cervus axis*) vary with vegetation, season, biotic pressure, poaching and abundance of predator population. Habitat preference of these two study species is related to different ecological factors. The habitat requirements of these species are very complex. No detail study has been done on their population ecology, status, distribution and habitat preference in Bangladesh. The Sundarbans Reverve Forests is a unique biological unit of habitat for two study species. The main tiger prey is the Spotted Deer, and thereby study of predator-prey relationship is an important aspect for wildlife management. As we know that prey species depleting is a critical determinant factor of tiger population viability, so continuous monitoring and research on population density and distribution of the two prey species (Spotted Deer and Barking Deer) is necessary. In Bangladesh the natural population of Spotted Deer are now restricted to the Sundarbans. The deer population is declining due to biotic pressure on land and water resources. This book is the out come the PhD research study and it will give us an opportunity to know the present population status, distribution, habitat preference, predator-prey relationship, home range and conservation measures of the two deer population in the Bangladesh Sundarbans. This information will be helpful to student researcher and forest officers who are working in the various fields related to biodiversity conservation in the Sundarbans.

11 January 2007
Dhaka

Mohammad Osman Gani
Chief Conservator of Forests

Preface

The natural population of Spotted Deer are confined in the Sundarbans Reserved Forests of Bangladesh. They are the main prey species of the Bengal Tiger, the biggest of cats which has now been eliminated from the most parts of its ranges. Bengal Tiger is a flagship species in our country and it has long inspired human cultures with their power and beauty. The critical issue of tiger conservation are related with the abundance of deer population in the Sundarbans. But no systematic scientific study has been done on the population status and distribution in the Bangladesh Sundarbans. There are 9 (nine) different types of vegetation and the density of the deer also varies according to the vegetation types.

The population status and distribution of the prey species of tiger is very important issue among the wildlife biologists and conservationists. However in absence of systematic baseline data and regular monitoring to tiger and their main prey species, it is not possible to explore management intervention. In the nature there is a close relationship between predator and prey population. The Bangladesh Sundarbans is a unique biological unit of habitat for two study species. The main tiger prey is the Spotted Deer and Barking deer. Prey species depletion is a critical determinant factor of tiger population viability. So continuous research and monitoring of the deer population is necessary. During the year 1999 to 2001 a a part of my Ph.D. research I have conducted a detail study on the population ecology of Spotted Deer and Barking Dear of Bangladesh Sundarbans. I have used different survey methods and also radio-telemetry equipment during the study. This book is the outcome of my research study. This beautifully illustrated and informative book examines the critical issues of deer conservation.

It gives me very much pleasure to express my sense of gratitude to **Professor Kazi Zaker Hussain**, Department of Zoology, University of Dhaka for supervision, suggestions, continuous assistance and valuable contribution to the production of this book. I am extremely grateful to **Mohammad Osman Gani,** the Chief Conservation of Forests, Bangladesh for his continuous support, encouragement and advice in the process of production of the book. My special thanks to **Professor Ainun Nishat**, Country Representative, IUCN, Bangladesh for extending all support and assistance throughout my study in the Sundarbans Reserved Forests.

I would like to convey my thanks to my wife Anuva Dey, my younger brother M.r. Dey, Chairman, Department of Zoology, Khilgoan Model Degree College, Dhaka and Mr. Arif Ahmed, computer operator for data processing, computer typing and continuous support during the production of the book.

I wish to express my deep gratitude to all the Forest Department staff, mangrove dwellers and fisher folk who entrusted me with their traditional knowledge, suffered the hardship of accompanying me into mangrove swamps, guided me through the remote water ways.

Date : 8 January 2007
Chittagong

AUTHOR

EXECUTIVE SUMMARY

The study on population dynamics, population density and fluctuation, radio telemetric home range (RTHR), activity pattern, movement, dispersal, social interaction herd structure, habitat preference of the Spotted Deer and Barking Deer was made between January, 2000 and December, 2002 in the Sundarban reserved Forests (SRF) as a part of Ph.D. research study (Dey 2004).

The Spotted Deer was found throughout the Sundarbans Reserved Forests and population was 83000 approximately. The mean density (no/sq km) varied from 3-4 in Sundri *(Heritiera fomes)*, 10-13 in Sundri-Gewa *(H. fomes-Excoecaria agallocha)*, 6-7 in Gewa-Sundri *(E. agallocha-H. fomes)*, 12-14 in Sundri-Passur-Kankra *(H. fomes–Xylocarpus mekongensis-Bruguiera gymnorrhiza)* and Gewa *(E. agallocha)* forest, 15-16 in Gewa-Goran-Passur *(E. agallocha-Ceriops decandra-X. mekongensis)*, 14-18 in Passur-Kankra-Baen *(X. mekongensis-B. gymnorrhiza-A. officinalis)*, 43-55 in Goran Gewa-Keora *(C. decandra-E. agallocha-Sonneratia apetala)* and 112-195 in Keora Gewa *(S. apetala-E. agallocha)* open grassland associations. The least preferable habitat was the pure Sundri *(H. fomes)* forest and the most preferable habitat was the Keora Gewa open grassland association. The Spotted Deer population density decreased with the increase of canopy closure and was the lowest in pure Sundri (2 to 4/sq. km) where canopy closure was 70-80%, and the highest in Keora-Gewa open grassland association (112 to 175/sq. km) where canopy closure was 40-50%.

The Barking Deer exists only in the five different vegetation types out of nine different vegetation types in the Sundarbans Reserved Forests and population size was 2150 approximately. The mean population density (no/sq. km) varied from 1-2/sq. km. in Sundri forest, 2-3/sq km in Sundri-Gewa and Passur-Kankra-Baen forest, 4-5/sq. km in Gewa Sundri forest and 3-5/sq. km in Sundri-Passur-Kankra forest. The Barking Deer was found only in the north and northeast regions.

A population decrease was recorded in October-January (non-breeding season) and an increase was recorded in April-September which was considered as peak breeding season of the Spotted Deer, However they were found to breed throughout the year. The population remained more of less stable during March to July and average ratio of male: female: fawn was 15:60:25, and on other hands during peak breeding season (August September) and average ratio of male: female: fawn was 15:50:35.

The radio-tracking home range (RTHR) of both the sexes varied from 140-200 ha during the non-breeding season (October-January) in the SRF. The home range of the male increased to 295 to 410 ha during the peak-breeding season (August-September) which was about two times larger than that of the non-breeding season. The home range of the female during the breeding season increased to 1.5 times larger than that of the non-breeding season. A male shared a overlap home range area with 4 to 5 females during the rutting period.

The home range (RTHR) of Barking Deer also varied from 45-90ha during the non-breeding season (November-February) in the SRF. The home range of the male increased to 80 to 170 ha during the rutting period, which is about two times larger than in the non-breeding season. The home range of the female during the breeding season increased to 1.25 times larger than that of the non-breeding season. A male shared a home range with 2 to 3 females during the rutting period.

Radio-telemetric study on the habitat preference of the Spotted Deer in the Sundarbans Reserved Forests showed that the Keora-Gewa open grassland association was the most suitable habitat for both the sexes during the winter and summer. Although both the sexes preferred forested area throughout the year, male were more associated with forest than that of females.

Food plants of Spotted and Barking Deer were recorded in the Sundarbans Reserved Forests. The both species of deer used 85 plants out of which 20 are trees, 12 shrubs, 9 creepers/climbers and 44 herbs/sedges.

The Spotted Deer was more active during the day than at night. The total activity for both the sexes significantly increased to 24.31 %- 33.41 % during the breeding season. The total traveling distance of a male varied from 1700 to 2300 meters during the non-breeding season (December -January) and 2900 to 4500 meters during the rutting period. The total traveling distance of female varied from 1200 to 2100 meters per day (24 hours) during both the non breeding season and breeding season.

The Barking Deer was more active during the night. The total activity for both the sexes significantly increased to 21.50%- 25.77% during the breeding season. Total traveling distance of a male deer varied from 1330 to 1670 meters during the non-breeding season (December- January) and 2100 to 2900 meters during the rutting period. The total traveling distance of a female deer per day (24hrs) varied from 950 to 1700 meters during both the breeding and non-breeding season.

The Spotted Deer prefers to live in herds and the average herd size was 8. On the other hands, the Barking Deer preferred to live in both solitary form or in pair, herd structure an social organization were absent.

The summary of the deer population study including other major mammals are given below :-

Spotted Deer (*Cervus axis*)	83,000
Barking Deer (*Muntiacus muntjak*)	2,150
Wild Boar (*Sus scrofa*)	28000
Rhesus monkey (*Macaca mulatta*)	51,000

Chapter-1

INTRODUCTION

1.1 Biography of the Deer in South Asia Region

Deer are a unique group of mammals recognized for their grace and beauty. Deer comprise a distinctive order of mammals, the ungulate having hoofs. The general structure of deer is in conformity with the structure of Bovine ruminants.

Deer are for the most part inhabitants of forest and grassland. With the development of firearms, deer everywhere become more vulnerable. Hungry families wanted meat. Hides could be sold. Medicines, magical or Otherwise could be made of certain parts. Deer provide numerous readily utilizable products (meat, hides and antlers) and their population have suffered comic durable reduction from over-exploitation. Conversion of lowland forest areas into agricultural field is a major threat for deer conservation (Dey, 2004).

There are 17 existing genera under family Cervidae. Asia has 9 (2 extending to Europe) including both primitive and derived forms (Grubb and Gardner 1999). Asia is quite rich with cervus deer. There are 31 species and 97 subspecies of cervus deer under of genus *Cervus, Alees, Axis, Capreolus, Elaphodus, Elaphurus, Hydropotes, Mazama, Megamuntiacus, Muntiacus and Rangifer* in Asia. Most of them are native to China, Indonesia, Philippines, Cambodia, Japan and Taiwan. In South Asia there are 7 species and 13 subspecies of cervus deer are found. The status and distribution of cervus deer in the South Asia Region is given below (Grubb and Gardner 1999) :

Status and distribution of cervus deer of South Asia Region

Species	Sub-species	Common name	IUCN and CITES Status	Countries with range
I. *Cervus axis*	C. a. axis (Erxleben, 1777)	Spotted Deer	NO	Bangladesh, Nepal India, Srilanka. (Introduce to Argentina, Australia, Brazil, Hawaiian Islands, New Guinea, U.S.A, Yugaslavia)
2. *Axis porcinus*	*A. p. porcinus* (Zimmermann 1780)	Hog Deer	LR, nt	India, Nepal, Srilanka; Pakistan and Bangladesh (rare and only recorded in Khagrachari area of Chittagong Hill tracts.
3. *Cervus duvauceli*	*C. d. branderi* (Pocook, 1943)	Swamp Deer or Barasingha	EN	India
	C..d. duvauceli (Cuvier, 1823)	Swamp Deer or Barasingha	VU	India and Nepal.
	C. d. ranjitsinhi (Groves, 1982) .	Swamp Deer or Barasingha	CR	India and Bangladesh (extinct)

4. Cervus elaphus	*C. e. affinis* (Hadgson, 1841)	Shou	DD	Bhutan and Tibet.
	C. e. hanglu (Wagner, 1844)	Hangal	EN	Kashmir and India.
5. Cervus eldi	*C. e. eldi* (Clelland, 1842)	Eld' s Deer	VU	India (Manipur)
6. Cervus unicolor	*C. u. unicolor* (Kerr, 1792)	Sambar	CR	India and Bangladesh (Chittagong Hill Tracts and Sylhet), Nepal.
7. Muntiacus muntjak	*M. m. muntjak* (Zimmermann 1780	Barking Deer	EN	Bangladesh, Bhutan, India, Nepal and Myanmar.
	M m. aureus (Hamilton Smith 1826)	Barking Deer	LR,lc	India, Myanmar and Pakistan
	M. m. malabaricus	Barking Deer	LR,lc	India and Srilanka
	M m. vaginalis (Boddaert, 1785)	Barking Deer	LR,lc	India, Nepal and Myanmar.

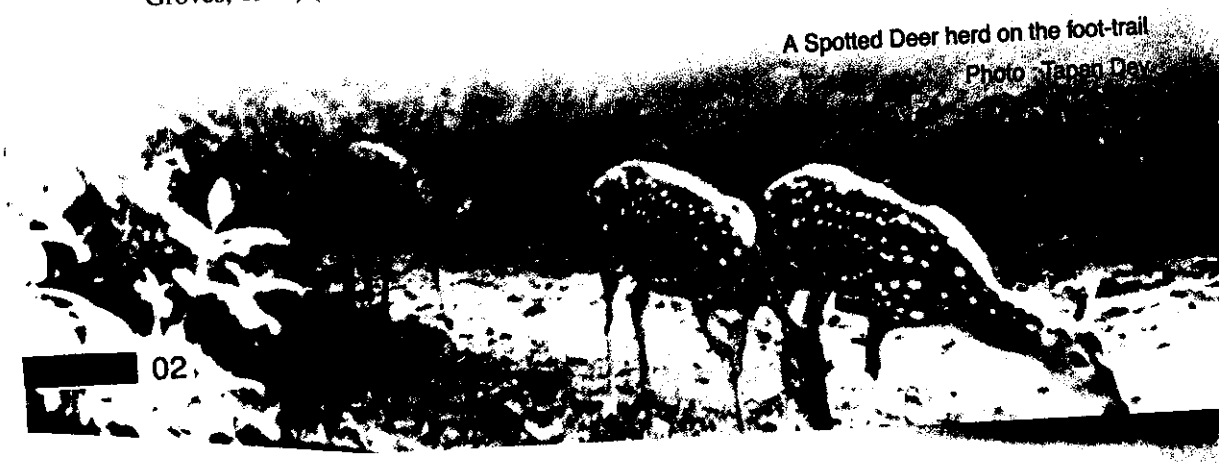
IUCN Categories

EX-Extinct, CR-Critically Endangered, EN-Endangered, VU-Vulnerable, LR-Lower Risk, cd-Conservation Dependent, nt-Near Threatened, lc-Least Concern, DD-Data Deficient, NO- Not Threatened

A distribution map of the Spotted Deer and Barking Deer in the South Asia Region has been developed with the help of Environmental System Research Institute (ESRI 1992) digital database.

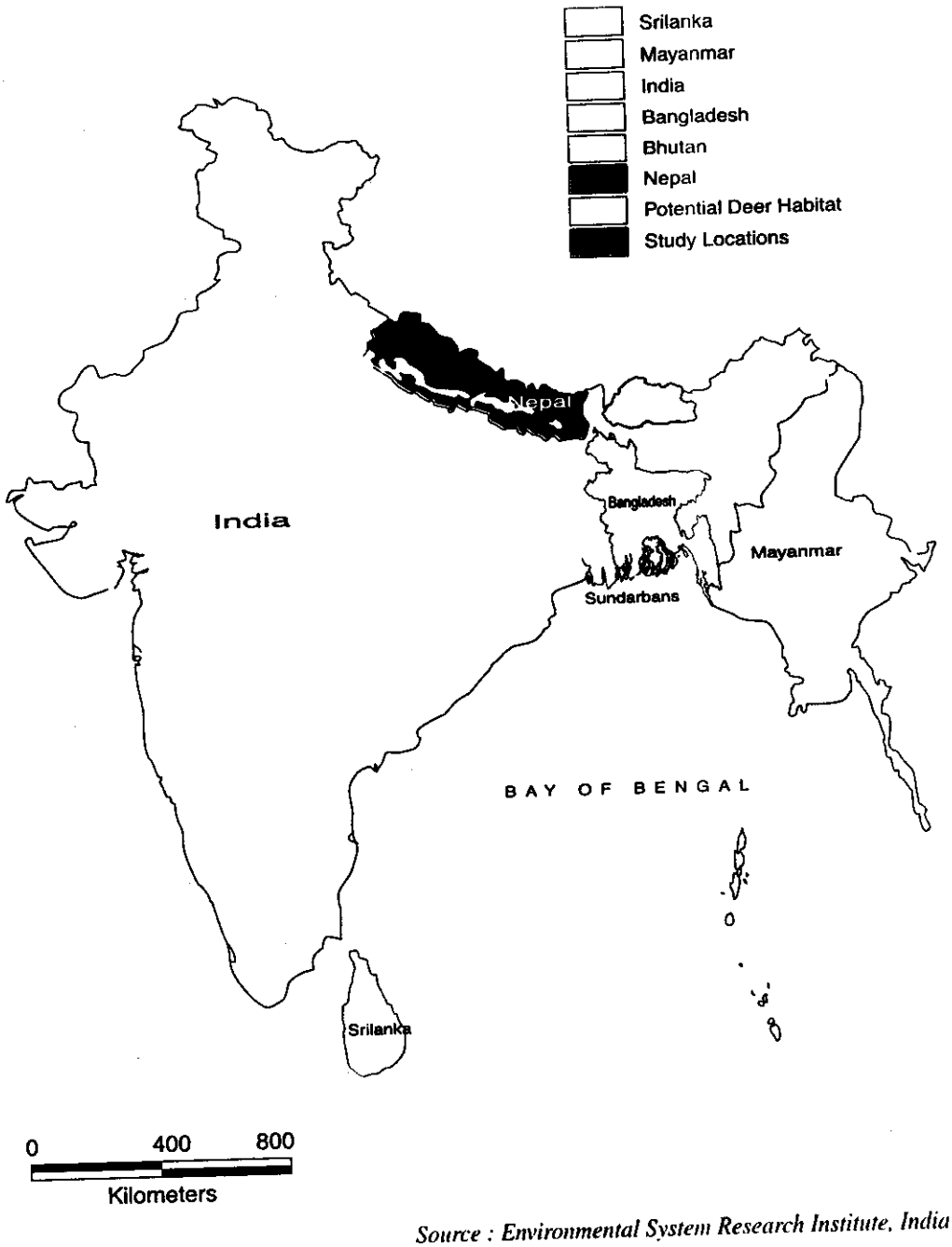
Deer Habitat in Bangladesh

There were five species of deer in Bangladesh namely Spotted Deer (*Cervus axis axis* Erxleben,1777), Barking Deer (*Muntiacus muntjak muntjak* Zimmermann,1780), Hog Deer (*Axis porcinus porcinus* Zimmermann, 1780), the Sambar (*Cervus unicolor unicolor* Kerr, 1792) and Swamp Deer or Barasingha (*Cervus duvaucili ranjitsinhi* Groves, 1982) (Sarker and Sarker, 1988)



A Spotted Deer herd on the foot-trail
Photo: Tapan Dey

Map showing the distribution of the Spotted Deer and Barking Deer in the South Asia Region



Source : Environmental System Research Institute, India

They are widely distributed across the Indian Peninsula, Burma, Srilanka, and Indo Malayan countries (Blandford, 1891 and Prater, 1980). According to present information Swamp Deer and Hog Deer have become virtually extinct. In the middle of 20th century Swamp Deer and Hog Deer were found in low-lying grassland of Sylhet and the Chittagong Hill Tracts. Due to the destruction of habitat and biotic pressure, they become extinct from Bangladesh. In the year 2003 a pair Hog Deer were collected from Khagrachari area, and they were kept in the Dulahazara Safari Park. The Spotted Deer is not threatened in Bangladesh as per IUCN

The remaining 2(Two) species, Barking Deer and Samber Deer) is also threatened and vulnerable. Samber Deer (*Cervus unicolor unicolor* Kerr) populations are also threatened and vulnerable. Few decade back Sambar Deer were found in all forests. Now they are confined in Chittagong Hill Tracts and part of Sylhet Forests.

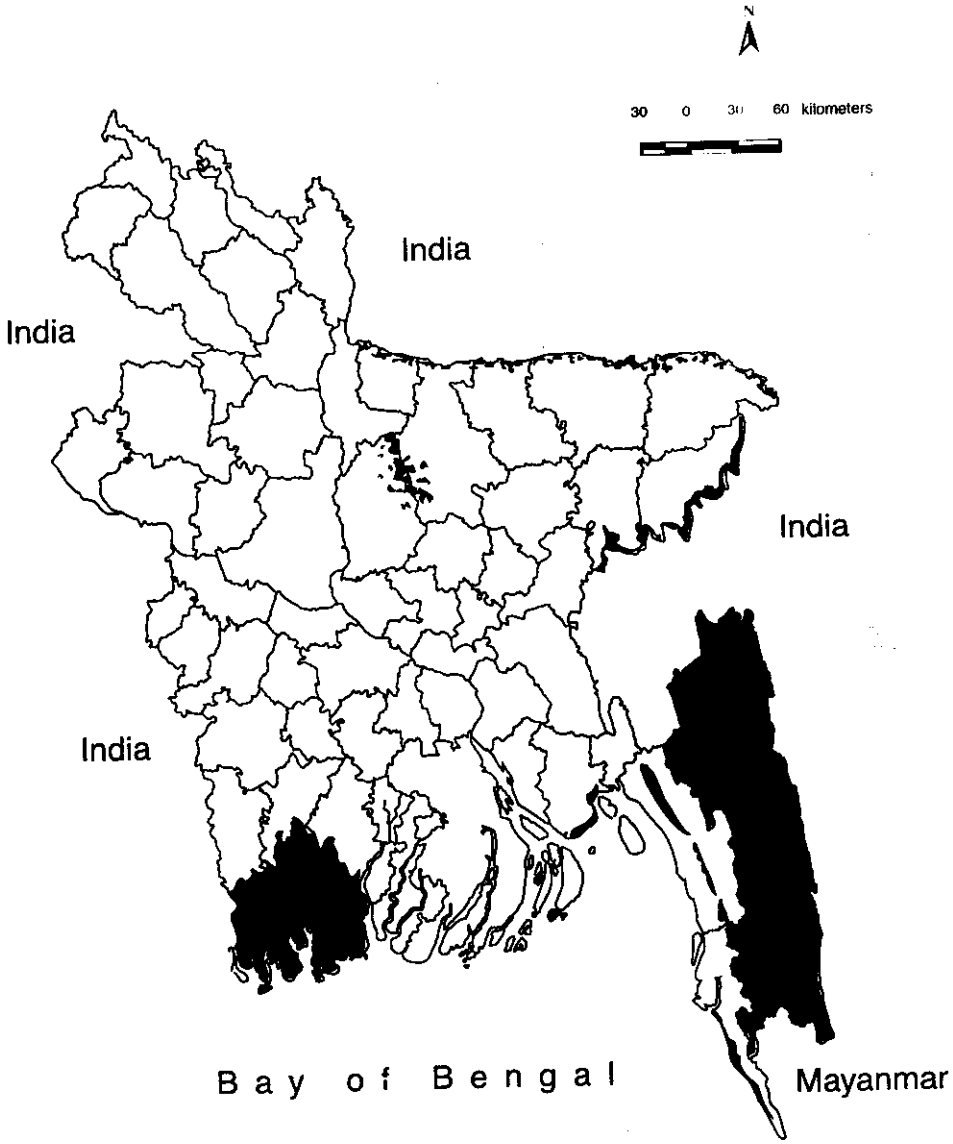
The Spotted Deer (*Cervus axis*) is not threatened or endangered (IUCN Bangladesh. 2000). The Spotted Deer also called Chital locally is considered as the most beautiful of all cervids (Schaller, 1967). It is widely distributed in the subcontinent. It is found nearly throughout India, Bangladesh, Nepal and Srilanka. In South Asia the Spotted Deer occurs at the base of the Himalayas, however ascending the mountains beyond the lower spurs, from the neighborhood of the Sutly to Nepal, but not in Sikim. It is not found in Punjab plains, not in Sind, and only the eastward in Rajputana. It is also wanting in Assam and to the east of the Bay of Bengal, but common in the Sundarbans of Bangladesh and India. In the middle of 19th centuary, it was found throughout Bengal, Orissa, the North-west Provinces, Central India, Mysore, Malabar and Srilanka (Blandford, 1891 and Prater, 1965).

In Bangladesh they are normally confined in the Sundarbans Reserved Forests (SRF), but are most abundant in the south, where stretches of extensive grassland and scattered forests of Keora trees occur. Grasslands provide excellent grazing grounds, and Keora leaves and fruits are preferred food for the deer. Such combinations of vegetations are found in the Sundarbans East, Sundarbans South and Sundarbans West Wildlife Sanctuary areas. In all these areas in the south plentiful

Spotted Deer in the Shundarbans sometimes numbering more than a hundred in a herd can be seen grazing in the meadow-like grasslands. The forests get denser and closed towards the north and the density of deer population is less in the north. There are 9 (nine) different types of vegetation in the Sundarban Reserved Forest (SRF). But no systematic scientific study has been made on the population status and distribution in the SRF. Hendrichs (1975) estimated 80,000 Spotted Deer in the SRF and he has not provided any basis for the estimation. In 1976 several pair of Spotted Deer were introduced in the Nizum Deep National Park of Noakhali Forest Division, now their population size is about 12000-13000 and it creats critical situation in the Park and adjacent islands.

The Barking Deer (*Muntiacus muntjak*) Endangered in Bangladesh (IUCN Bangladesh 2000). It was nearly found throughout India, Myanmar, Bhutan, Nepal and Bangladesh at

Spotted Deer and Barking Deer Distribution in Bangladesh



1. Spotted Deer distribution
2. Baking Deer distribution

all thickly wooded hills, never in the plains, nor in free forest areas. In Bangladesh, they are found in the Chittagong Hill Tracts, Sylhet, Coxís Bazar, Chittagong, Madhupur Sal forest, Garohills and in the Sundarbans Reserved Forest. The population of Barking Deer was much higher in the past than it is now. The population is decreasing very rapidly due to illegal hunting, destruction of their habitats, lack of food, lack of public awareness and commercial exploitation. In the SRF they are confined in the north and north-east area where fresh water flow is more. From management aspect of view it is very important to know the population size and habitat requirement of the Barking Deer in the SRF.

Bangladesh has adopted the flagship species approach to wildlife and biodiversity conservation using charismatic animals such as the Bengal tiger (*Panthera tigris*) as umbrella species, to preserve the intact assemblages of large mammal and their habitats. In the recent year, the status of the prey species of the tiger have caused grave concern among conservationists due to negative impact of illegal hunting, ecological changes and biotic pressure. However in absence of scientific rigorous baseline data and regular monitoring of tiger and their prey populations remains unknown in the SRF.

The population density, home range, herd composition and activity pattern of the Barking and Spotted Deer vary with vegetation, season, biotic pressure, poaching and abundance of predator population. Habitat preference of this two study species is related to different ecological factors. The habitat requirements of this two study species are very complex. No detail study has been done on the population ecology, status, distribution, habitat preference, dispersal and movement, herd structure and composition in Bangladesh.

The SRF is a unique biological unit of habitat for two study species. The main tiger prey is the Spotted Deer, and there by study of predator prey relationship is an important aspect for wildlife management. As we know that prey species depletion is a critical determinant factor of tiger population viability. So continuous monitoring and research on population density and distribution of the two prey species (Spotted Deer and Barking Deer) is necessary. So Dr. T.K. Dey(2004) has made an extensive study on the population status, distribution, habitat preference, predator-prey relationship home range, activity pattern and conservation measures of the Spotted deer and Barking Deer in the SRF.

1.2 Short Description of the Spotted Deer (*Cervus axis*)

Local Names : Chitra Horin, Chital

Size : The Spotted Deer is at its best in the Himalayan Foothills, in the Jungles of the Terai, and in Madhya Pradesh. A well-built stag from these parts stands 90 cm at the shoulder and weighs about 85 Kg. The record head measures 101 cm. A 85 cm. antler would be good anywhere 80 cm in South India.

A Spotted Deer herd in the Karamjal WBC

Distinctive characters. The Spotted Deer is perhaps the most beautiful of all deer. Its coat is a bright refous-fawn profusely spotted with white at all ages and in all seasons. Old bucks are more brownish in color and darker. the lower series of spots on the flanks are arranged in longitudinal rows and suggest broken linear markings.

The graceful antlers have three tines, a long brow tine set nearly at right angles to the beam and two branch tines at the top. the outer tine, the continuation of the beam. is always longer. It may be noted that old bucks often have one or more false points on the brow antler where it joins the main beam.

Distribution. In India Spotted Deer are found in the Forests at the base of the Himalayas and practically throughout the Peninsula and Srilanks wherever there is jungle combined with good grazing an a plentiful supply of water. It is unknown in the arid plains of the Punjab, Sind. in the large portion of Rajputana. and the countries east of the Bay of Bengal. It is found in Assam in the Goalpara, Kamrup and Darrang Districts. In Bangladesh natural population only found in Sundarban Reserved Forest, Nizum Dip National Park and Char Kukri Mukri Wildlife Sanctuary.

Habits. One always associates Spotted Deer with beautiful scenery, with grassy forest glades and shaded streams. They are seen in herds of ten to thirty, which may contain two or three stags; but assemblages numbering several hundreds have been met with. They do not shun the proximity of villages, but enter cultivation, and frequently associate with many forest animals, particularly with monkeys. they are less nocturnal than Sambar and feed till late in the interval in some shaded spot.

The time at which the stags shed their antlers varies in different localities. In Madhya Pradesh and south India, it is usually in August and September. The new antlers are in velvet till the end of December. But stags carrying horns in various stages of development have been seen at all seasons. In Madhya Pradesh the pairing season is at its height in May. the rutting stag has a loud harsh bellow and combats between the males for the possession of the hinds are fierce an frequent. In north India the pairing is said to take place during the winter months. Fawns may be met with at any season. Usually the mother gives birth to a single fawn. Chital are prolific breeders; an interval of six months may see the production of a new family.

1.3 Short Description of the Barking Deer *(Muntiacus muntjak)*

Local Names. Chagallay Harin, Muntjak etc.

Size. Height at the shoulder of an adult male is from 50 to 75cm; Its weight about 22 to 23 kg. Excluding the pedicel, which may be up to 8 to 10 cm. long, the horn rarely exceeds 13 cm. The best Burmese head is 17.8 cm. Average Indian antlers measure 5 to 8 cm. the pedicel 8 to 10 cm. the maximum length obtained in the old C.P. is 17.8 cm, 17.1 cm. in South India.

Two female Barking Deers are manifesting intrinsic shy nature. Photo : Pench National Park, Central India

Distinctive Character .. the antlers are small, consisting of a short brow-tine and an unbranched beam. They : e set on bony hair-covered pedicels which extend down each side of the face as bony ri ges, hence the name Ribfaced Deer. In does tufts of bristly hair replace the male are v ll developed and are used by the animal in self-defense.

Distribution. Muntjac range over the greater part of the Indo-Malayan countries and are found also in China, F rmosa, and Japan. Various races are recognized over this wide range. The Muntjac of orth India is *M.m.vaginalis*. The southern form is M. m. aureus. A third race (*M. m. malac uricus*) is found in malabar and extends to Srilanka. The Muntjac of Tenasserim [*M. feae* (homas &Doria)] is regarded as a distinct species. The coat of the north Indian race is bright chestnut. A bright red form is equally common in Burma.

Habits. The haunts of the Muntjac are thickly wooded hills. In the Himalayas and S. India it occurs up to levels of 1500 to 2450 m., sometimes even higher. They are seen singly or in pairs or in small family parties. Muntjac keep to more or less thick jungle and come out to graze in the outskirts of forest or in open clearings. They are fairly diurnal in habit. The food consists of various leaves and grasses an wild fruits. the call from a distance sounds much like the bark of a dog. It is given out at intervals, usually in the mornings and evenings. sometimes after nightfall

When alarmed and in flight these deer give out a series of short cackling barks. A sharp rattle likened to the sound of castanets heard when Muntjac are bounding away is a vocal noise. Muntjac appear to breed at all seasons. the rut mainly takes place in the cold weather. The Young, usually one, sometimes two, are born at the beginning of the rains. Horns are shed during May and June.

1.4 Necessity of Population Ecology and Estimation Study

The population ecology of Barking and Spotted Deer is generally similar to other ungulates and herbivore mammals. Population characteristics and dynamics of deer vary in relation to physical and biological characteristics of individual habitats (Cheatum and Morton, 1946).

Dynamics in species trend, distribution and structure are the major factor to management. Population size and density of an animal in a particular habitat are important factors for understanding its population ecology (Krebs, 1972). Population size generally means the number of animal present in a particular area.

Population estimation can be determined by periodical survey trends related to this parameters especially of the target species or ecologically sensitive species. It helps to tackle the constraints to achieve the management goals. Population estimation of wildlife with a desired accuracy depending upon the management objective. The purposed of deer population survey in the SRF given below :-

Deer are the main prey base of Bengal Tiger (Flagship species) and it indicate the healthy of the forest. So deer population survey was done.

To evaluate the population trend is whether increasing, decreasing or stable.

To establish the baseline data of deer.

To know status of distribution of deer in different vegetation.

To know age and sex structure, and population fluctuation etc.

The Bengal Tiger (*Panthera tigris*) is an endangered animal; the largest member of the cat family is perhaps the most spectacular animal on earth. There is a thriving population of approximately 419 tigers in the SRF (Bangladesh Forest Dept, 2004). Tiger conservation has become a global issue in the recent year. The common prey of the Sundarban tiger are the Spotted Deer and the Wild Boar. In the Eastern Sundarbans, the tiger mostly depends on the deer. Outside Spotted Deer and Wild Boar, tiger also prey on the Barking Deer, otter, water monitor, lesser cat, monkey, snake, rodent, frog, crab, fish, bird and turtle etc. Wood cutters, Bawalis, Mawalis, fishermen, etc and trespassers entering the SRF for their livelihood fall prey to the man-eating tiger. On an average 30 persons are killed by the tiger every year. Sundarbans are being synonymous with 'man killing tigers'. Some of the Bengal Tigers have been phenomenal killers and their tendency of eating human flesh can be matched with other human predator in the world. Various theories have been postulated with regard to the man-eating behavior. Wanting of prey species in the Northern part of the SRF is an assumption to the human killing. But no quantitative research study so far has been done on the distribution of prey species in different vegetations and regions in the SRF.

As we know main of prey species of the Bengal Tiger in the SRF is the Spotted Deer. So it is a burning issue to know the population size and habitat requirement of Spotted Deer in the SRF. So it is an important conservation issue to know the abundance of prey species like Spotted Deer and Barking Deer in the SRF. Long term research on population ecology of free ranging population of Barking and Spotted Deer in Bangladesh has not been done so far.

Biodiversity conservation in the SRF is a burning issue at the moment. Different agencies are working to develop a sustainable wildlife management plan. But enough population data are not available. The past population data regarding Spotted Deer and Barking Deer including major mammals estimation in the SRF is given in the Table-1.

Table - 1 : Past population data on the major mammals of the SRF

Species	Hendrich (1975)	Sarker (1982)	Gittins & Akand (1984)	Salter (1984)	Tamang (1993)	Bangladesh Forest Dept. (2005)
Spotted Deer *(Cervus axis)*	80,000	-	-	-	94,000	-
Barking Deer *(Muntiacus muntjak)*	-	-	-	-	-	-
Bengal Tiger *(Panthera tigris)*	350	425	440	425	362	419
Wild Boar *(Sus scrofa)*	20,000	-	-	-	45,000	-
Rhesus Macaque *(Macaca mulatta)*	40,000	-	1,26,000	88,000	40,000	-

This estimation had not any strong basis and methodology, and it has created lot of confusion. If we want to conserve the Bengal Tiger we have to conserve the prey population like the Spotted Deer, Wild Boar, Rhesus Monkey and Barking Deer. Prey depletion is a critical determinate of tiger population viability. Since 2003 no systematic study has been done on the population estimate of Spotted Deer and Barking Deer. Dey (2004) has made a detail systematic study as a part of his Ph.D research study.

1.5 Use of Radio telemetry in the study of Population Ecology.

Most research on herbivore mammals has been done by netting and direct observation techniques which may be of benefit in studying population dynamics but can reveal little o the behavior of individual animals. When such techniques are applied to the study of ranging behavior like home range, movement and activity pattern can lead to misleading result.

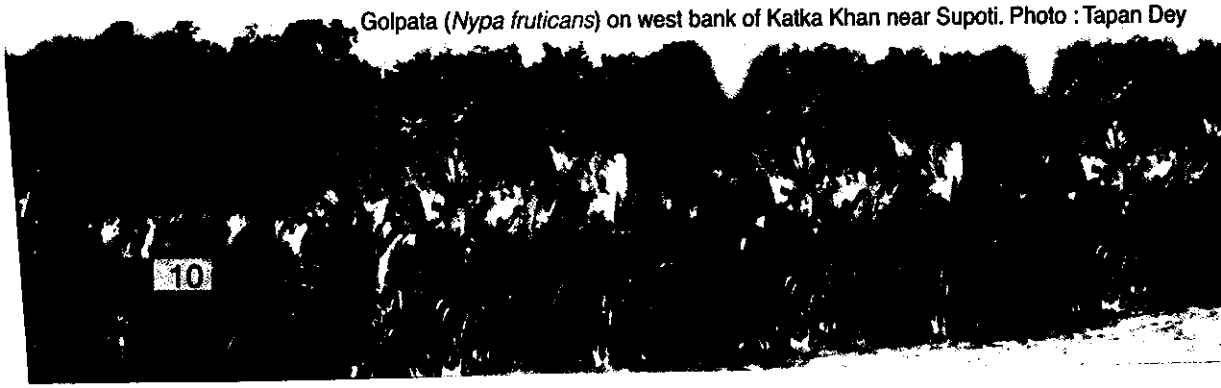
A new area in the study of home range and movement of free living animals came out throuth the development of miniature radio-transmitters and suitable receivers. Early descriptions of radio-tracking systems are provided by Cochran and Lord (1963), Cochran *et. al* (1965), Sniff and Tester (1965) and Tester (1964).

Radio tracking provides a useful technique for studying dynamics of wildlife population. Movements provide information on how animals use the environment, migration patterns, dispersal and activity patterns. Home range estimates quantify the area used by the animal. Habitat use studies provide information on habitat preference. Survival studies provide estimates of mortality rates and population studies estimate the number of animals in the population (White and Garrott, 1990).

Carnivores have received much attention due to th invention of miniature transmitter in 1963. Some of the early radio-tracking studies were on the Grizzle bear, *Ursus horribilis*; Striped skunk, *Mephitis mephitis* ; Red fox, *Vulpes vulpes* and Badgar, *Toxidea taxus* (Craighead 1965 ; Storm, 1965 ; Verts, 1967 ; Sergeant and Warner, 1972). The recent satellite tracking of Polar bear (Kolz, Lentfer and Fallek, 1978) and Tiger in Royal Chituan National Park, Nepal and in the SRD by GPS (Ground Position Survey) Collar is a great achievement in the field of radio-telemetric study of wildlife.

Barking Deer are active at dark, period, so ocular observation on activity pattern and movement is not possible during the day. Spotted Deer are active in day and also in night. Radio-telemetry generally provides better (usually larger) estimates of home range size than grid trapping. However, no research had been undertaken to analyze home range of Barking and Spotted Deer by the raidio-telemetry method nor of population ecology and habitat preference in the Sundarbans Reserved Forests.

Golpata (*Nypa fruticans*) on west bank of Katka Khan near Supoti. Photo : Tapan Dey



Chapter-2

SUNDARBANS : THE MANGROVE FOREST

The Sundarbans Reserved Forest (SRF) in Bangladesh is the single largest mangrove forest in the world.The SRF is a unique bio-climatic zone in a typical geographical situation in the coastal region of the Bay of Bengal. It is a landmark of ancient heritage of mythological and historical events and bestowed with magnificent scenic beauty of natural resources, which is internationally recognized for its wide biodiversity of mangrove flora and fauna both on land and water. The SRF the immenre tidal mangrove forests of Bangladesh is in reality a mosaic of islands of different shapes and sizes, perennially washed by brackish water suriling in and around the endless and mind-boggling labyrinths of turisting water channels. This is the only habitat where natural population of the Spotted Deer is confined.

2.1 Location

The SRF is situated in the extreme southwest of Bangladesh between the river Baleswar in the East and the Harinbanga in the West adjoining to the Bay of Bengal. The forest is lying between latitude 21° 27'30" and 22°30'00" North and longitude 89°02'00" and 90°-00'00" East at the southern part of Khulna, Bagerhat and Satkhira civil districts.

2.2 Area

The forest has an area of some 6017 sq. km (7620 sq. km including the marine zone) determined from the visual interpretation of multispectral SPOT satellite data. Land area including exposed sandbars occupies 4,14,259 hectares (70%), water bodies 1,87,413 hectares (30%) (Table-2).

Table-2 : Major physiographic areas of the SRF

Description	Area (Km^2)
Land area (including sandbars)	4142.6
Marine zone	1603.2
River, channels, streams & canals	1874.1
Total area including marine zone	7620.0
Total area excluding marine zone	6016.7

Source: 1995 data BGD/84/056 GIS

Sundarbans Reserved Forest Showing the Major Vegetation Types

Legend

- Sundri
- Sundri-Gewa
- Sundri-Passur-Kankra
- Gewa
- Gewa-Sundri
- Gewa-Goran-Passur
- Goran-Gewa-Keora
- Passur-Kankra-Baen
- Keora-Gewa-Open grassland

- International Boundary
- Reserved Forest Boundary
- Range Boundary
- Wildlife Sanctuary

Source

RIMS/GIS Database Unit
Bangladesh Forest Department
Ban Bhaban, Dhaka.

2.3 Geology

The upper SRF forest grows on geologically recent soil formations. The substratum consists entirely of Quaternary Era sediments, sand and silt, intercalated with marine salt deposits and clay. A number of geomorphological and resultant hydrological chances have contributed to the present location and condition of the Sundarbans. The rising of the western part of the delta caused separation of ancient branches of the Ganges from the area, which today comprises the Indian Sundarbans. This resulted in the accretion at the river mouth and increase in salinity waters intruding in the western part of the delta (Chaudhury and Ahmed, 1994).

2.4 Soil Characteristics

The SRF soil is finely textured and the sub-soil is stratified and at greater depth is compacted (Choudhury, 1968). Hassan and Mazumder (1990) mentioned that soils were slightly calcareous, uncured or partly cured clayey deposits which were homogenous both: critically and horizontally. Organic carbon and nitrogen in the topsoil (15 cm depth) were 0.62% and 0.05% respectively on dry weight basis. In the eastern part of the forest, the rivers supply fresh silt every year, the top layer is soft and fertile. In the western Sundarbans where there is little fresh supply of silt, even the surface soil has settled down to a hard mass, and the ground is much less suitable for fast tree growth.

2.5 Tides and Hydrology

Tides in the SRF are semi-diurnal with a small diurnal irregularity. In the eastern Sundarbans, the irregularity is minor but much more pronounced in the west (Seidensticker and Hai, 1985). Mean spring range in the mouth of the Passur River (east delta) is 2.4 m. Based on the frequency of tidal inundation, especially during the May–October period, the Sundarbans can be divided into four hydrological zones –

(a) Areas inundated by all tides:

(b) Area inundated by normal high tides;

(c) Areas inundated only by spring high tides;

(d) Areas inundated by the monsoon high tides;

Spotted Deer *(Cervus axis)* are a common sight in the Sundri (*H. fomes*) forest of the SRF. (Photo : Michael Mastaller)

2.6 River System

A complex network of streams and rivers varying considerably in width and depth intersects the entire area. Some of the big rivers are several kilometers in width. The Sundarbans receives large volumes of fresh water from inland rivers flowing from the north and of saline water from the tidal incursions from the sea. The fresh water is charged with alluvium containing plant nutrients. This together with the salinity of the tidal water is the major factor determining the productivity of the forest ecosystem.

At a comparatively recent period, all the rivers were connected with the Ganges like Bhairab, Madhumati,Gorai. Now, only the Baleswar has direct connection and is responsible for fresh water supply to the eastern part of the Sundarbans. A number of rivers namely, the Passur, the Sipsa, the Arpangasia, the Malancha and to a slight extent the Jumuna and Raimangal have indirect connections and receive the overflow of the Ganges during the rainy season. They also received a considerable amount of local drainage throughout their long and meandering courses during the monsoon.

2.7 Soil and Water Salinity

The salinity increases from East to West and North to South. But remains less than 6 dS m-1 even in the driest month (Hassan & Razzaque, 1981). Soil salinity in April -May remains between 2 and 4.5 dS m^{-1} in most parts of the Sundarbans. The range is considered to be at low salinity level. However, salinity has considerably increased in recent years due to diversion of Ganges water upstream at Farakka in the Indian territory (Shall, 1982a). Soil salinity data were collected regularly from four representative areas of the Sundarbans since 1976. Peak salinity level occurs in AprilóMay and drops gradually in the soil and abruptly in water after June. Soil salinity shows erratic variations. Based on the degree of soil salinity, the Bangladesh Sundarbans has been divided into three salinity zones- less saline (salinity<2 dS m-1). moderately saline (2-4 dS m-1) and strongly saline (>4 dS m-π).

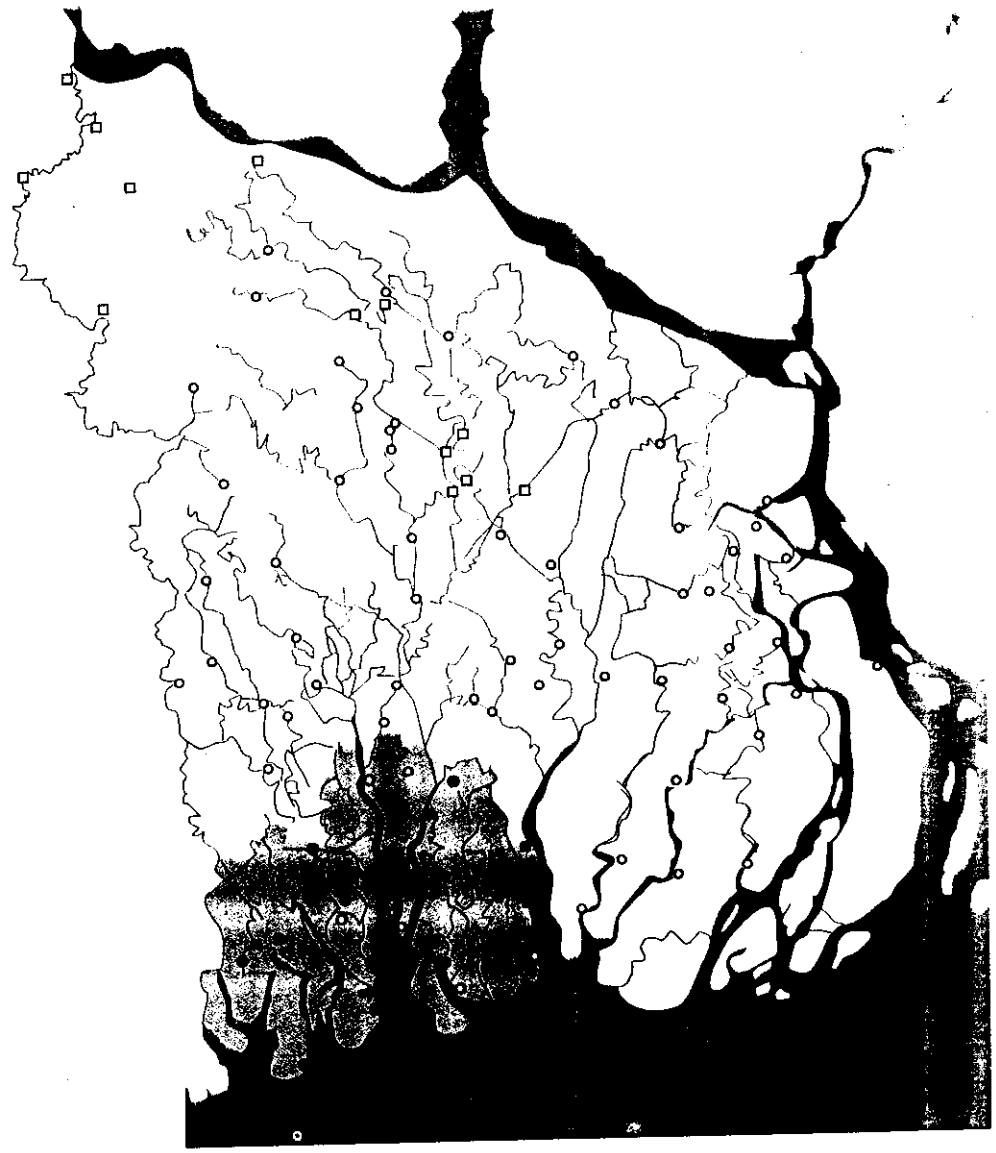
Water salinity along the northern part of the Sundarbans ranges from 1 to 9 ppt in the late monsoon (Septemer). This range in water salinity during the dry season (May) varies from 4 to 28 ppt (Siddiqi, 2001).

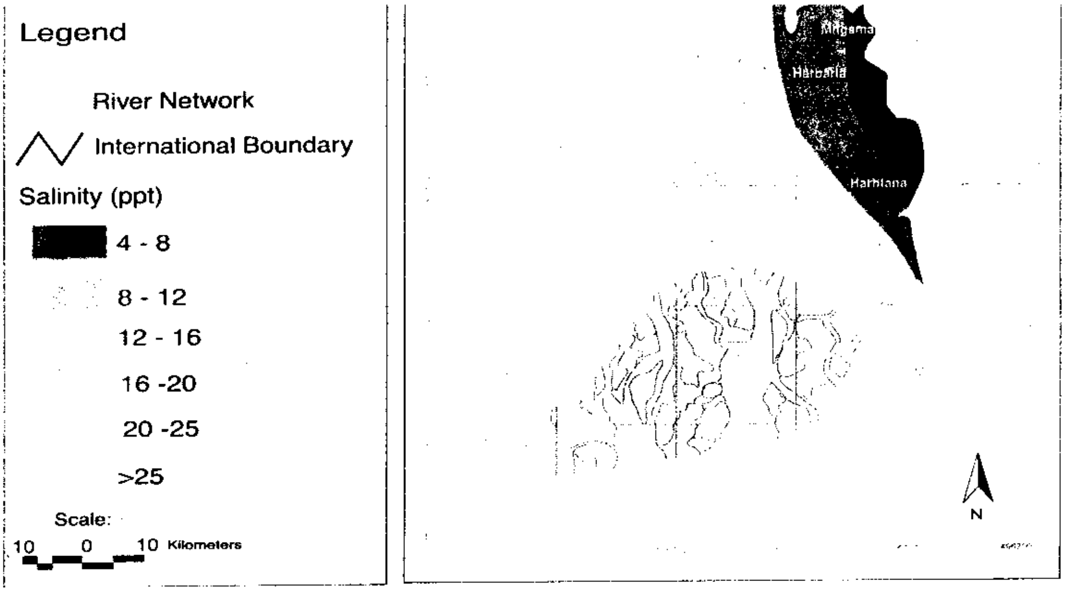
2.8 Climatic Condition

The climate of the SRF is humid. Temperature is fairly equable due to the proximity of the sea. Highest temperatures occur in April and May and lowest in December and January. Mean annual maximum and minimum temperatures vary between 30° and 21° C, mean annual relative humidity varies from 70% to 80%. Humidity is highest in June-October and lowest in the month of February. Annual rainfall in the Sundrabans is in the range of 1640-2000 mm as apparent from the data recorded in the four stations adjacent to the forests. July, August and September are the wettest months and December, January

River Network System for the Sundarbans Reserved Forest

(Source : SWMC 2002)

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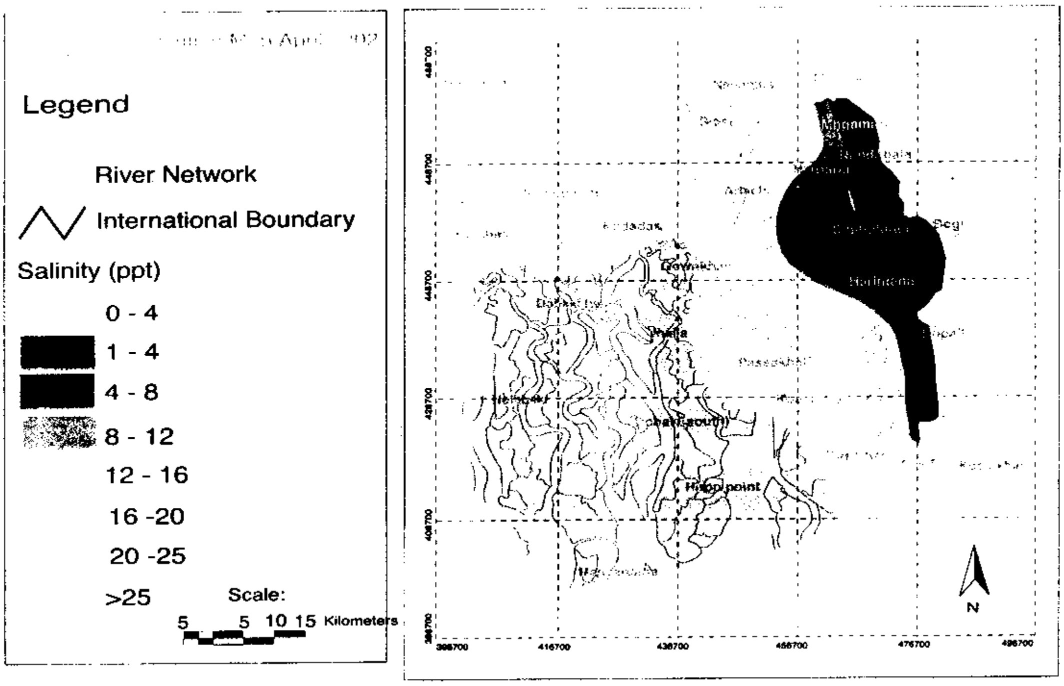
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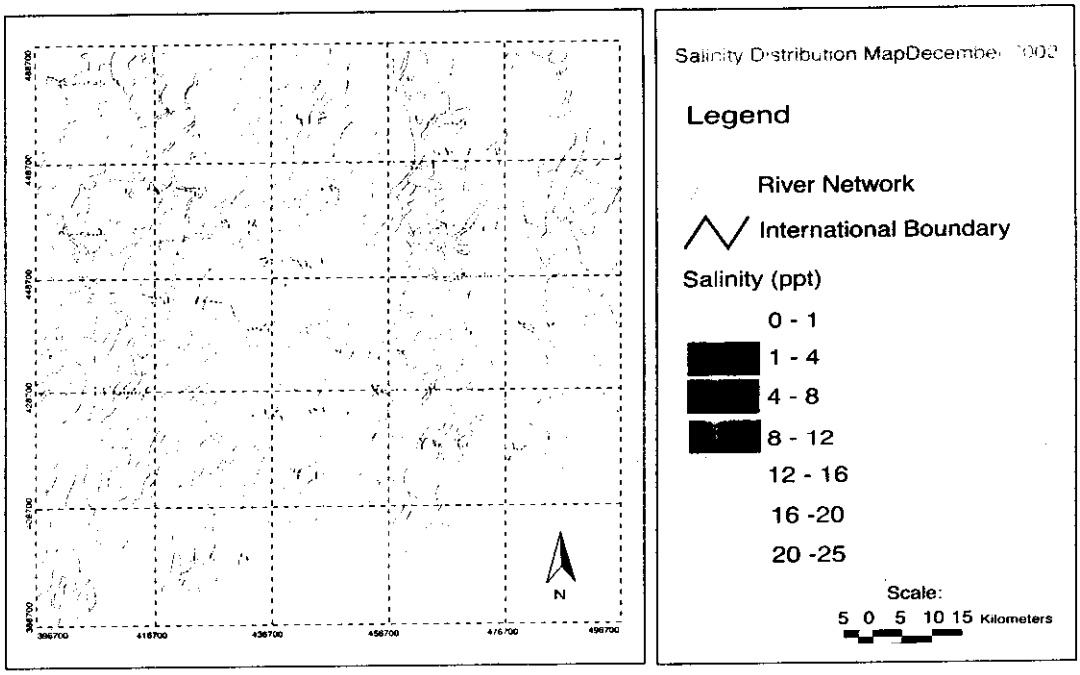
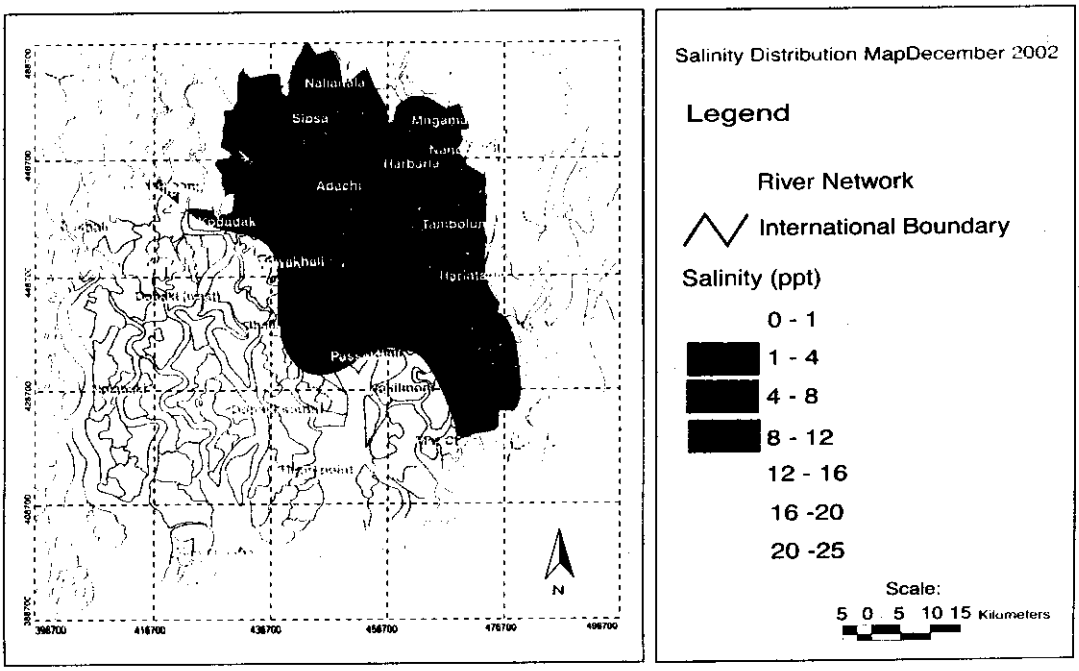
Salinity distribution: Post-monsoon condition (Souce: IWM 2002)





and February the driest. On average, 80% of the total annual rain is received from June to September. Following the monsoon, from Noverber to February, the cool season sets in. From February or March, temperatures begin to rise and in April and May there are usually violent storms. Further storms may also occur in the monsoon and tidal waves can result in widespread inundation.

2.9 Forest type of the SRF

Sir David Prain (1903b) for first time systematized the Sundarbans forests into three main areas, viz, (i) Southern costal strip and South- Western part, with dominant mangrove and species; (ii) Central zone of *Heritiera* sp. and (iii) North-Eastern part with savannah type of vegetation.

Curtis (1933) classified the Sundarbans into four main zones viz; (i) Salt water forests (ii) Mangrove forest (iii) Moderately salt-water forests and (iv) Fresh water forest.

Champion and Seth (1968) described the Sundarbans under the following sub-divisions (i) Mangrove scrub (ii) Mangrove forest, (iii) Salt water mixed forests or Heritiera forests and (iv) Brakishwater mixed or Heritiera forests.

Naskar (1983) proposed following five different categorized under the Sundarban tidal mangrove forests:

(a) The sea-face or beach forests.

(b) The flora of formation low-lying cultivated zones

(c) The flora of the river-banks and

(d) The swamp forests.

2.10 Floristic Composition.

The mangrove tract in Sundarban signifies the species ecological effect due to tidal ingress of sea underterred by upstream flow and plant community manifests abnormal adaptation like development of pneumatophores (breathing roots, stilt roots etc).

The maintree spp of Sundarbans are Sundri, Gewa, Goran, Keora, Passur, Golpata, Kankra, Garjan, Hental, Bola, and Singra etc. Innumerable still roots in Garjan, Goran, Gewa, etc help to keep the stems erect against the turbulent current of streams and nalahs and also help the plants in respiration. Most of the mangrove spp. are also characterized by vivparous germination as in case of germination as in case of Kankra, Goran, Gajan, Khalsi, Tora etc providing anchorage with pancil-like roots developed before detachment of the seed from the parent.

The floristic composition of the SRF is rich compmpared to many other mangroves of the world. Prain (1903) recorded 334 species of plants belonging to 245 genera and 75 families for the Sundarbans and adjoining areas (Appendix-1). Heining (1892) reported 70 species from 34 families for the entire Sundarbans (India and Bangladesh) other than plants, there are 16 algae and 13 orchids were recorded. Chaffey and Sandom (1985).

Some economic important plants of the Sundarbans Reserved Forest

a. Goran *(Ceriops decandra)* forest
b. Stilt root of Garjan *(Rhizophora mucronata)*
c. Flowering shoot of Sundri *(Heritiera fomes)*
d. Gewa *(Excoecaria agallocha)* fruits
e. The brething roots of Baen *(Avicennia officinalis)*
f. Kankra *(Bruguiera gymonorrhiza)* fruits and flowers
g. Successional stages of Keora *(Sonneratia apetala)* forest

and Dey (1995) presented a list of 91 species in the Bangladesh Sundarbans form 37 families. *Heritiera fomes* and *Exoecaria agallocha* are the principal species. Sundari (*Heritiera formes*) covers about 73% and Gewa covers 16% of total landmass constitutes about 65% of the total merchantable timber. Canonizado and Hossain (1998) have identified nine different vegetation types with % of vegetation cover namely Sundri (18.77%), Sundori-Gewa (26.52%) Sundri-Passur-Kankra (2.39%), Gewa (5.38%), Gewa- Sundri (18.95%), Gewa-Goran-Passur (8.66%), Gora-Gewa-Keora (16.22%), Passur-Kankra-Baen (10.08) and Keora-Gewa open area (2.07%).(Table-3).

Table-3 : Major Vegetation types of the SRF including area

Vegetation types according to pre-dominant species	Area (ha)	Area (sq.km)	% of the total area
Sundri	74,992.0	749.92	18.77
Sundri-Gewa	105973.0	1059.73	26.52
Sundri-Passur-Kakra	9556.0	95.56	2.39
Gewa	21520.0 2	15.20	5.38
Gewa-Sundri	75703.0	757.03	18.95
Gewa-Goran-Passur	34604.0	3460.4	8.66
Goran-Gewa-Keora	64807.0	648.07	16.22
Passur-Kakra-Baen	4030.0	40.30	10.08
Keora-Gewa-Open gressland	8286.0	82.86	2.07
Total	**399471.0**	**3994.71**	**100.00**

Source- Integrated Forest Management Plan for the Sundarban Reserved Forest .By Canonizado and Hossain (1998).

Additional species (even tree species) are likely to further increase the species total. For example, Khatun and Alam (1987) detected three species of Avicennia. Chaffey and Sandom (1985) listed only *Bruguiera gymnorrhiza*, Recentaly; *B. parviflora* has been repoerted (M. Shahidullah). Again, only *Rhizophora mucronata* has been reported from the Bangladesh Sundrabans, whereas in the Indian Sundarbans. *Rhizophora apiculata* is also found. The ecological condition of the Indian Sundarbans is to some extent different from the Bangladesh Sundarbans particularly with regard to level of salinily and degree of tidal inundation. This might influence the species difference and abundance.

2.11 Canopy class

Canopy closure is an important aspects of animal distribution. There is a decrease in canopy closure in recent years. In 1960 canopy closure was 78%. A survey made in 1985 showed 65% of the forest as having a canopy classes and it indicate worsended situation further. Pre-dominant canopy classes are having only 30% or more closure. In general, the forest is more closed in the east than in the west. The canopy closure in the east is

usually more than 70% in the middle part it is between 30% and more than the western part has from 30 to less than 70%.

2.12 Faunal Composition

The SRF are rich in terrestrial, aquatic and avian faunal Species. The forest and waterways provide, demlling places, habitats, breeding areas and refuge for wide variety of species including & species of amphibian, 42 species of reptiles, 161 bird species and 40 species of mammals, many of which are endangered in other parts of the world. (Table- 4).

The SRF fauna is rich and varied. However, in recent decades several important animals have disappeared from the area for good. Many more are endangered or in a vulnerable condition (Appendix-II). Detailed survey on the population status of animals has seldom been carried out. As a result, it is difficult to assess the absolute or relative population density of various important animals. Only a few authors have studied this vast animal resource and they have mainly investigated the species composition. Numbers of existings species in the area and population density of each also vary in the available reports.

The magnificiant among the animals on land is Bengal Tiger. Spotted deer, Barking deer and Wild boars are there in plenty. Besides those Jungle cat, Fishing cat, Civet cat, Monkey, Bengal fox, Jackle, Water monitor, Monitor Lizard. Snakes are important faunal spp. On the land. Among aquatic fauna, Estuarine Crocodile, Batagur (River Terrapin), marine turtiles, tiger prawns, different types of crabs, Hilsa fish, Vetki, Pares etc are important.

In the past, Wild Buffalo, 2 species of deer, Javan Rhinoceros had already been extinct. Recently 2 speceis of amphibians, 14 species of reptiles, 25 species of birds and 5 species of mammals were recorded as an endangered species by IUCN.

Table-4: Showing the faunal biodiversity in the SRF.

Wildlife	No. of species available in Bangladesh	No. of species available in the SRF	Species biodiversity (%) in the SRF as compare to Bangladesh
Amphibians	23	8	34.78
Reptiles	154	35	22.72
Birds	632	186	29.43
Mammals	123	32	26.01
Fishes	325	177	54.46
Shrimps	35	24	68.57
Crabs	11	7	63.63
Total	**1303**	**469**	

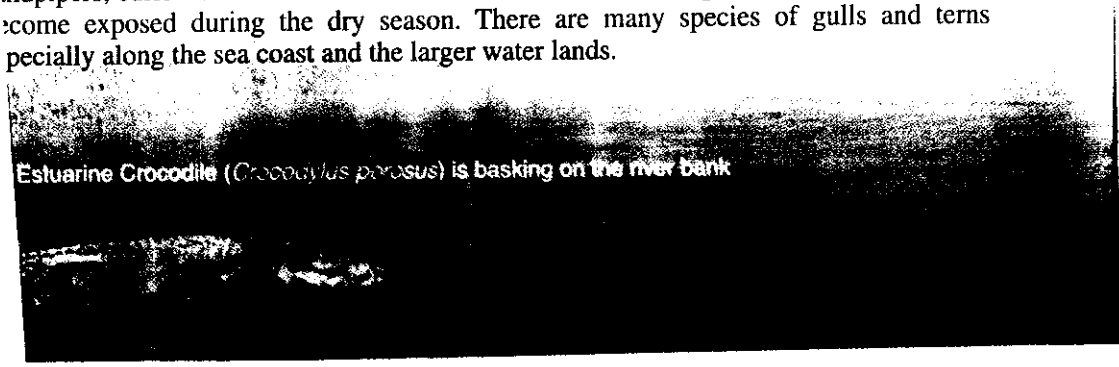
Mammals

Bengal Tiger in the Gewa-Goran forest near Kachikhali Wildlife Sanctuary

About 42 species of mammals were recorded during the present study. Some important animals are Bengal Tiger (*Panthera tigris*), Spotted Deer (*Cervus axis*), Wild Boar (*Sus scrofa*), Rhesus Macaque (*Macaca mulatta*) and Clawless Otter (*Lutra perspicillata*). The Sundrabans is one of the biggest reserves of the Royal Bengal Tiger. A survery was made in 2005 by Forest Department and he reported the persence of 423 individuals of tigers. Deer and wild boar constitue the main prey of the tiger. Although thet are plentiful, the cause of man eating behaviour of tigers is unknown. An individual tiger requires about 10 sq km territories for it dewelling (Tamang, 1993). These tigers are the ìtop consumersî in land and they solely depend on the Spotted Deer (*Cervus axis*), Wild Boar (*Sus scrofa*), Rhesus monkey (*Macaca mulata*) and Water Monitors (*Varanus salvator*). Next to the tiger, the most important wild animal in the SRF is the Spotted Deer and they prefer to graze in the open grassland. Barking Deer (*Muntiacus muntjak*) are found in the dense forest of the Northern area of the SRF. Gangetic Dolphin (*Platanista gangetica*) is also very common in the eatuary. The Reshus Macaque feed on mangrove fruits, leaves, soft pneumatophores and rhizomes of sedge and grasses. The other common wildlife were the Fishing Cat (*Felis viverrina*), Leopard Cat (*Felis bengalensis*), Crested Porcupine (*Hytrix indica*), Grey Mangoose (*Herpestes edwarsi*), Indian Flying Fox (*Pteropus giganteus*), Short-nosed Fruit Bat (*Cynopterus sphinx*) etc.

Birds

More than 300 species of birds have been recorded in the Sundarban delta including migratory birds (Chowdhury et al. 1994). About 100 species are migratory from the North temperate region during the winter. A total of about 186 has been recorded during the present study. Nine species of kingfishers were available in the forest. The other common birds like Little Cormorant, Purple Heron, Cattle Egret, Large Egret, Open-billed Stork, Lesser Adjutant Stork, Spotted Dove, Rose Ringed Parakeet, Crow Phasant, sandpipers, curlew and numberous other waders were seen along the muddy banks which become exposed during the dry season. There are many species of gulls and terns especially along the sea coast and the larger water lands.



Estuarine Crocodile (*Crocodylus porosus*) is basking on the river bank

Reptiles

There were about 57 species of reptiles have been recorded, 12 belongs to the order Chelonia, 44 belongs to Squamota and 1 belongs to Crocodilia (Chowdhury *et al.* 1994). The largest reptile of the Sundarbans is the Estuarine Crocodile (*Crocodylus porosus*). Its population has drastically declined. It is reported that there are probable only 150-200 individuals. Different species of monitor lizards and turtlies were well represented. Good number of snakes including the Cobra, King Cobra, Green Pit Viper, Rock Python and Sea Snakes were available in the SRF. However, a number of reptilian species are endangered. The Fresh Water Crocodile (*Crocodylus palustris*) has disappeared from the area.

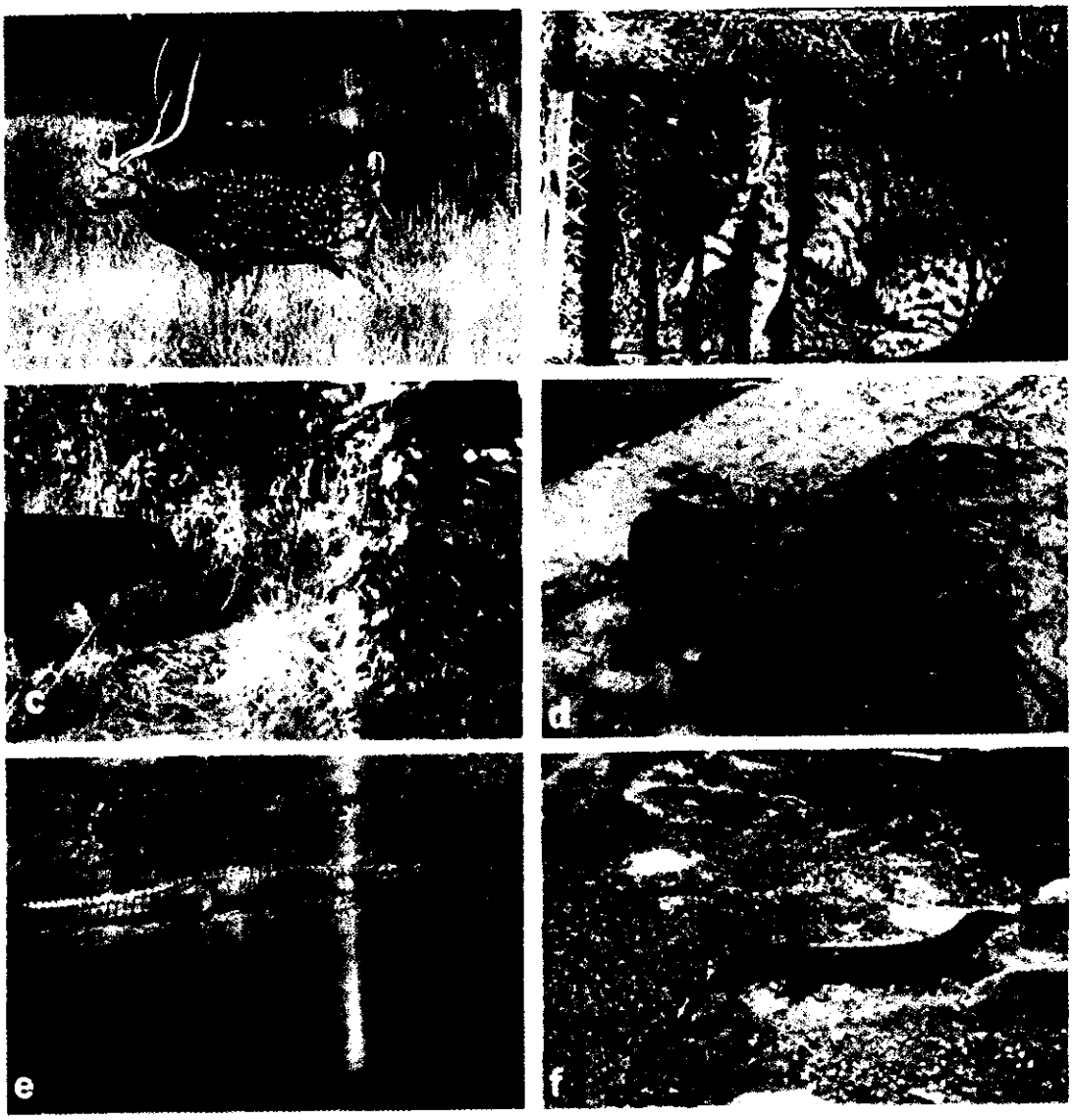
Amphibians

Eight species of amphibians have been recorded from the Sundarbans. This includes Tree frog. Bull Frog, Green Frog, common toad and other (Rashid *et al.* 1994). The family Microhylidae is represented by the species *Microhyla ornata*. Green Frogs were found in the Northern part of the SRF specially in the sweet water ponds of the Chandpai Range H/Q and it is an endangered species.

2.13 Ecological Zonation

The mangrove vegetation is often classified into different zones based on the depth of tidal inundation and presence of dominant species. Such zonation is not distinct in the Sundarbans. Irrespective of depth or duration of tidal inundation, the Sundarbans has been divided into three ecological zones based on the criterion of the level of soil salinity, which greatly influences the distribution of species. These are less, moderate and strongly saline zones. Different mangrove species have preference for different levels of salinity for survival and optimal growth. Sundri *(Heritiera fomes)* is the characteristic species of the less saline zone, Gewa *(Excoecaria agallocha)* of the moderately saline zone and Goran *(Ceriops decandra)* is typical of the strongly saline zone of the Bangladesh Sundarbans.Vegetation density varies in the different zones . The physical characteristics also vary as is apparent from the data recorded in 1990 and 1991(Siddiqi, 2001).

Less Saline Zone: It is located in the eastern and northeastern part of the forests. The area receives fresh water supply from the Ganges. During the rainy season, the salinity is very low and the soil gets a good coating of fresh silt each year. The forest floor is comparatively high so the tidal water does riot frequent inundate the area. This zone supports the best stands growing up to a height of 10 meters. In the northeast, the trees are tall and vigorous. Sundri (*H. fomes*) forms pure stand or stands in association with Gewa *(E. agallocha)*. Under dense cover of sundri, there is practically little undergrowth. In addition to Sundri and Gewa, Passur *(Xylocarpus mekongensis)*, Kankra *(Bruguiera gymnorrhiza.)* and Baen *(Avicennia officinalis)* are also present. The understorey is usually occupied by Singra *(Cynametra ramifiora)*, Amur *(Amoora cucullata)* and Goran *(Ceriops decandra)*. Golpata *(Nypa fruticans)* is plentiful and grows most luxuriantly on



Major wildlife of the study area (SRF)

a. Spotted Deer *(Cervus axis)*

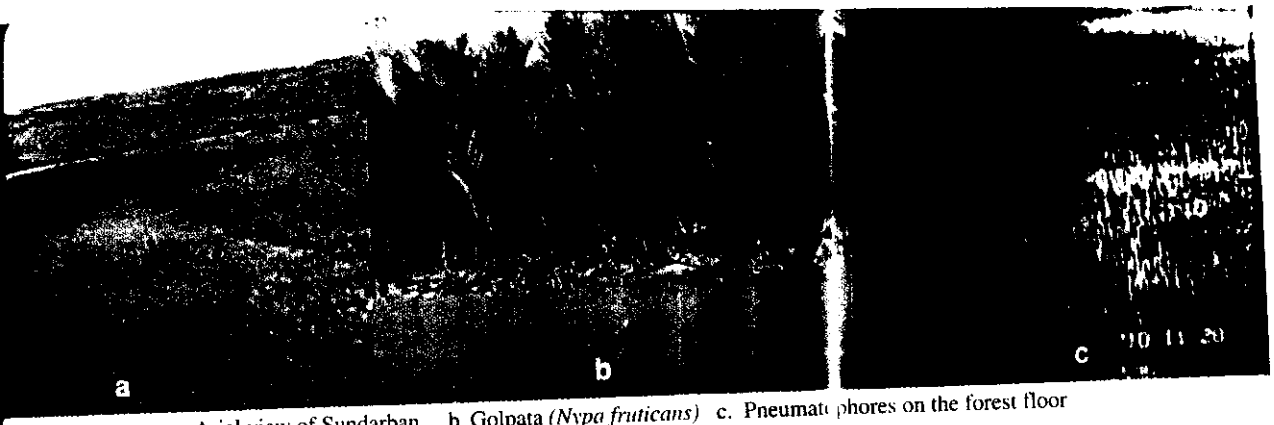
b. A Fishing Cat *(Felis vivarina)* resued from a village

c. A Wild Boar *(Sus scrofa)* in the Gewa forest

d. A pair of Rhesus Monkey *(Macaca mullata)* on the muddy floor

e. An Estuarine Crocodile *(Crocodylus porosus)* was basking on the river bank

f. Yellow land Monitor *(Varanus flavescens)*



a. Arial view of Sundarban, b. Golpata *(Nypa fruticans)* c. Pneumatophores on the forest floor

the bank of rivers and canals. Keora *(Sonneratia apetala* is also found in good proportion; it is a pioneer species and short-lived. It disappears from the areas where it first becomes established within 50 years or some making room for other species to occupy the land. Keora stands attain a height of 15m or more and tend to be divided into more or less even aged bands running parallel to watercourses each band representing a different period or year of colonization.

Moderately Saline Zone : This occupies the middle portion of the forest. Gewa is the dominant crop. A mixture of gewa, sundri with varying proportion of goran and other species are the characteristic of this zone. Sundri decreases towards the west and south.. However, Sundri, Passur, Baen and Dhundal (*Xylocarpus granatum*) may attain a greater height. Kirpa (*Lumnitzera racemosa*) frequently occurs in mixed stands with Gewa in the south. When Gewa is the predominant species there is frequently a patchy understorey of Goran. Golpata is also abundantly found in this zone. Keora is plentiful in this zone as compared to less or strongly saline zone.

Strongly Saline Zone This occupies the South and western part of the forests and covers a sizeable portion of forest lands. Salinity is higher in the dry season and water salinity is almost that of normal seawater salinity. Soil is hard due to lack of silt deposition. The forest is typically closed under story of goran having a height of about 4m. Keora. Baen, Kankra, Passur, Dhundul and Garjan (*Rhizophora mucronata*) occur isolatedly. Gewa is poorly developed. Golpata is uncommon. Hantal (*Phoenix paludosa*) is well represented on relatively raised lands.

Rhesus monkey is crossing the khal in Sundarbans

CHAPTER-3

ECOLOGICAL DESCRIPTION OF SOME STUDY PLOTS

3.1 Pellet Group Counting (PGC) Plots

The Summary of the location and description of vegetations of hte PGC plats in given in the Table–5.

1. PGC plot No-1 (Open grassland with Keora - Gewa Association)

Location

The PGC plot unit is located in the compartment No-6 and on the east bank of Katka Khal popularly known as Jamtola Mat near Katka wildlife sanctuary center under Sarankhola range. the plot was laid out in the open grassland adjacent to tree cover area and plot size was 10 m x 10 m = 100 sq.m. The GPS location is northing 21°51' 11.3" and casting 89° 47' 8.4" at the center of the plot.

Vegetation

The plot is the open grassland and there is not tree at all. The shrubby and herbaceous plants in the plots are Sungrass *(Imperata cylindrica)*, Durbagrass *(Cynodon dactylon)* Khas *(Saccharum spontaneum)*, Mulay *(Cyperus javanicus)*, Setpoli *(Premna corymosa)* *(Fimbristylis polytrichoides)*, Nolgrass *(Eriochloa procra)*, Tiger fern *(Acrostichum aureum)*, Dhanshi *(Myriostachya wightiana)*, Harkata *(Oryza coaractata)* Kewa kanta *(Pandanus foetidus)*, and Hargoza *(Acanthus ilicifolius)* etc.

Among the surrounding vegetation Keora *(Sonneratia aptala)* Gewa *(Excoecaria agallocha)*, Banjam *(Eugenia fruticosa)*, Sundri *(Heritiera fomes)*, Hental *(Phoenix paludosa)* etc. are important.

Overseas Development Authority (ODA) (1985) has classified the area partly as 3b and part y as "a" Table-5 Summary of locations and vegetations of the pellet group counting (PGC)

2. PGC plot No- 2 (Gewa-Sundri forest)

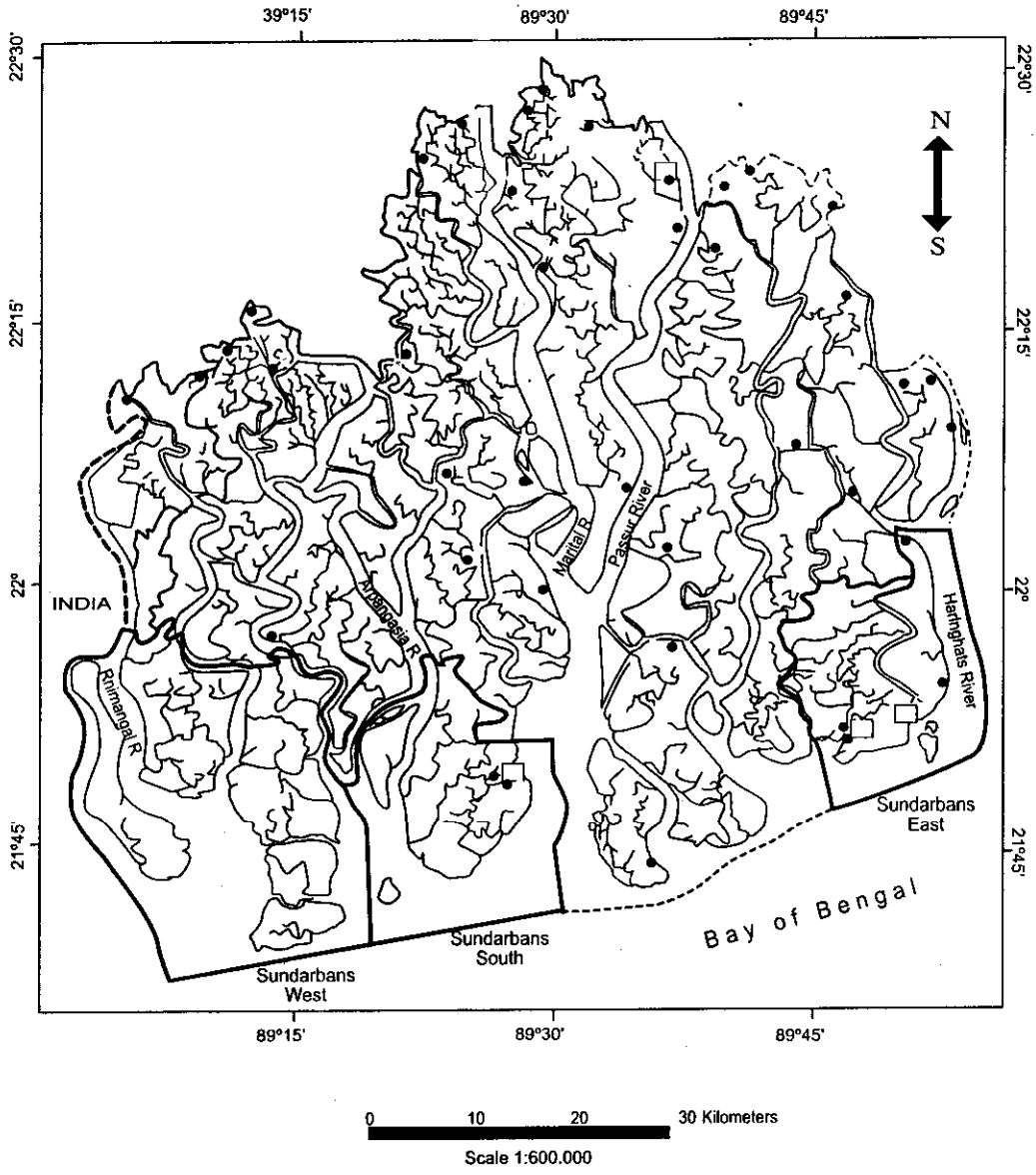
Location

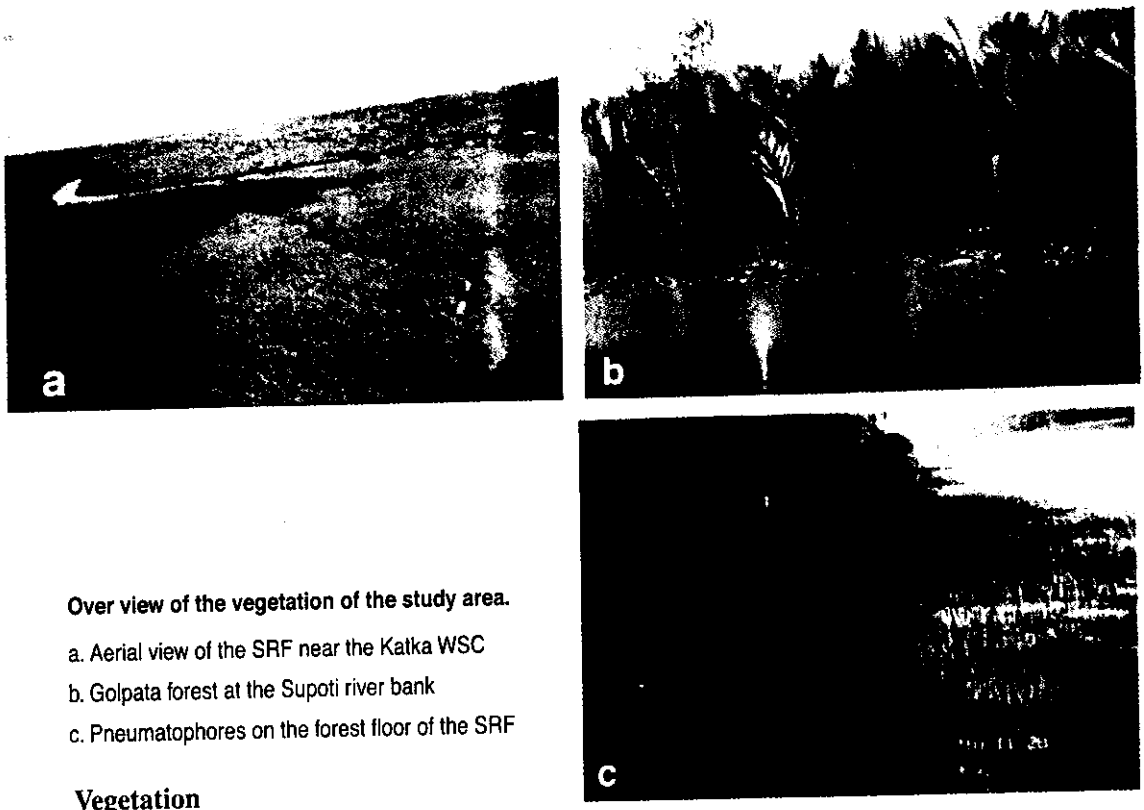
The PGC Plot is located in the compartment No–6 and on the West bank of Supoti Khal and north side of the Kachikhali Rest House under Sarankhola Range. Kachikhali Wildlife Sanctuary Centre also administers the area. The plot was laid out on the fringe of Gewa-Sundri forest plot size was 10 m x 10 m= 10 sq. m. The GPS location is northing 21° 51' 59.1" and easting 89° 50' 18.7" at the center of the plot.

Table-5 Summary of locations and vegetations of the pellet group counting (PGC)

PGC Plot No.	Name of Range	Name of nearest Patrol Post Istational Centre	Compart-ment No.	GPS location		Vegetation			
				Northing	Easting	Vegetation type	Conopy	Average	ODA Classifi.
PGC-1	Sarankhola	Kata W.S.C (Jamtola)	C-6	21° 51' 4.3"	89°47' 08.4"	Keora-Gewa open grassland	-	0-5	3b,a
PGC -2	Sarankhola	Kachikhali W.S.C	C-6	21∞ 51' 59.1"	89∞ 50' 18.7"	Gewa - Sundri	50-60	6-8	3a
PGC .3	Chandpai	Karamjal Wildlife Breeding Centre	C-31	22° 25' 38.8"	9° 35' 29.5"	Sundri-Passur-Kankra	70 - 80	17	1a
PGC -4	Khulna	NilkamalW.S.C (Hiron Point)	C-44	21° 48' 11.2"	89° 27' 02.3"	Gewa	40-50	7	3b
PGC -5	Satkhira	Dubeki P.P.	C - 50A	22° 05' 40.4"	89° 19' 46.1"	Gewa-Goran-Passur	50-60	8	3b
PGC -6	Satkhira	Mandarbaria W.S.C	C-55	21° 45' 01.7"	89° 17' 35.1"	Goran-Gewa-Keora	50-60	6	3b
PGC -7	Chandpai	Harbaria P.P	C-26	21° 17' 58.7"	89° 38' 10.8"	Sundri	70 - 80	16	1a
PGC -8	Chandpai	Marapassur P.P	C-27	22° 19' 41.2"	89° 37' 14.2"	Sundri-Gewa	70 - 80	12	2a
PGC .9	Chandpai	Laodub P.P	C-31	22° 29' 09.3"	89° 32' 12.7"	Passur -Kankra-Baen	70 - 80	15	1a
PGC -10	Chandpai	Tambulbonia P.P	C-13	22° 12'1.6"	89°41' 11.7"	Sundri	70 - 80	17	1a
PGC -11	Sorankhola	Bogi F. S.	C-1	22° 12' 28.1"	89° 47' 51.0"	Sundri	70 - 80	18	1a
PGC -12	Sarankhola	Sarankhola F. S	C-1	22° 12' 27.5"	89° 48' 38.2"	Sundri	70 - 80	19	1a
PGC -13	Sarankhola	Dasherbharani P.P	C-24	22° 17' 12.7"	89° 47' 12.8"	Sundri-Gewa	70 - 80	12	2a
PGC -14	Sarankhola	ewdhara P.P.	C-27	22°14' 13.8"	89° 43' 12.5"	Sundri-Gewa	40 - 60	12	2b
PGC -15	Chandpai	Jongra P.P.	C-31	22° 22' 19.5"	89° 37' 08.6"	Sundri-Passur-Kankra	70 - 80	16	1a
PGC -16	Chandpai	Sibsa P.P.	C-30	22° 23' 12.8"	89° 27' 12.7"	Sundri-Passur-Kankra	70 - 80	15	2a
PGC -17	Khulna	Hodda P.P	C-35	22° 27' 19.8"	89° 25' 11.7"	Sundri-Passur-Kankra	70 - 80	15	2a
PGC -18	Khulna	Patcosta P.P	C-19	22° 1' 22.4"	89° 25' 14.4"	Gewa	50-60	10	3b
PGC -19	Chandpai	Dhansagar P.P.	C-25	22° 20' 14.2"	89° 46' 18.2"	Gewa-Sundri	70 - 80	15	2a
PGC -20	Chandpai	Baddamari P.P.	C-28	22° 23' 54.8"	89° 39' 14.2"	Gewa-Sundri	50-60	12	2b
PGC -21	Satkhira	Kalagachia P.P	C-46	22° 12' 50.7"	89° 14' 21.8"	Gewa-Goran-Passur	30-50	8	3b
PGC -22	Khulna	Khasitana P.P	C-37	22° 13' 08.9"	89° 21' 11.6"	Gewa-Goran-Passur	40-60	8	3b
PGC -23	Khulna	Hansaraj P.P	C-18	21° 49' 56.9"	89° 25' 13.5"	Gewa-Goran-Passur	40-60	8	3b
PGC -24	Sarankhola	Kokilmoni P.P	C-8	21° 56' 42.8"	89° 35' 48.7"	Gewa-Goran-Passur	50 -6 0	8	3b
PGC -25	Khulna	Sutarkhali F.S.	C-32	22° 28' 23.8"	89° 29' 28.5"	Passur-Kankra-Baen	70 - 80	16	1a
PGC -26	Chandpai	Laoduh P.P	C-31	22° 29' 46.9"	89° 32' 28.5"	Passur -Kankra-Baen	70 - 80	15	a
PGC -27	Khulna	Nilkamal W.S.C	C-44	21° 49' 26.9"	89∞ 27' 28.5"	Keora-Gewa open grassland	50- 60	8	3b

Map of the Sundarbans Reserved Forests showing the location of the grids, PGC and LTC units





Over view of the vegetation of the study area.

a. Aerial view of the SRF near the Katka WSC

b. Golpata forest at the Supoti river bank

c. Pneumatophores on the forest floor of the SRF

Vegetation

The numbers of plant inside the plot was less, but it the representative of the vegetation is dominated by Sundri *(Heritiera fomes)*, Passur *(Xylocarpus mekongensis)* and Kankra *(Bruguiera gymnorrhiza)* the other species were Baen *(Avicinnia officinalis)*, Gewa *(Excoecaria agallocha)*, Keora *(Sonneratia apetala)*, Bhola *(Hibiscus tiliaceous)*, Shingra *(Cynometra ramifora)*, Kewakanta *(Pandanus foetidus)* Hodo *(Acrostichum aureum)*, Kalilota *(Derris spinosa)*, Gilalota *(Derris trifoliata)*, and Sungrass *(Imperata cylindrica)*.

The average canopy height is 17 meters and canopy closure is 70-80%. ODA (1985) has classified the vegetation as 1a class.

Description of the remaining PGC plots are given in the Table-4

3.2 TRANSECTS

A total of 42 (forty two) transects were laid out in 9 (nine) different vegetation units in the SRF (Table-6a and 6b), 3 in Sundri, 15 in Sundri-Gewa, 5 in Sundri-Passur-Kankra, 1 in Gewa, 6 in Gewa-Sundri, 3 in Gewa-Goran-Passur, 5 in Goran-Gewa-Keora, 1 in Passur Kankra-Baenand 3 in Keora-Gewa open grassland.

1. Transect No-1 (Sundri-Passur-Kakra forest)

Location

The transect unit was situated in the compartment no- 31 near the Karamjal Wildlife Breeding Center under the Chandpai Range on the South bank of the Karamjal khal. The transect line was laidout proceeded to the east west diction upto I Ian long. The GPS location was northing 22° 25' 35.2" and easting 89°35' 30.6" at the starting point .

Table-6a: Summary of location and vegetation of the transect units in the Sundarbans Reserved Forest (T -1 to T -24).

Transect No.	Name of Range	Name of nearest Patrol Post/Station Centre	Compartment No.	GPS Position		Vegetation			
T-1	Chandpai	Karamjal Wildlife Breeding Centre (W.B.C)	C-31	22°25'35.2"	89°35' 30.6"	Sundri-Passur -Kankra	70 - 80%	17m	1a
T-2	Sarankhola	Katka Wildlife Sanctuary Centre (W.S.C)	C-7	21°51'11.5"	89° 46' 32.4"	Keora-Gewa	50 - 60	5-14	2b,3b
T-3	Chandpai	Laodub Patrol Post (P.P.)	C-31	22°24'07.3"	89° 32' 10.4"	Sundri	70 - 80	18	1a
T-4	Khulna	Nilkamal W.S.C	C-44	21°49'25.1"	89° 27' 31.5"	Keora-Gewa open grassland	50-60	8	3b
T-5	Chandpai	Harbaria P.P.	C-26	22°17'&5.7"	89° 37' 09.6"	Sundri	70 - 80	17	1a
T-6	Sarankhola	Sarankhola Range H/Q	C-1	22°12'26.0"	89° 48' 51.0"	Sundri-Gewa	70 - 80	16	1a
T-7	Sarankhola	Dasherbharani P.P.	C-24	22°17'18.0"	89° 47' 22.0"	Gewa-Sundri	50 - 70	12	2b
T-8	Chandpai	Marapassur P.P.	C-29	22°19'39.0"	89° 37' 07.1"	Sundri-Gewa	70 - 80	16	1a
T-9	Chandpai	Mrigamari P.P.	C-28	22°21'57.1"	89° 40' 10.8"	Sundri-Gewa	70 - 80	17	1a
T-10	Chandpai	Tambulbonia P.P.	C-13	22°12'307"	89° 42' 08.3"	Sundri-Gewa	70 - 80	16	1a
T-11	Satkhira	Kalagachia P.P.	C-46	22°12'53.8"	89° 14' 30.5"	Gewa-Goran-Passur	30 - 50	8	3b
T-12	Satkhira	Munshigonj P.P.	C-46	22°16'12.3"	89° 12' 00.2"	Gewa-Sundri	50 - 60	12	2b
T-13	Satkhira	Kaikhali Forest Station (F.S)	C-48	22°11 '32.8"	89° 04' 48.1"	Gewa-Goran-Keora	40 - 60	7	3b
T-14	Satkhira	Chunkuri P.P.	C-47	22°13'04.4"	89° 09' 45.6"	Gewa-Sundri	50 - 60	11	2b
T-15	Satkhira	Kadamtola F.S	C-47	22°13'40.0"	89° 10' 54.9"	Gewa-Sundri	50 - 60	12	2b
T-16	Satkhira	Dingimari P.P.	C-51	22°30'31.1"	89° 13' 14.9"	Goran-Gewa-Keora	70 - 80	6	3a
T-17	Khulna	Khasitana P.P.	C-37	22°13'13.5"	89° 21' 04.8"	Gewa-Goran-Passur	40 - 60	8	3b
T-18	Khulna	Sakbaria P.P.	C-36	22°18'09.9"	89° 20' 11.3"	Sundri-Gewa	70 - 80	12	2a
T-19	Khulna	Patcosta P.P.	C-19	22°01 '32.9"	89° 25' 43.8"	Sundri-Gewa	70 - 80	12	2a
T-20	Khulna	Gewakhali P.P.	C-19	22°04'60.4"	89° 23' 20.2"	Gewa	50 - 60	8	3b
T-21	Khulna	Hodda P.P.	C-35	22°27'10.4"	89° 25' 00.3"	Sundri-Passur-Kankra	70 - 80	15	2a
T-22	Khulna	Adachai P.P.	C-34	22°16'14.7"	89° 29' 47.8"	Sundri-Gewa	70 - 80	12	2a
T-23	Khulna	Kalabogi F.S.	C-33	22°24'40.0"	89° 28' 11.2"	Sundri-Passur-Kankra	70 - 80	16	1a
T-24	Khulna	Sutarkhali F.S.	C-32	22°28'13.1"	89° 29' 59.2"	Passur -Kankra-Baen	70 - 85	16	1a

Table-6 b: Summary of location and vegetation of the transect units in the Sundarbans Reserved Forest (T -25 to T -42)

Transect No.	Name of Range	Name of nearest Patrol Post/Staton Centre	Compartment no	GPS location		Vegetation			
				Northing	Easting	Vegetation type	Canopy closure (%)	Average heigh (m)	ODA classifi cation
T-25	Khulna	Pasakhali P.P.	C-17	22° 04' 14.9"	89°33' 42.0"	Sundri-Gewa	70 - 80%	14	2a
T-26	Khulna	Sibsa P.P.	C-30	22° 23' 02.5"	89°27' 06.4"	Sundri-Passur-Kankar	70 - 80	15	2a
T-27	Khulna	Nilkamol W.S.C.	C-44	21° 49' 02.1"	89°27' 35.7"	Goran-Gewa-Keora	50-60	8	3b
T-28	Sarankhola	Chandeswar P.P.	C-5	21° 57' 04.1"	89°52' 64.2"	Gewa-Sundri	70 - 80	8	3a
T-29	Sarankhola	Supoti F.S	C-5	22° 02' 49.2"	89°49' 50.0"	Sundri-Gewa ,	70 - 80	12	2a
T-30	Sarankhola	Dudmukhi P.P.	C-2	22° 05' 22.7"	89°46' 54.2"	Sundri-Gewa	75 - 85	14	2a
T-31	Sarankhola	Kokilmoni P.P	C-8	21° 56' 43.6"	89°35' 50.4"	Goran-Gewa-Keora	50 - 60	8	3b
T-32	Chandpai	Baddamari P.P	C-28	22° 23' 54.3"	89°39' 41.2"	Gewa-Sundri	50 - 70	12	2b
T-33	Chandpai	Dhansagar F.S	C-25	22° 20' 41.9"	89°46' 04.1"	Gewa-Sundri	70 - 80	13	2a
T-34	Chandpai	Jewdhara P.P.	C-27	22° 24' 31.7"	89°43' 02.4"	Sundri-Gewa	40-60	12	2b
T-35	Sarankhola	Bogi F.S	C-1	22° 12' 28.0"	89°47' 01.0"	Sundri	70 - 80	18	1a
T-36	Sarankhola	Dumoria P.P.	C-1	22°10'04.1"	89°52' 34.9"	Sundri-Gewa	70 - 80	14	2a
T-37	Sarankhola	Dubla Fisharmen Hut F.S.	C-45	21°43'49.1"	89°36' 13.2"	Gewa-Goran-Keora	50-60	8	3b
T-38	Chandpai	Charapatia P.P.	C-10	22° 06' 02.2"	89°37' 42.9"	Sundri-Gewa	70 - 80	12	2a
T-39	Khulna	Bhomarkhali P.P.	C-18	21° 59' 04.3"	89°28' 34.3"	Sundri-Gewa	70 - 80	12	2a
T-40	Khulna	Hansaraj P.P.	C-18	21° 59' 06.2"	89°25' 31.6"	Sundri-Gewa	70 - 80	11	2a
T-41	Sarankhola	Katka W.S.C (Jamtola)	C-6	21° 51' 18.5"	89°47' 05.6"	Keora-Gewa open grassland	40 - 50	1-6	3b,a
T-42	Chandpai	Jongra P.P.	C-31	22° 22' 09.6"	89°37' 0.5"	Sundri-Passur-Kankra	70 - 80	1-6	1a

Pellet group counting vegetation units in the SRF

a. PGC plot no - 1 in the Keora - Gewa open forest at Jamtola under the Kalka WSC

b. PGC plot no - 2 in the Gewa - Sundri open forest at the Kachikhali WSC

c. PGC plot no - 3 in the Sundri - Passur - Kankra forest at Karamjal

d. PGC plot no - 5 in the Gewa - Groan forest at Dubeki

e. PGC plot no - 7 in the Sundri forest at Harbaria

f. PGC plot no - 9 in the Passur - Kankra - Baen forest at Laodub

Transect vegetation units in the SRF

a. Transect no-36 in the Sundri- Gewa forest at Dumuria
b. Transect no - 37 in the Goran - Gewa.forest at Dubla
c. Transect no- 39 in the Sundri - Gewa forest at Bhomarkhali
d. Transect no - 41 in the Keora - Gewa open forest at the Katka WSC
e. The pure Keora forest (an ideal habitat of the Spotted Deer) at Kokilmoni
f. Aerial view of the vegetation of the Transect no - 27 at the Nilkamal WSC

Vegetation

The area is under fresh water zone and the vegetation is dominated by Sundri with Kankra *(Bruguiera gymnorrhiza)* and Passur *(Xylocarpus mekongensis)*. The predominant species are Gewa *(Excoecaria agallocha)* and Baen *(Avicennia officinalis)*. The other species are Keora *(Sonneratia apetala)*, Bhola *(Hibiscus tiliaceous)*, Hental *(Phoenix Paludosa)*, Kewakata *(Pandanus foetidus)*, Amur *(Amoora cucullata)*, Hargoza *(Acanthus ilicifolius)*, Hodo *(Acrostichum aureum)*, Sundrilota (Brownlowia tersa), Shingra *(Cynometra ramiflora)*, Kalilota *(Derris trifoliata)*, Nolgash *(Eriochloa procera)*, Golpata *(Nypa fruticans)*, Bowlilota *(Sarcolobus globosus)*, Dekilota *(Stenochlaena palustris)* and Dhanshi *(Myriostachya wightiana)* etc.

The average canopy height was 17 meters and canopy closure was 70-80%. ODA (Overseas Development Authority) in 1985 has classified the vegetation under la class. The Description of the remaining transects is given in the Table- 6a and 6b.

3.3 Ecological description of the Grids in the Sundarbans Reserved Forest

The summary of the location and vegetation of the grids is presented in the Table-7 and 8.

(1) Grid-l (Sundri- Passur-Kankra forest)

Location

The grid was located in the compartment no-31 and on the South bank of the Karamjal khal near the Karamjal Wildlife Breeding Center under the Chandpai Range. The grid was laid out inside the Sundri-Passur-Kankra forest. The grid size was 1500m X 1500m = 2.25sq.Km. The GPS location was northing 22° 26' 24.8" and easting 89° 37' 10.6" at the northeast comer of the grid.

Vegetation

The area is under fresh water zone and the vegetation is dominated by Sundri with Kankra *(Bruguiera gymnorrhiza)* and Pas sur *(Xylocarpus mekongensis)*. The predominant species are Gewa *(Excoecaria agallocha)* and Baen *(Avicennia officinalis)*. The other species are Keora *(Sonneratia apetala)*, Bhola *(Hibiscus tiliaceous)*, Hental *(Phoenix paludosa)*, Kewakata *(Pandanus foetidus)*, Amur *(Amoora cucullata)*, Hargoza *(Acanthus ilicifolius)*, Hodo *(Acrostichum aureum)*, Sundrilota *(Brownlowia tersa)*,

Shingra *(Cynometra ramiflora)*, Kalilota *(Derris trifoliata)*, Nolgash *(Eriochloa procera)*, Golpata *(Nypa fruticans)*, Bowlilota *(Sarcolobus globosus)*, Dekilota *(Stenochlaena palustris)* and Dhanshi *(Myriostachya wightiana)* etc.

The average canopy height was 17 meters and canopy closure was 70-80%. The ODA (Overseas Development Authority) in 1985 has classified the vegetation under la class.

Map showing location of the grid no-1 in the Sundarbans Reserved Forest.
Scale = 1:50,000

Symbol

Sundri		Passur kankra	
Sundri gewa		passur kankra baen	
Sundri passur		baen	
Sundri passur kankra		keora	
Gewa		Scattered baen	
Gewa mathal (coppice)		Scattered keora	
Gewa goran		Scattered passur and / or dhundal	
Gewa sundri		Scrub and jow thicket	
Goran		Grass and bare ground	
Goran gewa		Tree plantation	

HEIGHT CLASSES

1>15 metres 2.<15 >10 metres 3.<10 >5 metres 4. <5meters

CANOPY CLOSURE CLASSES

a.>70% b.<70 >30% c.<30 >10%

(2) Grid no-2 (Keora-Gewa open grassland association)

Location

The grid was located in the compartment no-6 and on the East bank of the Katka khal and the area is popularly known as Jamtola Math. It is a part of Katka Wildlife Sanctuary Centre under the Sarankhola Range. The grid was laid out in the Keora-Gewa-open forest and the grid size was 1500m X 1500m = 2.25 sq. kIn. The GPS location was northing 21°5' 12.5" and easting 89° 46' 21.6".

Vegetation

The area is under moderately fresh water zone and the vegetation is dominated by Keora *(Sonneratia apetala)* and Gewa *(Excoecaria agallocha)*. The other species are Sundri *(Heritiera fomes)*, Baen *(Avicennia officinalis)*, Banjam *(Eugenia fruticosa)*, Bhola *(Hibiscus tiliaceous)*, Hental *(Phoenix Paludosa)*, Kewakata *(Pandanus foetidus)*, Amur *(Amoora cucullata)*, Hargoza *(Acanthus ilicifolius)*, Hodo *(Acrostichum aureum)*, Sundrilota *(Brownlowia tersa)*, Shingra *(Cynometra ramiflora)*, Kalilota *(Derris trifoliata)*, Nolgash *(Eriochloa procera)*, Golpata *(Nypa fruticans)*, Bowlilota *(Sarcolobusglobosus)*, Dekilota *(Stenochlaena palustris)*. The open grasslands were occupied by Sungrass *(Imperata cylindrica)*, Durbagrass *(Cynodon dactylon)* Khas *(Saccharum spontaneum)*, Mulay *(Cyperus javanicus)*, Setpoli *(Premna corymosa)* *(Fimbristylis polytrichoides)*, Nolgrass *(Eriochloa procra)*, Tigerfem *(Acrostichum aureum)*, Dhanshi *(Myriostachya wightiana)*, Harkata *(Oryza coaractata)* Kewakanta *(Pandanus foetidus)* and Hargoza *(Acanthus ilicifolius)* etc.

Overseas Development Authority (ODA) (1985) has classified the area partly as 3b and partly as 1a.

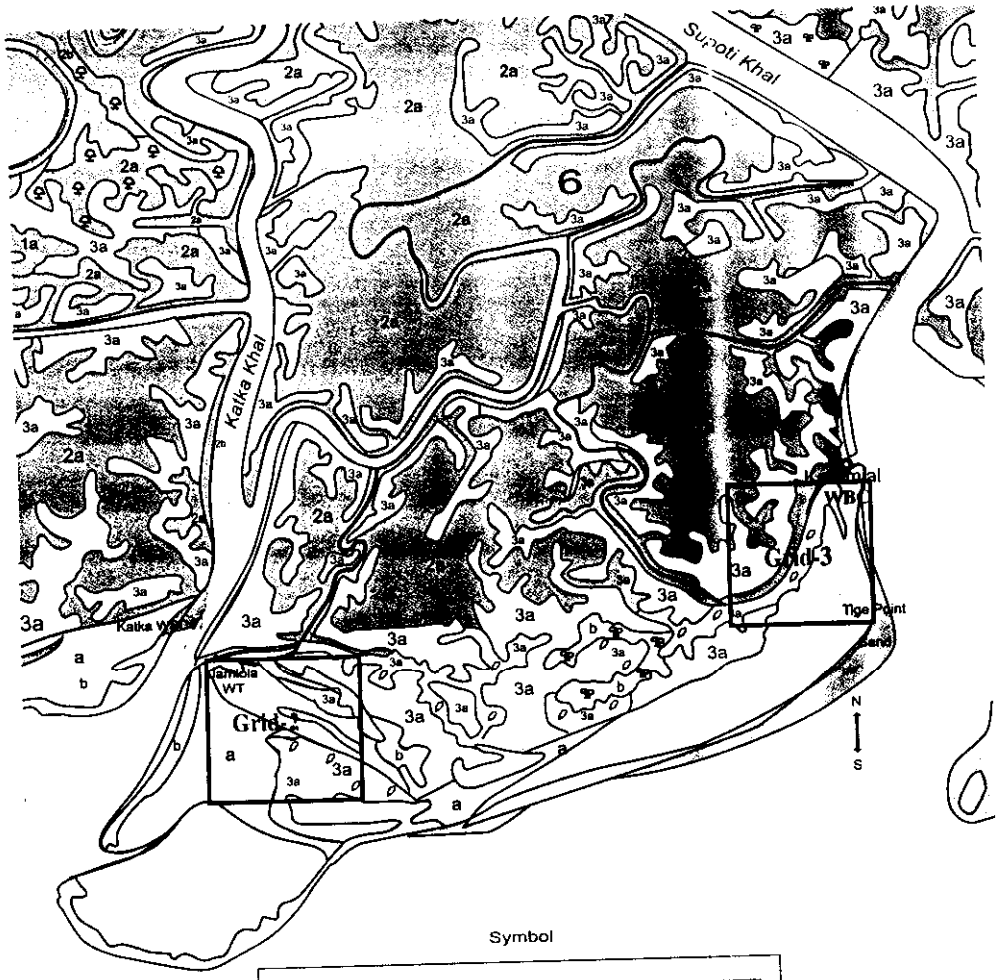
The description of grid- 3 and 4 is given in the Table-7 and 8.

Table-7: Summary of the location and vegetation of the grid units.

Grid No.	Name of Range	Name of the nearest Patrol Post/Staton Centre	Compartment no	GPS location		Vegetation			
				Northing	Easting	Vegetation type	Canopy closure (%)	Average heigh (m)	ODA classification
G-1	Chandpai	Karamjal Wildlife Breeding Centre	C-31	22° 26' 24.8"'	89∞37' 10.6"	Sundri-Passur-Kankra	70-80	17	1a
G-2	Sarankhola	Katka Wildlife Sanctuary (Jamtola) Centre	C-7	21° 51' 12.5"	89∞ 46' 21.6"	Keora-Gewa	50 - 60	5-14	2b,3b
G-3	Sarankhola	Kachikhali Wildlife Sanctuary Centre Sanctuary (Chankhala Math)	C-6	21 ° 51' 49.9"	89° 50' 14.1"	Gewa - Sundri	50 - 60	6-8	3b
G-4	Khulna	Nilkamal Wildlife Sanctuary Centre	C-44	21°48' 58.8"	89° 27' 48.4"	Goran-Gewa-Keora	50 - 60	8	3b

Map showing vegetation types of the grid no-2 and grid no-3 in Sundarbans Reserved Forest.

Scale = 1:50,000



Symbol

Sundri		Passur kankra	
Sundri gewa		passur kankra baen	
Sundri passur		baen	
Sundri passur kankra		keora	
Gewa		Scattered baen	
Gewa mathal (coppice)		Scattered keora	
Gewa goran		Scattered passur and / or dhundal	
Gewa sundri		Scrub and jow thicket	
Goran		Grass and bare ground	
		Tree plantation	

HEIGHT CLASSES

1.<15 metres 2.<15 >10 metres 3.<10 >5 metres 4.<5metres

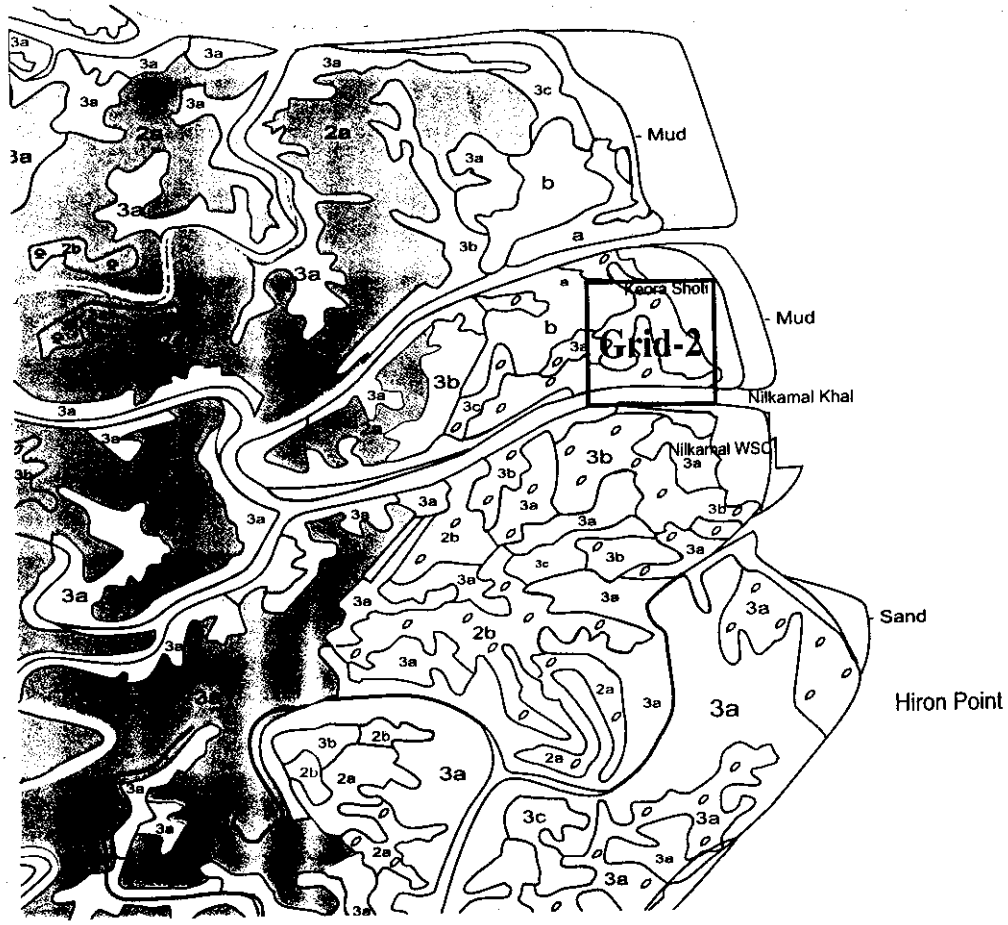
CANOPY CLOSURE CLASSES

a.>70% b.<70 >30% c.<30 >10%

a.>70% b.<70 >30% c.<30 >10%

Map showing location of the grid no-4 in the Sundarbans Reserved Forest.

Scale = 1:50,000



Symbol

Sundri		Passur kankra	
Sundri gewa		passur kankra baen	
Sundri passur		baen	
Sundri passur kankra		keora	
Gewa		Scattered baen	
Gewa mathal (coppice)		Scattered keora	
Gewa goran		Scattered passur and / or dhundal	
Gewa sundri		Scrub and jow thicket	
Goran		Grass and bare ground	
Goran gewa		Tree plantation	

HEIGHT CLASSES

1.>15 metres 2.<15 >10 metres 3.<10 >5 metres 4.<5meters

CANOPY CLOSURE CLASSES

a.>70% b.<70 >30% c.<30 >10%

Table- 8 : Description of the different habitat types (vegetation type) in the study grid areas.

Grid no. and location	Habitat name	% of study area	Habitat characteristics
Grid-1 (Karamjal WBC)	Sundri-Passur-Kankra Sundri-Gewa Submerged and grassland	80% 10% 10%	Mangrove forest dominated by Sundri (*Heritiera fomes*), Passur (*Xylocarpus mekongeness*), Kankra (*Bruuiera gymnorrhiza*) and Gewa (*Excoecaria agallocha*).
Grid-2 (Katka WSC)	Keora Gewa Grassland	55% 17% 28%	This is a coastal line mangrove forest dominated by Keora (*Sonneratia apetala*) and Gewa (*Excoecaria agallocha*). The grass land are dominated by *Imperata cylindrica, Saccharum spontaenum, Saccharum benghalens, Cynodon dactylon, Desmostachia bipinnata, Eriochloa procera* etc.
Grid-3 (Kachikhali WSC)	Gewa-Sundri Open grassland Gewa Keora	15% 57% 20% 8%	Mangrove forest in moderately fresh water zone dominated by Gewa (*Excoecaria agallocha*) and Sundri (*Heritiera fomes*) and Kewa (*Sonneratia apetala*) etc. Part of the area is grassland dominated by some indigenous species like grid-2
Grid-4 (Nilkamal WSC)	Goran-Gewa Keor Goran Keora Open grassland Gewa	20% 20% 20% 32% 8%	Mangrove forest in strongly saline zone dominated by Goran (*Ceriops decandra*), Gewa (*Excoecaria agallocha*) and Keora (*Sonneratia apetala*). The grasslands are dominated by *Imperata cylindrica, Cynodon dactylon* etc.

An alarmed Spotted Deer (Photo : Rubaiyal and Elisabeth Mansur)

Deer herd in Katka-Kochikhali (Photo : Khansru Chowdhury)

CHAPTER- 4

DEER POPULATION ESTIMATION

4.1 Introduction

Population size generally means the number animal present in a particular area. An extensive and in some cases elaborate body of mathematical theory has been developed regarding population dynamics and animal abundance (White *et al.*1982). However, in a number of cases such theory has been characterized by a relative lack of interaction with relevant population data (White *et al.* 1982). Population density of small mammals has been estimated using three methods such as non-trapping, removal trapping and non-removal trapping.

Karanth et al (2000) estimated prey species of tiger (Spotted Deer, Barking Deer, Samber etc) in the tropical dry deciduous forest of Nagarhole Reserve of Karnataka, India by the line transect survey and the population density of the Spotted Deer (*Cervus axis*) and Barking Deer (*Muntiacus muntjak*) were 38.1 sq.km and 6.0/sq.km respectively. But no population study has been conducted in the mangrove forest.

The following methods are suitable to estimate the population size of deer in the forestland.

i. Pellet group count (PGC) method.
ii. Line transects count (LTC) method
iii. Complete count (CC) method
iv. Track count method.
v. Night spotlight count method.
vi. Water hole Count method

During the study Dey (2004) has used pellet group count method, line transect count method and complete count methods for population estimation of the Spotted Deer and Barking Deer.

4.2 PELLET GROUP COUNT SURVEY

During the study for field data collection the following materials and methods were used by Dey (2004) which are also presented in the Table-9 in summary form.

4.2.1 Data collection

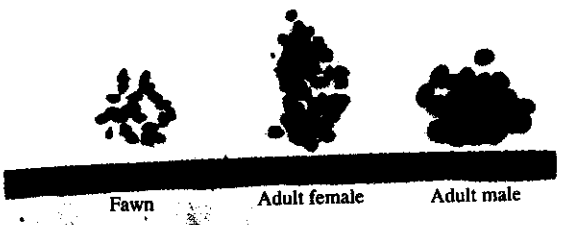
Field work related to the assessment of deer population was carried out from dry season October 2000 to December 2001. The Sundarbans Reserved Forest is sub-divided into 55 compartment each varying in size from 4000-16000ha. Visit to the SRF is possible only by launch, speedboat, cabin cruiser or houseboat. Forest Department launch was used for

movement. Visiting all the compartments made general reconnaissance. Intensive data collection was carried out in 35 compartments including Sundarbans East, Sundarbans South and Sundarbans West Wildlife Sanctuaries. A total of 27 plots were laidout in nine different types of vegetation in the SRF, and the data were collected from the 15th October to 30th December, 2001 weekly basis for 5 to 6 weeks continuously.

Table-9 : Data recording methods and material.

Location	GPS (Ground Position Survey) and field maps
Vegetation type	ODA map, sheet maps from direct observation within 50 m. radius (in case of the SRF).
Vegetation cover	Ocular estimate of percent cover by dominant and co-dominant species and with the help of ODA maps.
Physiography	Descriptive statement
Exposure	Compass
Elevation	Haga altimeter
Slope	Abney's level
Soil and Geology	Descriptive statement and visual evaluation
Soil and site moisture	Descriptive statement and visual evaluation
Plots	GPS, Gunter chain and Tape (50 m.)
Distance to free water rivers and khals	Map and ocular estimate
Escape cover	Identification of most common plants within a 15 m. radius and from ODA maps analysis.
Plant species	Examination of plants
Wildlife identification	Direct observation and also using binocular.

A Pellet group of Spotted Deer in the forest floor



Comparison of pellet group of male, female and fawn Spotted Deer

The plot size was 10m x 10m covering on area of 100 sq.m. The Spotted Deer and the Barking Deer were observed and classified by sex, age and herd size according to the type of vegetation occupied. Adult, sub- adult, juvenile and young was estimated on the basis of comparative size. Visibility was poor in all forest types at all time except in some coastal grass areas and Keora forests. Poor visibility combined with the impractical to census animals on foot. So indirect method census of the Spotted and Barking Deer was applied like pellet group counts during 24-hours period of continuous observation, total defections of free-ranging tamed Barking and Spotted deer were recorded with reference to the habitat subunits where the feces were deposited and the animal activity at the time of deposition. Once during each 2-week 1 pair, 2 individuals or pair of mature deer were released and allowed to roam freely for a 24 hours period. Four different deer were used on each site, but only 4 (2 Spotted Deer and 2 Barking Deer) deer were observed on a given date in captivity at the Karamjal Wildlife Breeding Centre. Only 2 particular does would remain together for the period of observation, thus necessitating 2 separate observers on days when different deer were used. The observer stayed with the deer the entire 24-hours. From the size of pellet male, female and fawn can be identify easily. The fawn pellet size was comparatively smaller than the mature male and female.In addition to recording defecations, percents total activity time was determined. Grazing, ruminating, resting, sleeping, traveling, standing, playing and drinking were the activities noted.

4.2.2 Method of Analysis of PGC data

Application of the method is as follows:

A number of plots is located in such a manner that the study area is adequately represented and of the sampling designs must be employed here.

Then the number of pellet group is counted in each plot. Then let

N=t/r

Where

N=No. of deer per sample plot area.

t=Pellet groups per sample area.

r = Defecation rate

So number of deer per hectare will be N x 1000 & if it is multiply total hectare of the study area it will gives the population size of deer. If it is multiply by 10000, then we can have population density per sq. km.

4.3 LINE TRANSECT COUNT SURVEY

4.3.1 Line transect counting theory and techniques

Most deer species are not individually identifiable, and are therefore not amenable to the capture-recapture sampling type of approach. Because the vision and hearing of ungulate prey are relatively poor, they can be seen and counted. However, because of the screening effect of the vegetation in forested habitats, it is not appropriate to count tigers prey using

block counts or total counts, or other methods which assume that all animals in the sampled area are seen (Lance *et. al.* 1994; Thompson *et al.* 1998).

The method involves observers moving along straight trails called transect counting animals seen on either side. Additionally, using range finders and compasses, the observer measure the distance and angle from the transect to animals that are seen. During analysis, these counts and associated distance data are used to generate sighting probabilities. Transect data can be analyzed using computer programs that estimate detection probabilities to estimate the animal abundance (N) in the sample area from the estimation process, density can be estimated directly.

4.3.2 Field techniques

Unlike sampling methods based on fixed width transects, the line transect method does not assume that all objects within a specified width are detected. Rather the assumption is that objects on the line are seen with probability that the number of objects sighted away from the line decreases in some fashion.

These transect lines are comprising generally 2.5-4 km long, but considering the topography and geographical condition of the SRF, 1.0 km long straight trails (Chilla) were cut and marked clearly using painted tags.

Two trained observer walked along the line counting prey animals observed side of the line. The sample counts were done between 0600-0900 and 1600-1900 hours when prey animals species were most active and the included angle (sighting angle) between the transect line and the center of the animal cluster were recorded. The sighting distance was measured with optical range finders (15m-180m range) and the angles were calculated from the azimuths (bearings) recorded using a liquate levels of sampling effort, we used trained volunteers to collect field data from line transect surveys. At each site about 10-20 such volunteers carried out the surveys under our supervision. ëIn the case of Spotted deer surveys in the SRF, considering the physical barriers like khals, small and big rivers 1000m (lkm) long transects were found to be satisfactory. In areas where deer density is low, transects longer than 1000m may be more appropriate. A minimum of approximately 5-10 separate transect lines were selected within each area of vegetation type. During the present study 1000 m (lkm) long transect were established in the SRF. Considering the physical barrier like khals, nalla charas and rivers etc.

Care must be taken when choosing the timing of surveys. Seasonal environmental fea such as vegetation growth, or high tide of low tide may lead to difficulties in finding dung. in turn may greatly increase the level of effort required to obtain the desired precision, or result in an underestimate of the number of animals in the region. Dry season (October March) is the best time for pellet group count, on other hands line transect survey can be done throughout the year in the SRF.

4.3.3 Data collection

Once the survey design has been completed, the starting position can be determined based on topographic features extracted from a map, or by using a global positioning

system (GPS). A compass can then be used to determine the direction in which observers should walk. in woodland areas, however following a compass bearing along a straight line can be difficult. The size of a rope or cable of known length, with additional length marks along it, provides an effective means of marking the line. The cable can be placed along the desired bearing and observers can then walk alongside it. This has the additional advantage that the transect line is dearly marked, facilitating the recording of perpendicular distances of detected objects from the line. The cable can also be used as a tool for measuring the distance should be skipped between transect lines.

During the present study LTC data were collected from May/ 2001 to February/2002, in 42 (Forty two) different types of vegetation the SRF.

To study the distribution of animals in the SRF along transect in the absence of source of disturbance 1 km long walking trail (locally called Chill a) were selected adjacent to the nearest Forest offices. A total of 42 permanent transect lines of 1 km long were laid out / selected in the SRF

Each transect was covered once in the morning (0530 to 0630 h) and once in the evening (1600 to 1830 h) each week. The transects were covered from starting and ending alternatively in order to minimize any basis arising from variation in animal activity with time. For each sighting the central location of the animal group was noted, and the perpendicular distance from this location to the transect line (or Chilla) was recorded on each side (20 m to 30 m range) using a range finder (20m to 60m range) at 10m class intervals, in addition details of group composition. Sometimes a range finder was used wherever possible.

4.3.4 Data analysis

Line-of-sight measurement are used in the King Census Method; in the Webb method measurements are taken perpendicular from the transect to the fleshing location (Webb, 1942). The formula of the King census

$$P = \frac{AZ}{ZYX}$$

Where

P= population

A= total area of study

Z= number flushed

Y = average flushing distance

X = length of line

Flush radius is defined only towards the direction of approach. Here, the probabilities of observing the animals our proportions to the widest part of the pattern (generally proportional to the length of the projection of the pattern on the perpendicular to the line

of travel). 10 morning and 10 afternoon count of deer were made between 10th to 30th of each month from July to December /2000-2001. Twenty additional counts were made in early of late November 2001 to December better the operability at that time. We also used regular wildlife observation data sheet recorded by the Forest Department staffs at the Kachikhali Chankhola Math area. Each deer seen was scrutinized closely with binocular of recorded as a buck, doe or fawn. Accuracy tests revealed that less than 5% of individual marked yearling (sub-adult) bucks were being misclassified as does. Most fawn were born between March-August and reached near adult size in December however, error in the identification of fawns are believed rarely to have exceeded 5% of the does / Generally counts were not taken when it is raining or windy or exceptionally high tide in monsoon.

4.4 COMPLETE COUNT SURVEY

Six different habitat types were identified in the study area, four in the SRF. The study area in the SRF (Grid-I, 2, 3 and 4) is composed of a mosaic of small habitat types relatively evenly distributed.

The study was conducted between January 2000 and December 2001 in the SRF Four grids were established in the SRF

4.4.1 Grid design

The grid design is very important for complete count. The spacing between station depends on the movement pattern of the animals. If the animals are slow moving the spacing between two consecutive stations should be smaller and if the animals are fast moving the spacing between two consecutive station should be more. Spotted & Barking deer are more or less sedentary or site specific. There daily movement various from 2-3km. So 1500m X 1500m = 2250000 sq.m = 2.25sq.km grid was selected.

The grid consists of 30 rows laid from North to South and East to West spaced 50m apart with 30 station. The total number of stations were 961in a particular grid. In each radio-station, a 4m long Muli-bamboo was placed and the pegs were numbered by permanent paint and marked by a pieces of red marking tape/cloth. This was helpful for detecting the position during the night & day in the thick forest to identify the station.

4.4.2 Data collection

Forest Department is maintaining wildlife observation records in three wildlife sanctuaries of the SRF since 1994. But these records have created lot of controversy due to the lack of skill staffs. During the present study all the staffs, who has recorded the wildlife observation records were trained under the Sundarbans Bio-diversity Conservation Project and wildlife data sheets were supplied to them.

A group of trained staff usually has recorded the daily wildlife observation records giving more emphasis on the Barking & Spotted Deer. During complete counting day, 30-35 peoples including trained staffs & skilled labors where engaged for counting wildlife.

Every person has to follow the gridline North to South or East to West direction and he has to record the animals whatever he observed. More emphasis has given on major ground wildlife including arboreal monkey. But every body has to keep silence.

Tow years sitting records of Spotted Deer (male, female & fawn) were maintained carefully in the Jamtola Chankhola Math at Kachikhali Wildlife Sanctuary Centre (WSC).

Total count method was applied only in the SRF, 5 occasions in grid-I, 6 occasions in grid-2, 4 occasions in grid-3 and 3 occasions in grid-4. During the total count operations major ground wildlife including arboreal monkey was recorded.

4.5 RESULTS AND OBSERVATION

4.5.1. Observation and results of the Pellet Group Count survey

1) Population size and density of the Spotted Deer

27 (Twenty seven) pellet group plots were established in the nine different types of vegetation in the SRF during October to December 2001 and the results of the population census was presented in the Table-10. The standard defecation rate of the Spotted Deer was 13 PG/day and the number of pellet was 70-80 per pellet group. The Spotted Deer was found in all plots. The mean density (no/sq km) of the Spotted Deer in different types of vegetation were as follows: 4 in Sundri, 12 in Sundri-Gewa, 14 in Sundri-Passur-Kankra, 14 in Gewa, 7 in Gewa-Sundri, 16 in Gewa-Goran-Passur, 55 in Gewa-Goran Keora, 18 in Passur-Kankra-Baen and 175 in Keora-Gewa open grassland .Population density was lowest in the pure Sundri forest and highest in the Keora-Gewa open grassland areas. A total of 8324 Spotted Deer was estimated by the PGC method. The study also has indicated that the most suitable habitat of the Spotted Deer is the Keora-Gewa open grassland association and the poor habitats were Sundri and Sundri-Gewa forests.

2) Population size and density of the Barking Deer

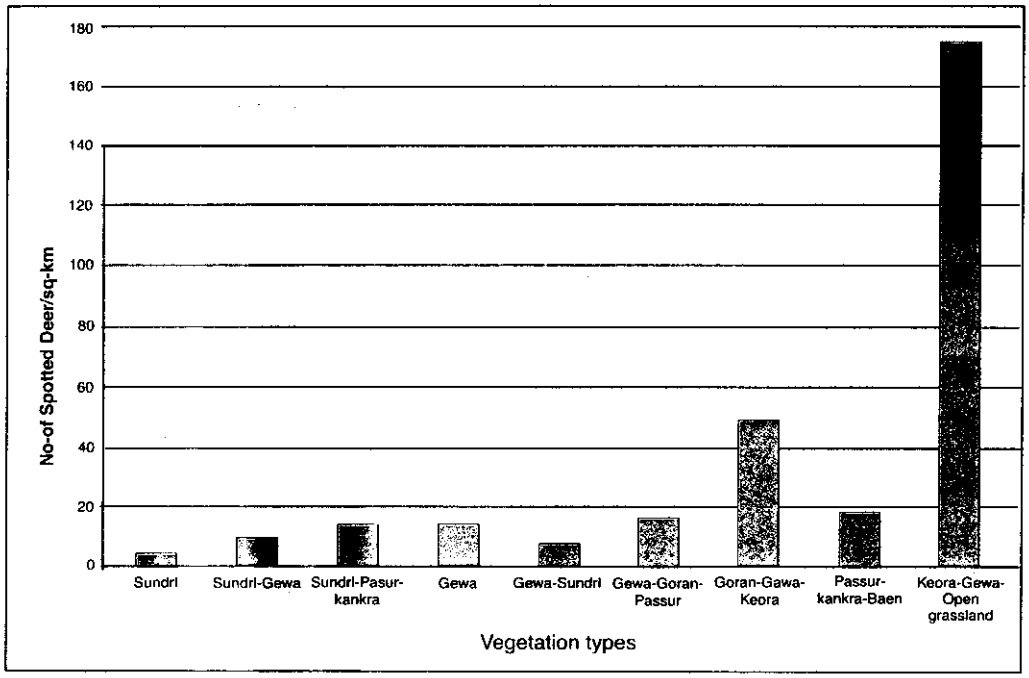
PGC method also was applied similarly in the nine different types of vegetation of the SRF in the 27 PGC plots from October to December 2001 and results is presented in the Table-11. The study reveals that the Barking Deer exists one in the five different types of vegetation like Sundri, Sundri-Gewa, Sundri-Passur-Kankra, Gewa-Sundri and Passur-Kankra-Baen association. The mean population density (no/sq km) were as follows: 2 in Sundri, 3 in SundriGewa, 3 in Passur-Kankra-Baen, 4 in Gewa-Sundri and 5 in Sundri-Passur-Kankra forest. The Barking Deer was found only in the North and Northeast regions within 16 compartments (C-l, 2, 3, 4, 5, 6, 13, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33 and 34) out of the 55 compartments of the SRF, specially in the fresh water and moderately fresh water zones. They were not found in the high saline zone. A total of 2265 Barking Deer was estimated in the SRF. The habitat zonation of the Barking Deer is presented in the map.

Table-10 : Comparative population density and size of the Barking Deer in relation to the vegetation types in the SRF as estimated by the PGC survey during October to December 2001.

Sl. No.	Vegetation types according to predominant species	Total area (sq. km)	Data collection period	Duration in days	Number of PGC plots	Total no. of pellet group observed	Mean no. of PG per plot	Defecation rate/day	Density of Spotted Deer (No/Sq. km)	Total no. of Spotted Deer in each vegetation type.
1	Sundri	749.92	150et-26Nov.	42	4	1	0.0059	13	4	2,999
2	Sundri-Gewa	1059.73	15 oet-26 Nov.	42	3	2	0.1580	13	12	1277
3	Sundri-Passur-Kankra	95.56	20 oet-1 Dec.	42	4	3	0.0178	13	14	1,338
4	Gewa	215.20	15x10-12 Dee	28	2	1	0.0178	13	14	3,012
5	Gewa-Sundri	757.03	20 Oet-1 Dec.	35	3	1	0.0095	13	7	5,299
6	Gewa-Goran-Passur	346.04	26 Nov-30Dee	35	4	3	0.0214	13	16	5,536
7	Goran-Gewa-Keora	648.07	15 Nov-12 Dec.	28	2	4	0.0714	13	59	38236
8	Passer-Kankra-Baen	40.30	20 Oet-1 Dec.	42	3	3	0.0238	13	18	725
9	Keora-Gewa-open grassland	82.86	15 Nov.-20 Dee	35	2	16	0.2285	13	175	14500
	Total	**3994.71**				**27**	**28**			**83024**

Table-11 : Comparative population density and size of the Barking Deer in relation to the vegetation types in the SRF as estimated by the PGC survey during October to December 2001.

Sl. No.	Vegetation types according to predominant species	Total area (sq. km)	Data collection period	Duration in days	Number of PGC plots	Total no. of pellet group observed	Mean no. of PG per plot	Defecation rate/day	Density of Spotted Deer (No. PerSq. km)	Total no. of Spotted Deer in each vegetation type
1	Sundri	280.63	150et-26Nov.	42	4	0.50	0.125	12	2	561
2	Sundri-Gewa	256.04	15 oet-26 Nov.	42	3	0.5.	0.166	12	3	768
3	Sundri-Passur-Kankra	49.73	20 oet-1 Dec.	42	4	1.0	0.25	12	5	248
4	Gewa-Sundri	157.73	20 Oet-1 Dee	35	3	0.50	0.166	12	4	630
5	Passer-Kankra-Baen	19.31	20 Oct-1 Dec.	42	3	0.50	0.166	12	3	58
	Total	**3994.71**				**17**				**2,265**



3) Variation of population density of the Spotted Deer with canopy closure and height classes

Population density of herbivore mammals is related with ground vegetation cover, water and shelter (Smith *et al.* 1975). The relationship between population density and cover density (canopy closure) probably has evolved as an adaptation for predator avoidance but may also be influenced plant growth pattern (Hirth 1977).

All social groups and population density of the Spotted Deer wet based on cover density and vegetation height. The data on canopy closure (%) and average vegetation height were collected from the ODA maps and field observation, and the population density of the Spotted Deer in the different types of vegetation was estimated on the basis of PGC survey. Chi-square test were done on the basis of pooled data. In the both cases calculated chi-square value (252.0951 and 113.8339) are higher than the tabulated value. Significant differences of the Spotted Deer density were observed in the dense wooded forest and open grassland. Spotted Deer groups were smallest in dense cover and largest in open grassland areas with no cover. Similarly population density of the Spotted Deer were more in the low height forest than the tall height forest which is statistically significant.

4) Variation of population density of the Barking Deer with canopy closure and height classes

The population density of the Barking Deer whether depend on cover density and

vegetation height were tested. The data on canopy closure (%) and average vegetation height were collected from the ODA maps and field observation in the SRF, and the population density of the Barking Deer in the different types of vegetation was estimated on the basis of PGC survey. Chi-square test were done on the basis of pooled data. In the both cases calculated chi-square value (1.1751 and 2.0058) are less than the tabulated value. Significant differences of the Barking Deer density were not observed in the dense wooded forest and open wooded forest, and also in tall height and low height forest. The

Barking Deer density were more or less similar in dense wooded forest and open wooded forest though they prefer dense forest.

4.5.2 Line Transect Count Survey

1) Species composition in the transect vegetation units

During the entire LTC period a total of 10, 544 individuals 13 (Thirteen) different species of major mammals, reptiles and birds were recorded in the transect vegetation in the SRF. The summary of transect counting census is presented in the Table-12a and 12b.

Cabined species % of the Spotted Deer (*Cervuss axis*) was 59.33% of the total observed animals, the highest of all observed species. The combined species % of the Barking Deer was 1.52%. The combined species % of the other species were Wild Boar (*Sus scrofa*) 6.81%, Bengal tiger (*Panthera tigris*) 0.17%, Rhesus Monkey (*Macaca mulatta*) 22.03%, Monitor Lizard (*Varanus spp*) 6.92%, Jangla Cat (Felis chaus) 0.33%, Fishing Cat (*Prionailurus viverrina*), 0.09%, Clawless Otter (*Aonyx cinerea*) 0.43%, Estuarine Crocodile (*Crocodylus porosus*) 0.14% , Python (*Python morolus*) 0.18%, and Indian Porcupine (*Hytrix indica*) 0.18% .

A total of 6256 Spotted Deer were observed in 42 transect 998 observation days and this species were observed in the all transect in the SRF (Table-12a and 12b). Similarly a total of 160 Barking deer were found in 19 transects out of 42 transects in compartment no-1, 2, 3, 4, 5, 6, 13, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33 and 34 of the SRF. There was no observation record of the Barking Deer in the remaining 35 compartments in the SRF.

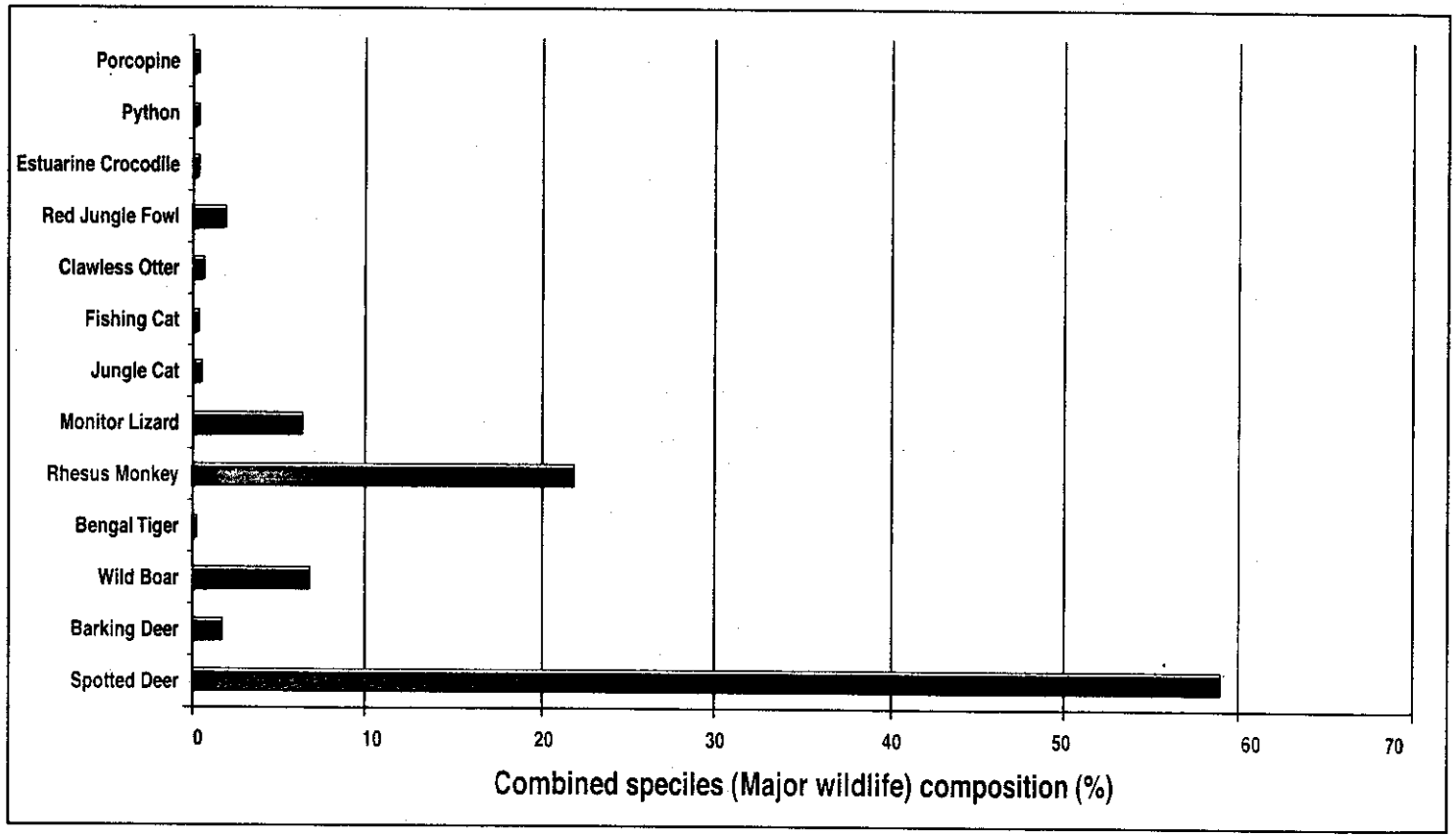
A Juvenile Spotted Deer at the Kachikhali WSC

Table- 12 a. Total of major ground wildlife including arboreal Rhesus monkey recorded during the LTC survey (T-1 to T-20)

Date of observed on	Total Observation days	Number of animal observed													Total animal observed
		Sootted Deer	Barking Deer	Wild Boar	Bengal Tiger	Rhesus Monkey	Monitor Lizard	Jungle !d!!	Fishing Cat	Clawless Otter	Red Jungle Fowl	Estuarine Crocodile	Python	Procopine	
T-1	35	77	23	20	-	49	17	1	1	1	4	-	1	1	194
T-2	40	1344	-	31	3	376	36	2	-	1	18	1	1	1	1814
T-3	30	18	14	10	1	24	10	1	1	2	3	-	-	-	84
T-4	20	642	-	25	-	23	17	1	-	1	4	1	-	-	713
T-5	35	42	8	12	1	29	25	-	-	-	1	-	1	-	119
T-6	24	36	6	15	-	32	16	-	1	1	14	-	2	-	123
T-7	15	18	8	10	-	17	11	1	1	1	3	-	1	2	73
T-8	21	21	7	12	1	26	21	-	-	1	2	1	-	-	91
T-9	25	30	9	10	-	22	16	-	-	1	4	1	-	-	93
T-10	32	48	8	10	-	17	11	-	-	2	3	1	1	-	91
T-11	46	207	-	33	-	97	27	1	-	-	8	-	-	-	373
T-12	25	45	-	14	-	75	28	2	-	1	2	-	-	-	167
T-13	20	56	-	12	1	44	23	-	-	2	7	-	-	1	146
T-14	30	63	-	14	-	37	19	1	-	-	1	-	-	2	137
T-15	20	42	-	11	-	35	7	-	-	-	2	-	-	1	98
T-16	25	320	-	19	1	41	15	1	-	1	1	2	-	-	401
T-17	40	204	-	38	-	85	15	4	-1	3	36	1	-	-	387
T-18	15	18	-	26	1	27	18	-	-	2	6	-	-	-	198
T-19	28	42	-	21	-	28	17	1 -	1	2	1	-	-	113	
T-20	35	126	-	22	-	24	24	-	1	--	8	-	-	-	204

Table- 12 b: Total of major ground wildlife including arboreal Rhesus monkey recorded during the LTC survey in the SRF (T-21 to T-42)

Date of observed on	Total Observation days	Number of animal observed													Total animal observed
		Spotted Deer	Barking Deer	Wild Boar	Bengal Tiger	Rhesus Monkey	Monitor Lizard	Jungle !d!!	Fishing Cat	Clawless Otter	Red Jungle Fowl	Estuarine Crocodile	Python	Procopine	
T-21	20	78	-	13	I	31	32	2	-	I	4	-	-	1	164
T-22	35	49	6	12	-	19	16	I	-	2	6	-	-	-	III
T-23	20	48	5	tl	1	33	19	I	1	-	2	-	1	- .	121
T-24	15	42	4	10'	-	23	21	I	-	-	3	-	I	-	III
T-25	25	45	-	19	-	18	16	-	-	I	I	-	-	-	100
T-26	15	39	4	12	I	22	17	-	-	2	4	-	-	-	101
T-27	10	138	-	35	-	87	29	2	-	I	I	-	-	-	293
T-28	25	30	-	30	I	177	18	-	-	-	2	-	1	-	258
T-29	35	35	-	22	-	76	22	-	I	4	1	1	1	1	163
T-30	35	42	4	15	1	59	10	I	-	2	4	1	2	-	142
T-31	15	279	-	19	-	41	13	2	-	I	7	2	-	-	359
T-32	10	18	19	8	-	23	8	1	I	-	3	-	1	2	83
T-33	12	18	18	5	-	48	12	-	-	2	1	-	2	1	108
T-34	15	18	5	5	-	51	12	1	-	2	4	-	1	2	101
T-35	10	9	2	8	1	18	2	1	1	-	2	-	1	1	45
T-36	15	12	5	6	-	8	9	-	1	1	2	-	1	1	46
T-37	20	252	-	29	1	42	11	2	-	1	4	1	-	-	343
T-38	21	21	-	15	-	31	15	1	-	2	3	-	-	-	88
T-39	10	21	-	17	-	28	16	-	-	-	1	-	-	-	83
T-40	15	42	-	14	-	18	12	-	-	-	5	-	-	-	91
T-41	45	1593	-	36	2	341	35	2	-	1	7	-	-	2	2019
T-42	14	28	5	13	-	23	12	1	-	1	1	1	1	1	87
Species total		6256	160	719	18	2320	730	35	10	45	197	15	19	20	10544
Combined species percentage		59.33	1.52	6.81	0.17	22.03	6.92	0.33	0.09	0.43	1.87	0.14	0.18	0.18	100%



Combined species composition (%) in 42 transect units of the SRF as eatimated by the LTC survey.

Table-13: Population density of the Spotted Deer in the 42 different transect vegetation units.

Transect No.	Period of transect counting	Total no. of observed (in days)	Total no. of observed Spotted Deer observed	Average no. of Deer observed per per transect observation	Transect area (sq. km)	Mean density (deer/sq.km)
T-1	May-Aug-2001	35	15	0.43	1000mx40m= 0.04sq.km	11
T-2	May-Aug-2001	40	412	10.32	1000mx60m= 0.06 sq.km	172
T-3	May-Aug-2001	30	4	0.13	0.04 sq.km	3
T-4	Jun-Sep-2001	20	128	6.42	0.06 sq.km	107
T-5	Jun-Sep-2001	35	9	0.24	0.06 sq.km	4
T-6	Jun-Sep-2001	24	13	00.54	0.06 sq.km	9
T-7	Jun-Sep-2001	13	3	0.23	0.04 sq.km	6
T-8	Jul-Oct-2001	23	9	0.40	0.04 sq.km	10
T-9	Jul-Oct-2001	23	10	0.44	0.04 sq.km	11
T-10	Jul-Oct-2001	32	19	0.60	0.06 sq.km	10
T-11	Jul-Oct-2001	46	41	0.90	0.06 sq.km	15
T-12	Jul-Oct-2001	25	9	0.36	0.06 sq.km	6
T-13	Jul-Oct-2001	20	11	0.55	0.04 sq.km	14
T-14	Jul-Oct-2001	30	13	0.43	0.06 sq.km	7
T-15	Aug-Oct-2001	20	8	0.40	0.06 sq.km	7
T-16	Aug-Oct-2001	25	63	2.52	0.06 sq.km	42
T-17	Aug-Oct-2QO1	40	41	1.02	0.06 sq.km	17
T-18	Aug-Oct-2001	15	6	0.44	0.04 sq.km	11
T-19	Aug-Oct-2001	28	17	0.60	0.06 sq.km	10
T-20	Aug-Oct-2bb1	35	25	0.72	0.06 sq.km	12
T-21	Aug-Oct-2001	20	16	0.80	0.06 sq.km	13
T-22	Aug-Oct-2001	35	13	0.36	0.04 sq.km	9
T-23	Sep-Nov-2001	20	10	0.48	0.04 sq.km	12
T-24	Sep-Nov-2001	12	7	0.58	0.04 sq.km	14
T-25	Sep-Nov-2001	25	16	0.66	0.06 sq.km	11
T-26	Sep-Nov-2001	17	9	0.53	0.04 sq.km	13
T-27	Sep-Nov-2001	10	28	2.80	0.06 sq.km	46
T-28	Sep-Nov-2001	25	6	0.24	0.04 sq.km	6
T-29	Sep-Nov-2001	35	13	0.36	0.04 sq.km	2
T-30	Sep-Nov-2001	35	14	0.40	0.04 sq.km	10
T-31	Nov-Dec-2001	15	56	3.73	0.06 sq.km	62
T-32	Nov-Dec-2001	70	25	0.36	0.06 sq.km	6
T-33	Nov-Dec-2001	11	4	0.36	0.06 sq.km	6
T-34	Nov-Dec-2001	15	10 0.	0.66	0.06 sq.km	11
T-35	Nov-Dec-2001	8	6	0.25	0.06 sq.km	4
T-36	Nov-Dec-2001	15	2\50	0.40	0.04 sq.km	10
T-37	Nov-Dec-2001	20	59	2.50	0.06 sq.km	42
T-38	Jan-Feb-2002	21	5	0.44	0.04 sq.km	11
T-39	Jan-Feb-2002	10	9	0.54	0.06 sq.km	9
T-40	Jan-Feb-2002	15	472	0.60	0.06 sq.km	10
T-41	Jan-Feb-2002	45	319	10.56	0.06 sq.km	176
T-42	Jan-Feb-2002	14	6	0.42	0.04 sq.km	10

2) LTC estimate of the Spotted Deer

The observation record of the Spotted Deer at the transect units in the SRF is presented in the Table-14. The results shows that a total of 1569 Spotted Deer was observed in 998 observation days.

3) LTC estimates of the Barking Deer

The observation records of the Barking Deer in the transect units in the SRF is presented in the Table-14. the result shows that 46 Barking Deer were observed in 998 observation days.

Habitat zonation map of the Barking Deer in the Sundarbans Reserved Forests

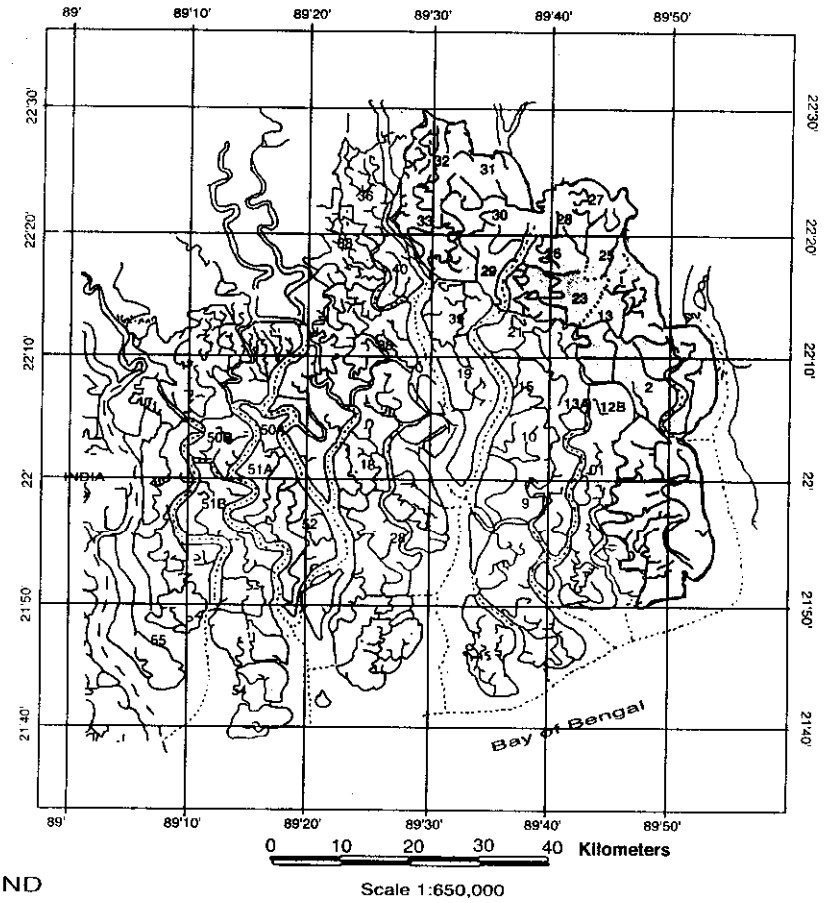


Table.14: Population density of the Barking Deer in the 42 transect vegetation units

Transect No.	Period of transect counting	Total no. of observed (in days)	Total no. of Barking deer observed	Average no. of deer observed per per transect observation	Transect area (sq. km)	Mean density (deer/ sq.km)
T-1	May-Aug-2001	35	6	0.17	100mx40m= 0.04 sq.km	4
T-2	May-Aug-2001	40	-	-	1000mx60m= 0.06 sq.km	-
T-3	May-Aug-2001	30	2	0.07	0.04	2
T-4	Jun-Sep-2001	20	-	-	0.06	-
T-5	Jun-Sep-2001	35	3	0.08	0.06	1
T-6	Jun-Sep-2001	24	3	0.12	0.06	2
T-7	Jun-Sep-2001	13	2	0.15	0.04	4
T-8	Jul-Oct-2001	23	3	0.13	0.04	3
T-9	Jul-Oct-2001	23	3	0.13	0.04	3
T-10	Jul-Oct-2001	32	2	0.06	0.06	1
T-11	Jul-Oct-2001	46	-	-	0.06	-
T-12	Jul-Oct-2001	25	-	-	0.06	-
T13	Jul-Oct-2001	20	-	-	0.04	-
T-14	Jul-Oct-2001	30	-	-	0.06	-
T-15	Aug-Oct-2001	20	-	-	0.06	-
T-16	Aug-Oct-2001	25	-	-	0.06	-
T-17	Aug-Oct-2001	40	-	-	0.06	-
T-18	Aug-Oct-2001	15	-	-	0.04	-
T-19	Aug-Oct-2001	28	-	-	0.06	-
T-20	Aug-Oct-2001	35	-	-	0.06	-
T-21	Aug-Oct-2001	20 -	-	0.06	-	
T-22	Aug-Oct-2001	35	2	0.05	0.04	1
T-23	Sep-Nov-2001	20	1	0.05	0.04	1
T-24	Sep-Nov-2001	12 1	0.08	0.04	2	
T-25	Sep-Nov-2001	25	-	-	0.04	-
T-26	Sep-Nov-2001	15	1	0.05	0.04	1
T-27	Sep-Nov-2001	17	-	-	0.06	-
T-28	Sep-Nov-2001	25	-	-	0.04	-
T-29	Sep-Nov-2001	35	-	-	0.04	-
T-30	Sep-Nov-2001	35	3	0.08	0.04	2
T-31	Nov-Dec-2001	15	-	-	0.06	-
T-32	Nov-Dec-2001	10	4 0.40	0.06	7	
T-33	Nov-Dec-2001	11	4 0.36	0.06	6	
T-34.	Nov-Dec-2001	15	2	0.13	0.04	3
T-35	Nov-Dec-2001	8	1	0.12	0.06	2
T-36	Nov-Dec-2001	15	2	0.13	0.04	3
T-37	Nov-Dec-2001	20	-	-	0.04	-
T-38	Jan-Feb-2002	21	-	-	0.04	-
T-39	Jan-Feb-2002	10	-	-	0.06	-
T-40	Jan-Feb-2002	15	-	-	0.06	-
T-41	Jan-Feb-2002	45	-	-	0.06	-
T-42	Jan-Feb-2002	8	1	0.12	0.04	3
Total		**998**	**46**			

4.2.4 Population density and population size of the Spotted Deer.

The population density of the Spotted Deer is given in the Table-15 as following in Sundri forest 3/sq.km which was the lowest, 10/ sq.km in Sundri-Gewa, 12/sq.km in Sundri-PassurKankra, 12/sq.km in Gewa. 6/sq.km; in Gewa-Sundri, 15/sq. km in Gewa-Goran-Passur, 43/sq. km in Goran-Gewa-Keora, 14/sq. km in Passur-Kankra-Baen and 174/sq, km in Keora-Gewa-open grassland.

The population density was highest in the Keora-Gewa open grassland. The estimated population size of the Spotted Deer in the SRF was 79531(Table-15).

A buck Spotted Deer at the foot-trail (Chilla) near Katka WSC

Table-15: Population density and size of the Spotted Deer as estimated by the line transect count (LTC) survey.

Sl No	Vegetation types according to predominant species.	Area (sq. km)	Transect units	Total no. of transect	Mean density of Spotted Deer (no./sq.k	Total no. of Spotted Deer
1	Sundri	749.92	T-3, 5, 35 T-6, 8, 9,10,18,19,22,	3	3	2,250
2	Sundri-Gewa	1059.73	25,29,30,34, 36,38,39, 40	15	10	10597
3	Sundri-Passur-Kankra	95.56	T-1, 21, 23, 26, 42	5	12	1,146
4	Gewa	215.20	T-20	1	12	2,582
5	Gewa-Sundri	757.03	T-7, 12, 14, 15,28,33	6	6	4,542
6	Gewa-Goran-Passur	346.04	T-11,13,17	3	15	5,190
7	Goran-Gewa-Keora	648.07	T-16,27,30,31,37	5	43	27,867
8	Passur-Kankra-Baen	40.30	T-24	1	14	5,642
9	Keora-Gewa open grass land	82.86	T-2,4,41	3	174	14417
	Total	**3,994.71**		**42**		**79531**

Table-16: Population density and size of the Barking Deer as estimated by the line transect count (LTC) survey

Sl No	Vegetation types according to predominant species.	Area (sq. km)	Transect units	Total no. of transect Unit	Mean density of Barking Deer (no./sq.km)	Total no. of Barking Deer in
1	Sundri	280.63	T-3, T-5, T- 35	3	1.66	466
2	Sundri-Gewa	256.04	T-6, T-8, T-9 T-10, T- 22, T-30 T-34, T-36	8	2.25	576
3	Sundri-Passur Kankra	49.73	T-1, T-23, T-26, T-42	4	2.25	112
4	Gewa-Sundri	157.73	T-7, T-32, T-33	3	5.66	893
5	Passur-Kankra baen	19.31	T-24	1	2.0	39
	Total	**763.44**	**19**	**2086**		

5) Population density and size of the Barking Deer

he population density of the Barking Deer is given in the Table-16. The observed Barking Deer density was 1.66/ sq km in Sundri, 2.25/sq km in Sundri-Gewa, 2.25/sq km in Sundri-Passur-Kankta, 5.66/sq km in Gewa-Sundri and 2/sq km in Passur-Kankra-Baen. The population density was the lowest in Sundri forest and the highest in Gewa-Sundri forest. The estimated population size of was 2086.

4.5.3 Complete Count survey

1) Species composition in the grid-I

A total of 438 animals was recorded during the 5 days total counts operations and the data is presented in the Table-17. There were 58 Spotted Deer *(Cervus axis)* & 36 Barking Deer *(Muntiacus muntjak)*. The population density of the Spotted Deer and Barking Deer were 5.1/sq.km. and 3.2/sq.km respectively. The population density of other species were as follows: Rhesus Monkey *(Macaca mulatta)* 12.5/sq.km, Wild Boar *(Sus scrofa)* 6.0/sq.km, Monitor Lizard *(Varanus spp)* 7.8/sq.km, Jangle Cat *(Felis chaus)* O.18/sq.km, Clawless Otter *(Aonyx cinerea)* O.1/sq.km, and Red Jungle Fowl *(Gallus gallus)* 2.4/sq.km.

2) Species composition in the grid-2

A total of 1710 animals was recorded during the 5 day total count operations and data is presented in the Table-17. There were 1326 Spotted Deer *(Cervus axis)* and population density was 98.2/sq.km. There was no record of the Barking Deer *(Muntiacus muntjak)* in this grid. The population density of other major animals were as follows: Rhesus Monkey *(Macaca mulatta)* 12.83/sq.km, Wild Boar *(Sus scrofa)* 7.2/sq.km, Monitor Lizard *(Varanus spp)*. 8.16/sq.km, Bengal Tiger *(Panthera tigris)* O.16/sq.km, Jangle Cat *(Felis chaus)* O.15/sq.km, Clawless Otter *(Aonyx cinerea)* 1.16/sq.km, and Red Jungle Fowl *(Gallus gallus)* 2.8/sq.km.

Table-17: Summary ofthe total count survey of major wild animals in the four different grid areas (each 2.25 sq. km) of the Sundarbans Reserved Forest.

Name of species	Grid -1 (Kara.mjal).			Grid - 2 (Katka)			Grid - 3 (Kachikhali)			Grid - 4 (Nilkamal)		
	No. of observation days	No. of animal observed	Density per sq. km.	No. of observation days	No. of animal observed	Density per sq. km.	No. of observation Days	No. of animal observed	Density per sq. km.	No. of observation Days	No. of animal observed	No. of observation Days
Spotted Deer	5	58	5.1	6	1326	98.2	4	785	87.2	3	522	77.33
Barking Deer	5	36	3.2	6	-	-	4	-	-	3	-	-
Rhesus monkey	5	140	12.5	6	173	12.83	4	95	10.5	3	90	13.33
Wild boar	5	67	6.0	6	43	7.2	4	30	7.5	3	23	7.8
Monitor lizard	5	88	7.8	6	110	8.16	4	70	7.75	3	54	9.66
Bengal tiger	5	-	0.08	6	3	0.158	4	1	0.11	3	-	-
Jungle cat	5	2	0.18	6	2	0.15	4	-	-	3	-	-
Clawless otter	5	18	1.6	6	16	1.16	4	11	1.22	3	9	1.33
Fishing cat	5	1	0.1	6	-	-	4	-	-	3	-	-
Red jungle fowl	5	27	2.4	6	38	2.8	4	29	3.22	3	22	3.26
Total	**438**		**1710**			**102**						**720**

3) Species composition in the grid-3

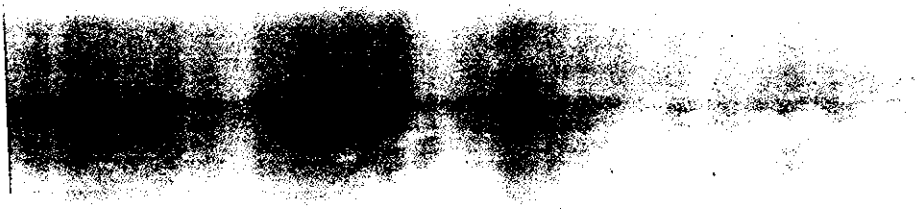
A total of 1021 animals was recorded during the 5 day total count operations and data is presented in the Table-17. There were 785 Spotted Deer *(Cervus axis)* and population density was 87.2/sq.km. There was no record of the Barking Deer *(Muntiacus muntjak)* in this grid. The population density of other major animals were as follows: Rhesus Monkey *(Macaca mulatta)* 10.5/sq.km, Wild Boar *(Sus scrofa)* 7.5/sq.km, Monitor Lizard *(Varanus spp)* 7.75/sq.km, Bengal Tiger *(Panthera tigris)* 0.11/sq.km, Clawless Otter *(Aonyx cinerea)* 1.22/sq.km, and Red Jungle Fowl *(Gallus gallus)* 3.22/sq.km.

4) Species composition in the grid-4

A total of 720 animals was recorded during the 4 day total count operations and data is presented in the Table-17. There were 522 Spotted Deer *(Cervus axis)* and population density was 77.33/sq.km. There was no record of the Barking Deer *(Muntiacus muntjak)* in this grid. The population density of other major animals were as follows: Rhesus Monkey *(Macaca mulatta)* 13.33/sq.km, Wild Boar *(Sus scrofa)* 7.8/sq.km, Monitor Lizard *(Varanus spp)* 9.66/sq.km, Clawless Otter *(Aonyx cinerea)* 1.33/sq.km, and Red Jungle Fowl *(Gallus gallus)* 3.26/sq.km.

5) Spotted Deer population fluctuation in the grid-3 (Jamtola Chankhala Math) of the Kachikhali Wildlife Sanctuary Centre

Population fluctuation of the Spotted Deer in the grid-3 was recorded for two years using daily and mean monthly observation record during the year 2000 and 2001, and the data is presented in the Table-18. A population decrease was recorded in December to January (non-breeding season) and increase was recorded in August to September which was considered as peak breeding season of the spotted Deer. However they were found to breed throughout the year. The population remain more or less stable during April to June and October to November, and average ratio of male : female: fawn was 15 : 60 : 25 and during the peak breeding season (August to September) average ratio of male : female: fawn was 15 : 50 : 25.



A herd of Spotted Deer (*Cervus axis*) is drawn to the water holes (Photo : Sariska National Park, India)

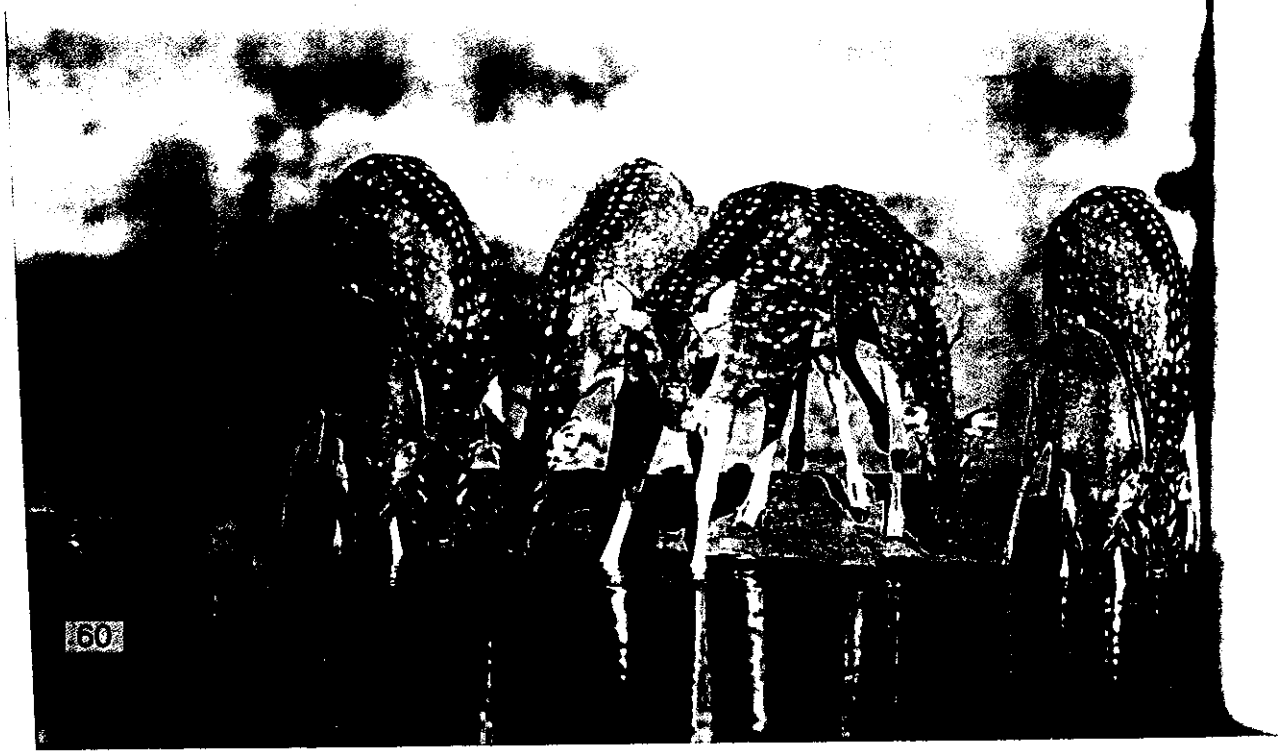
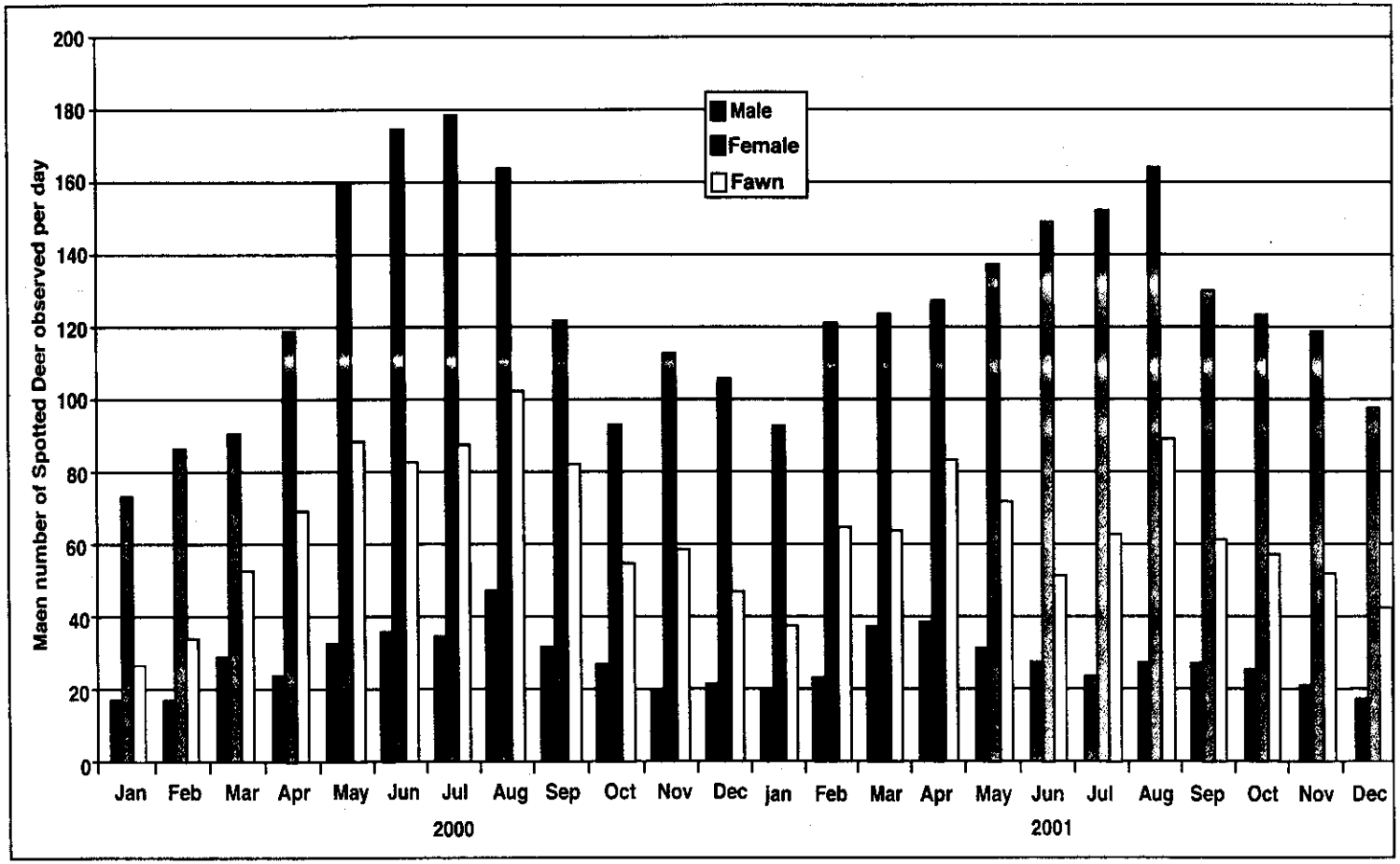
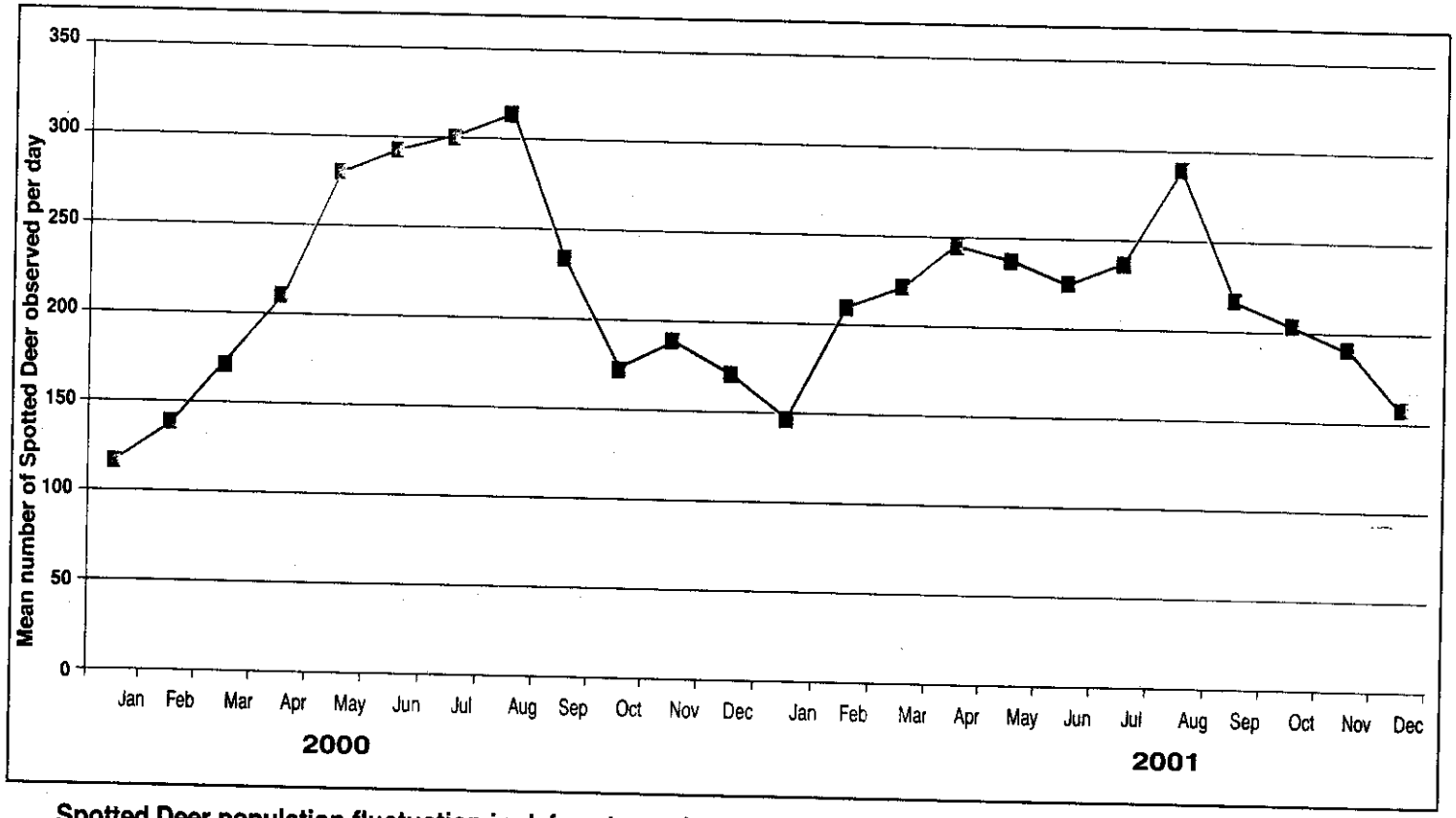


Table-18 : Spotted Deer population fluctuation in respect of sex and age-classes in the Jamtola Chankhola Math of the Kachikhali Wildlife Sanctuary Center during the year 2000 to 2001 on the basis of mean monthly and daily observation record

Year	Month	Males	Females	Fawns (including yearling)	Mean daily total	No. of fawns per 100 of total population	No of fawns per 100 of females	No. of males per 100 of females
2000	Jan	17	73	26	116	22	36	23
	Feb	18	86	34	138	24	39	21
	Mar	28	90	52	170	31	57	31
	Apr	22	118	69	209	33	58	19
	May	32	159	88	279	32	55	20
	Jun	35	174	82	291	28	47	20
	July	34	178	87	299	29	49	19
	Aug	47	163	102	312	33	62	29
	Sep	31	121	82	234	35	67	26
	Oct	26	92	54	172	31	59	28
	Nov	19	112	58	189	31	52	16
	Dec	20	105	46	171	27	44	19
2001	Jan	18	92	37	147	25	40	20
	Feb	22	120	64	210	32	56	18
	Mar	36	122	63	221	28	52	29
	Apr	37	126	82	245	33	65	29
	May	30	136	71	237	30	52	22
	Jun	26	148	51	225	23	34	17
	July	23	151	62	236	26	41	15
	Aug	27	163	89	289	31	54	22
	Sep	27	129	61	217	28	47	21
	Oct	25	123	56	204	27	45	20
	Nov	21	118	52	191	27	44	17
	Dec	18	97	43	158	27	44	18



Spotted Deer population fluctuation in respect of sex and age-classes in the Jamtola Chankhola Math of the Kachikhali Wildlife Sanctuary Center during the year 2000 and 2001 on the basis of mean monthly and data observation records.



Spotted Deer population fluctuation in deferent months at the Jamtola Chankhela Math of the Kachikhali Wildlife Sactuary Center during the year 2000 and 2001 on the basis of mean monthly and daily observation records.

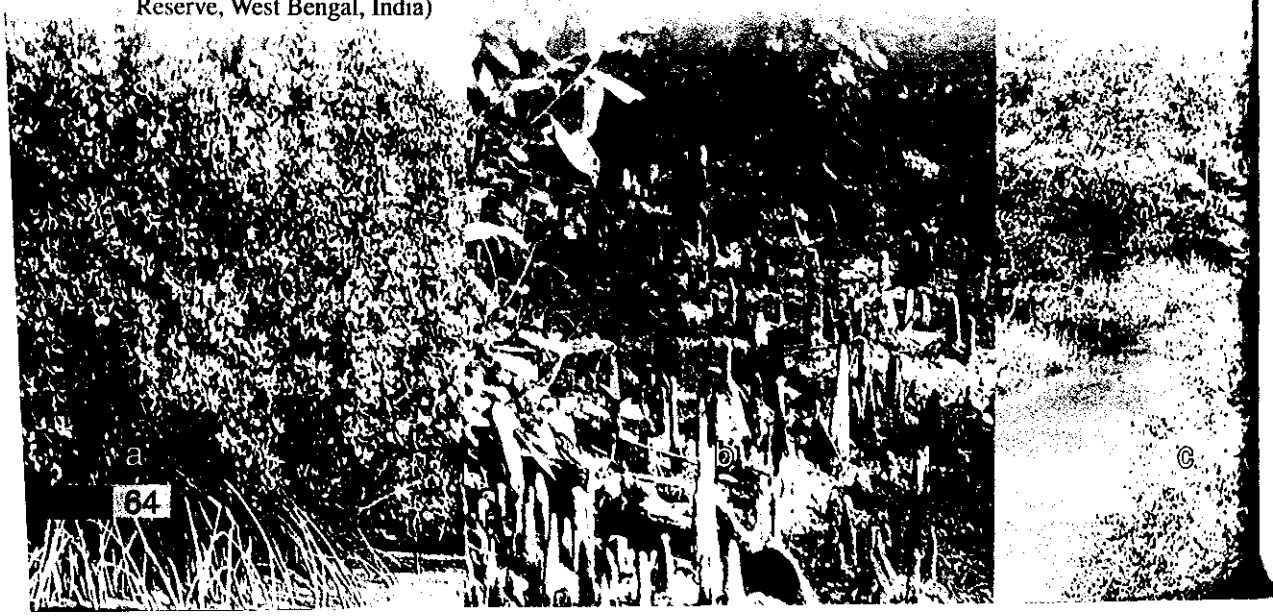
6) Spotted Deer population fluctuation in the grid-3 (Jamtola Chankhala Math) of the Kachikhali 'Wildlife Sanctuary Centre during the morning and evening time

Spotted Deer population vary with the different time of the day. During the present study comparison of the morning and evening population was made in the Kachikhali WSC and observation records are presented in the Table-19. The result indicates that the Spotted Deer like to graze in the late evening (x =218) as compare to early morning (x =106).

Table-19: Comparison of population composition of the Spotted Deer in the morning (0600-0800 hr) and evening (0400-0600hr) at the grid-3 (Jamtola Chankhola Math) of the SRF (23-06-01 to 03-07-01).

Date of obser vation	Morning (Q600-0800hr)						Evening (1600.1800hr)					
	No. of herd	No. of males	No. of famale	No. of yearling	No. of fawns	Total no. of spotted Deer	No. of herd	No. of males	No. of famale	No. of yearling	No. of fawns	Total no. of spotted Deer
23-06-01	13	11	60	11	18	100	27	32	120	30	27	209
24-06-01	11	9	50	9	12	80	19	11	66	12	15	104
26-06-01	13	11	65	15	18	109	24	30	150	40	25	245
27-06-01	12	10	85	12	14	121	23	28	150	29	23	237
28-06-01	14	11	81	11	13	116	22	19	160	28	25	232
29-06-01	10	10	61	12	20	103	24	16	140	37	35	228
30-06-01	13	12	65	13	22	112	20	22	140	46	27	235
01-07-01	12	10	60	15	22	107	21	16	156	31	29	232
02-07-01	17	13	60	13	26	112	23	20	162	30	28	240
03-07-01	13	10	56	14	23	103	21	18	145	35	24	222
Total	128	107	643	125	188	1063	224	212	1389	318	258	2177
% of		10.06	60.48	11.75	17.71	x=106		9.73	63.38	15.02	11.87	x=218

a. Kankra (*B. gymnorrhiza*) with its stild roots, b. Pnewmatophore root system of Sundri (*H. fomes*) c. Muddy islands with mangrove species (Photo : Sundarbans National Park and Tiger Reserve, West Bengal, India)



CHAPTER-5

HOME RANGE AND HABITAT PREFERENCE ESTIMATION BY RADIO-TELEMETRY

5.1 Introduction

Biologists use animal radio-tags for two main purposes, to locate study animals in the field, and to transmit information about the physiology or behavior. The concept of home range has been defined and refined by several authors (Burt 1943; Mohr 1947; Jewell 1966; Baker 1978). Burt (1943) defined the home range as that area traversed by the individual in its normal activities of food gathering, mating and caring for young.

The Spotted Deer is commonly associated with a mixture of forest and more open grass-shrub association (Graf and Nichols 1966; Ables et at. 1977; Dinerstein 1979b; Mishra 1982). However, it occupies a wide range of habitats from mainly grass-shrub vegetation in Wilpattu National Park, Srilanka (Eisenberg and Lockert 1972), to denser areas in the Gir forest of India (Berwick 1974).

Although Spotted Deer do congregate in large herds, the social structure of the species is loose, with individuals readily joining and splitting from groups (Mishra 1982). The only stable relationship is between mother and calf (Mishra 1982). Males are non territorial and in Nepal male groups are common except during the peak-mating season in April-May (Dinerstein 1980).

This study focused on Spotted Deer and Barking Deer movement and activity patterns, and habitat selection in the SRF in Bangladesh. The following hypotheses were tested; (1) home range in breeding and non-breeding season, (2) seasonal difference in forage availability in different habitats after the seasonal habitat preferences of deer, (3) habitat preferences vary. between the sexes in deer, (4) a fine-grained habitat structure (many small patches evenly distributed) reduces home range size in deer and (5) ranges of males and females increase during the rut.

The present study also attempted to identify the best method of calculating RTHR during breeding and non-breeding season and to determine the minimum number of radiolocations required for home range asymptotes of the Barking and Spotted Deer.

5.2 Study Area

Six different habitat types were identified in the study area, four in the SRF. The study area in the SRF (Grid-I, 2, 3 and 4) is composed of a mosaic of small habitat types relatively evenly distributed.

The Spotted Deer is by far the most common ungulate in the SRF. The area was protected from grazing by domestic stock and also from logging. The more detail description of the flora and fauna is given in the Chapter-2 and 3.

The study was conducted between January 2000 and December 2001 in the SRF. Four grids were established in the SRF for radio-telemetric study.

5.3 MATERIAL AND METHODS

During the present study for field data collection the following materials and methods were used.

5.3.1 Grid design

The grid design is very important for radio-tagged animal movement analysis. The spacing between radio-station depends on the movement pattern of the animals. If the animals are slow moving the spacing between two consecutive stations should be smaller and if the animals are fast moving the spacing between two consecutive station should be more. Spotted & Barking deer are more or less sedentary or site specific. There daily movement various from 2-3km. So 1500m X 1500m, = 2250000 sq.m = 2.25sq.km grid was selected.

The grid consists of 30 rows laid from North to south and East to West spaced 50m apart with 30 radio-station. The total number of' Radio-stations were 961 in a particular grid.

In each radio-station, a 4m long Muli-bamboo was placed and the pegs were numbered by permanent paint and marked by a pieces lof red marking tape/cloth. This was helpful for radio-tracking during the night & day in the thick forest to identify the radio-location.

5.3.2 Capture of deer

A major problem in work on wild animals is how to capture them safely and selectively. During the present study both stockade and netting methods were used though these are expensive and labour intensive. Capture drugs method was not applied.

Drop nets are most useful in semi natural conditions where animal regularly congregate in feeding areas. Ramsey (1968) reported the successful capture of several hundred White-tailed and Axis deer, and Pienaar (1969) has used drop nets to ture many medium sized species of African game. All netting techniques require rapid handling of captives so that damage is minimized. This method was successfully used for capturing Spotted Deer and Barking Deer in the SRF.

Radio–tagged Spotted Deer in Keora forest

A radio–tagged Spotted Deer is releaseing in Grid-1

5.3.3 Data collection

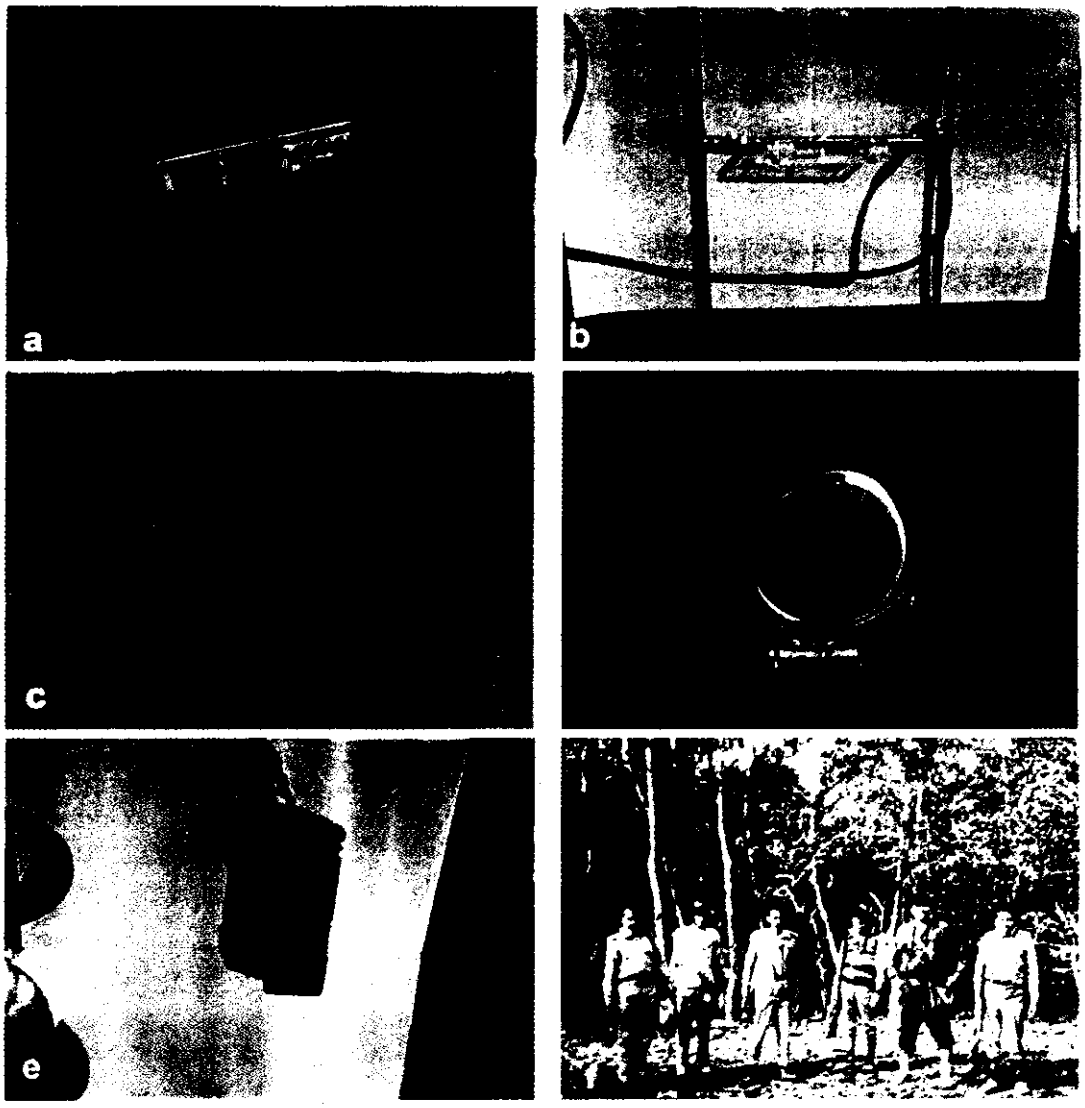
Tracking sessions began in January 2000 and continued until November 2001 at 23 weeks intervals. This period covers both the non-breeding and breeding season of potted and Barking deer. Radio-tracking operations were conducted in all six grids. Sometimes if the radio-tagged animals went outside the grids, then immediately reference oints were established around the new bedding place (outside of grid) with reference to the main grid and radio-tracking operation were continued. In such case GPS locations also were taken into account. A total of 5 male and 6 female Barking Deer, and 5 male nd 5 female Spotted deer were tagged with radio-collars during the study period . The summary of radio tagging with contact period, contact nights and number of fixes is presented in Table-20 and 21.

Table-20 : Radio-tagged Spotted Deer studied in the Sundarbans Reserved Forest during the year 2001

Species 1. D.No.	Sex	Age class	Mean body wt (K.g)	Location	Date of tagging	Contact period	Contact days (24 hrs)	Total no. of fixes
168	M	Adult	81.4	grid - 1	13/1/01	13 Jan-01 Jun-01	28	322
204	F	Adult	55.3	grid - 1	13/1/01	13 Jan-02 May-01	25	221
230	F	Adult	50.7	grid - 2	9/3/01 9	Mar-12 Jun-01	19	175
235	M	Yearling	50.1	grid - 2	9/3/01	9 Mar-10 Jun-01	17	144
238	M	Adult	76.2	grid - 3	28/4/01	28 Apr-13 Jul-01	11	130
254	F	Yearling	52.5	grid - 3	28/4/01	28 Apr-10 Sep-01	10	119
205	M	Adult	75.2	grid-3	01/06/01	13Jun-30 Dee-01	25	162
207	F	Adult	48.9	grid-3	01/06/01	14Jun-16 Dee-01	16	105
260	M	Adult	79.8	grid - 4	14/6/01	14 Jun-28 Dee-01	29	122
262	F	Adult	48.9	grid-4	24/6/01	24 Jun-30 Dee	18	113
Total						198	1613	

Table-21 : Radio-tagged Barking Deer studied in the Sundarbans Reserved Forest during the 2001.

Species 1. D.No.	Sex	Age class	Mean body wt (K.g)	Location	Date of tagging	Contact period	Contact days (24 hrs)	Total no. of fixes
697	M	Adult	25.5	Grid - 1	10-01-01	10 Jan-22 May-01	18	222
698	F	Adult	21.7	Grid - 1	10-01-01	10 Jan-29 Mar-01	22	198
699	F	Adult	19.6	Grid - 1	22-02-01	22 Feb-14 JUn-01	23	582
Total							63	582



Radio telemetric equipment and their uses

a. radio telemetric receiver Regal - 2000

b. Antenna of the receiver Regal - 2000

c. Acrylic radio-collar transmitter

d. Aluminium housing radio-collar transmitter

e. Garmin GPS 12 x L personal navigator

f. Field staff involving radio tracking data collection

5.3.4 Description of Radio-tracking equipment

(a) Microlite Transmitter (Two stage) Model GPI

The radio-collars were an integral loop type (Kenward, 1987) of the tiny two stage transmitter made by Titley Electronics Model GPI with 3 Volt DC mercury battery (Vartabrand with silver oxide-type 388). The transmitter are two categories: (i) One potted with dental acrylic and then glued onto a brass strip collar which function as the antenna. (ii) Another potted with aluminum housing. The both transmitters were connected with 45cm stranded whip antenna which were sealed in dental acrylic and attached to a collar of soft plastic.

During study period 10 aluminum housing transmitters and 8 acrylic housing transmitters were used. The average weight of collars varied 0.3-0.9% of the body weight of the radio-tagged animals and this may be considered as an ideal situation.

(b) Frequency

The frequency range of the transmitters was 150-151 MHz. The average range in flat ground was 4-8 Km or 30-35 Km by air, but this range was reduced in hilly undulating ground and thick bushes.

(c) Telemetry receiver

A Regal 2000 Telemetry Receiver (Titley Electronics Ltd.) was used during radio tracking. The receiver was charged for up to 8-12 hours by a special charger before every tracking session and the receiver was functioning for 2-3 nights/days and this duration depends on the mode of use.

(d) Directional finding antenna

A hand held collapsible (Model AH/C) H-frame antenna (Titley Electronics Ltd)

was used during the present study to determine the direction of the radio-tagged animals .

a. Bamboo post with red flag at the grid station

b. Radio location of the Radio-tagged Spotted Deer was tracking by the author

5.3.5 Mode of Operation of Regal 2000 Telemetry Receiver

The Regal 2000 receiver is a compact, lightweight, robust unit that has been designed specifically for wildlife research. Our aim has been to design a receiver that is packed with features and the latest technology, while remaining easy to carry and easy to operate under the most rigorous field conditions.

Radio tagged male (M 238) at the grid-3 in the SRF

5.3.6 Radio tracking procedure

(a) Attachment of radio-collars

The radio-collars (transmitter, battery and collar) were fitted on 19 adults (9 male and 10 female) and one sub-adults. Whenever a Spotted or Barking deer was required, it was collected by netting by a group of expert people. Tracking commenced after a 1-2 day recovery period, generally at the end of total counting session. Before collar attachment, the animals were measured and ear-tagged.

(b)Tracking Procedure

To enable accurate location of tracker position in the study grids, 20mx20m spacing peg site locations were marked by 4m high Muli bamboo with red marking tape at the top. The locations of the fixes were determined by a handheld compass bearing from two reference points, and then plotting on the map. Inside the grid, the peg stations acted as fixed position .

Radio-signals always peak along the line of the boom, with shortest element (director) towards the signal source. There is a smaller peak in the reverse direction and relatively small peaks to the sides. During the present tracking study, the hand held antenna was held in a horizontal position at the nearest peg location and then turned in a circle slowly and stopped when the signal null was found. The bearings were taken by a hand held compass and in night using a hand torch light, aligning with antenna direction. The data were recorded on the radiotracking field sheet with grid position and time. A bearing was recorded from one peripheral point, together with the strength of the signal, and whether it was fluctuating, and then another bearing was taken as soon as possible from a second peripheral grid point, chosen so that the angle between two bearings was + 900.

The present radio-tracking session were more or less discontinuous and no definite interval was followed as Barking and Spotted deer are restless animal and during the rutting and breeding season especially the males moved fast, and covered a long distance very quickly sometimes the tagged animals were attacked or drive by predator animals, then they were moving fast. When the animals were moving fast, then up to 5-10 minute interval tracking was done on the basis of signal strength. When the animals were more or less static, 30-60 minute intervals were used.

During the present study, a distance of 20-40 m was maintained between the trackers and the radio-tagged animals to keep the radio-collared animal undisturbed. In some cases the animals unexpectedly came close to the tracker (upto 10-15m) and then the volume of signal was immediately reduce, because the high signal sound disturbed the tracked animals.

Sometimes in the dense bush or on the sloping ground it was difficult to receive a signal from the hidden radio-tagged animals, by raising the receiving antenna up to 3-4m above the ground, it was possible to double reception range.

(c) Removal of collar

Most radio-tagged Barking and Spotted deer were recaptured in normal grid by net trapping and driving and the radio-collars were removed at the end of tracking period (180-200 days) . If the radio-tagged animals went outside the grid, 5-10 expert Forest Guards were placed in a semi-circular pattern around the hiding (or escape) bedding place immediately after detection by radio-tracking gear. In 50-60% cases it was possible to recapture the radio-tagged animals. During the present study only 6 radiotracked animals were not recovered.

5.3.7 Method of analysis

Activity and movement pattern of the radio-tagged animal were determined by plotting the radio-locations on graph paper and a grid co-ordinate map using the compass bearing as the reference point. Location of fixes for each animal were transferred to a scaled diagram of the grid by plotting the compass bearings. When the animals moved outside the grid or where the grid reference pegs were not visible at night, locations were recorded by putting new peg with red flag and with the help of Garmin GPS with the date and time. The following morning the distance of these fixes was measured with measuring tape along with a compass bearing from the nearest grid reference peg. In some cases, Garmin GPS was used to know exact location of the animal. A specific x, y co-ordinate value on the basis of the scale were determined. Location fixes for some resident animals were plotted month-wise separately.

After plotting all fixes of a particular animal, the x, y value put into the Text file of Microsoft excel of Macintosh computer and the radio-tracking home range (RTHR) estimated using the ANTELOPE program (Bradbury and Vehrencamp,1993).

Radio tagged male (M 235) Spotted Deer at the grid-2 in the SRF

Table - 22 : Summary of radio-tracking home range (RTHR) estimates of the Spotted Deer in the Sundarbans Reserved Forest during the entire study period using the Program ANTELOPE.

Species I.D.No.	Sex	Tracking period	No. of fixes	RTHR by MCP method (at 95% confidence) in hectares	RTHR by Elliptical method (at 95% map value) in hectares	RTHR by Andersen Fourier method (at 95% confidence) in hectares	RTHR by HMM method (at 95% isopleth's) in hectares
168	M	13 Jul- 01 Jun-2001	322	312.44	279.12	291.51	377.28
204	F	13 Jan - 02 May-2001	221	189.51	141.77	161.79	215.19
230	F	09 Mar - 12 Jul-2001	175	165.41	133.51	147.91	191.52
235	M	09 Mar-10 Oct-2001	144	291.55	242.17	259.22	315.21
238	M	28 Apr-13 Sep-2001	130	371.03	282.72	318.57	419.22
254	F	28 Apr -10 Dec-2001	119	141.51	127.54	139.50	172.41
260	M	14 Jan -18 Dec-2001	122	299.42	237.68	261.91	365.19
Male average home range size (ha)				x = 318.61	x = 260.42	x = 282.80	x = 369.22
Female average home range size (ha)				x = 165.47	x = 134.27	x = 149.73	x = 193.04

Table- 23: Summary of radio-tracking home range (RTHR) estimates of the Barking Deer in the Sundarbans Reserved Forest during the entire study period using the Program ANTELOPE.

Species I.D.No.	Sex	Tracking period	No. of fixes	RTHR by MCP method (at 95% confidence) in hectares	RTHR by Elliptical method (at 95% map value) in hectares	RTHR by Andersen Fourier method (at 95% confidence) in hectares	RTHR by HMM method (at 95% isopleth's) in hectares
697	M	20 Jan - 22 May, 01	222	112.32	77.87	86.15	151.39
698	F	20 Jan - 29 Mar, 01	198	92.71	62.13	79.12	118.73
699	F	22 Feb-14 Jun, 01	162	87.41	53.71	67.39	112.31
Male average RTHR (ha)				x = 112.32	x = 77.87	x = 86.55	x = 151.39
Female average RTHR (ha)				x = 90.31	x = 57.92	x = 73.25	x = 115.52

The program ANTELOPE

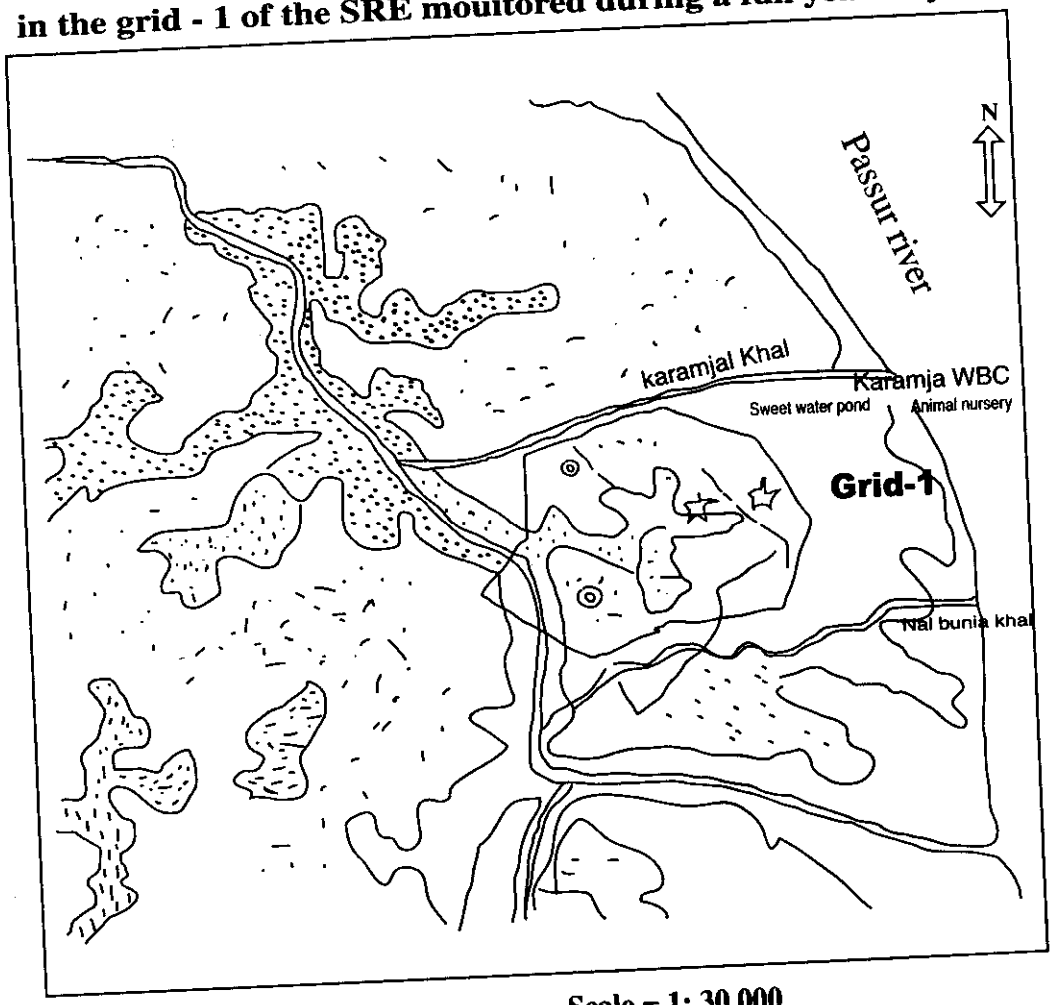
ANTELOPE is a program which accepts data files of x, y co-ordinates and perfonns a number of standard statistical or graphical analyses on them. The radiotracking home ranges (RTHR) were calculated using the following four models:

(i) Minimum convex polygon (MCP) model. (ii) Elliptical home range model

(iii) Anderson Fourier home range model.

(iv) Harmonic mean measure of animal activity area (HMM) model. (I) Minimum convex polygon (MCP) model.

Home range of male (M168) and female (F204) Spotted Deer in the grid - 1 of the SRE mouitored during a full year`s cycle.

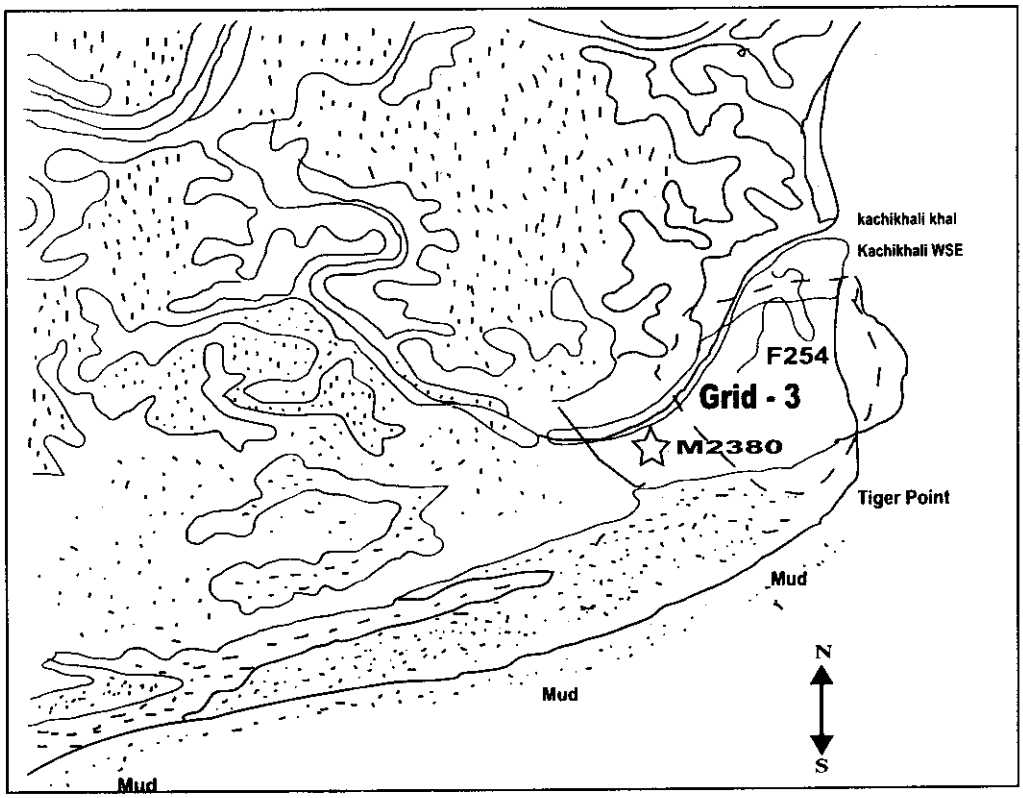


Scale = 1: 30,000

Legend

- Sundri- Pashur
- Sundri- Pashur- Kankra
- Sundri
- Submerged open grassland
- Radio location
- Khal
- Forest Office
- Home ranges of male (M 168)
- Home ranges of female (F 204)
- Permanemt bedding site
- Temporary bedding site

Home range of male (M238) and female (F254) Spotted Deer in the grid -3 of the SER monitored during a full year`s cycle.



Legend **Scale = 1: 30,000**

Sundri- Gewa	Khal
Gewa	Forest Office
Open grassland	Home ranges of male (M 238)
Keora	Home ranges of female (F 254)
Gewa - Sundri	Permanemt bedding site
Mud flat	Temporary bedding site
	Redio location

4.3.8 Habitat preferences

Frequency of occurrence of radiolocation were used to determine habitat preference. The data were split in to daytime (06:00-17:59) and nighttime locations (18:00-05:59) because of the tendency of animals to move into more open area during the evening and night.

Between cool dry season and hot summer season, marked phonological changes occur in the grasslands as a result of cutting and burning of winter grasses. Habitat selection within individual home ranges was also tested by comparing the frequency of location in the different habitat types with the habitat analysis only location where animals were either seen or were located by triangulation with the longest side of the triangle <200 m were used.

5.4 OBSERVATION AND RESULTS

5.4.1 Radio-tracking home range (RTHR) of the Spotted Deer

The RTHR of 8 (eight) Spotted Deer in Grid-I, 2, 3 and 4 in the SRF in were estimated on the basis of radio- tracking data by four different methods using the program ANTELOPE. The results of RTHR estimation of Spotted Deer in the SRF by the four different methods are presented in Table-22. The RTHR estimates for the Spotted Deer varied considerably in different methods. The home range of the Spotted Deer varied with sex, season and population density. The radio-tracking home range (RTHR) of both the sexes remained more or less the same 140-200 ha during the non-breeding season (December-January). The home range of the male increased to 295 to 410 ha during the peak-breeding season (August-September), which was about two times larger than that of the non-breeding season. The home range of the female during the breeding season varied from 150 to 200 ha which was 1.5 times larger than that of the non-breeding season.

The RTHR by HMM (Harmonic Mean Measure) method at 95% isopleths and RTHR by MCP (Minimum Convex Polygon) gave more or less the same home range estimates and the differences were less than 12%. The home range overlaps between the sexes were limited during the non-breeding period but increased during the breeding period.

A male shared a home range with 4 to 5 females during the rutting period. The female-female home range overlap was considerably less during the breeding and non breeding period as they were non-territorial in nature.

5.4.2 RTHR of the Barking Deer

A total of 3 (Three) Barking Deer radio-tagged in the SRF. The mean R THR estimates of these animals were compiled both the sexes during the breeding and non-breeding season by the presented in the Table-23.

In the SRF home range of Barking Deer varied with sex, season and population density. The radio-tracking home range (RTHR) of both sexes remained more or less the same (60-90 ha) during the non-breeding season (November-February). The home range of the

male increased to 140-170 ha during the rutting period, which is about two larger than in the non-breeding season. The home range of the female during the breeding season varied from 90-120 ha which was 1.25 times larger than that of the non-breeding season. The RTHR by the HMM (Harmonic Mean Measure) method at 95% isopleths and RTHR by the MCP (Minimum Convex Polygon) gave more or less the same home range estimates, and the differences were less than 18%. The home range overlaps between sexes were limited during the non-breeding period but increased during the breeding period. A male shared a home range with 2 to 3 females during the rutting period. The female-female home range overlap was considerably less during both the breeding and non-breeding seasons as they were non-territorial in nature. The area traveled during the day (early morning to late evening) was about 22% of the total night traveling distance.

5.4.3 Habitat preference and home ranges of Spotted Deer in the Sundarban

Both females and males were sedentary, with a large degree of range overlap between seasons as shown by the 2 females and 2 males from the same area. Mean total home range overlap for females ranged from 49-72%. For males, the total home range overlap ranged from 60 to 86%. Females had all their seasonal occupancy center within 200 m of each other in monsoon occupancy center 965 m from that in the winter season. Male M 168 had the longest distance between harmonic mean centers, with monsoon center 1258 m from the summer season center. These entire occupancy centers were located in Keora-Gewa forest with less than 100 m of the forest edge.

In the grid-3, the Keora- Gewa open grassland was a preferred habitat types for both sexes (M236 and F254) during the winter and summer season. The use of open grassland peaked in April when 57% of radio-locations were in this habitat.

Both females and males used Sundri-Gewa, Gewa-Keora, Goran-Gewa and Keora forest preferentially during day in the monsoon and summer.

Preference for Sundri-Gewa/ Goran-Gewa forest increased during the monsoon to a peak in July, where 76.2% of the daytime radio locations were in this habitat, because of the high mount (Killah) and suitable resting place in monsoon. They took shelter on this high mounts during the high tide.

Grassland was used preferentially by females at night during the pre-monsoon and monsoon. Males used grassland as expected in this period. Lumping males and females

Although both the sexes preferred forested habitat throughout the year, males were more associated with forests than females, the grownup males like to hide themselves in the dense forest and they occasionally come out of the forest at daytime.

Generally, the Spotted Deer made little further selection within their individual home ranges. Females used grassland pertains of their home ranges less than expected in the cool winter and the monsoon. The pure Sundri and Gewa forest and Goran forest were used less than expected in the hot summer season.

CHAPTER - 6

FOOD AND FOOD HABITS ANALYSIS

6.1. Introduction

Food availability is one of the most important factors influencing the distribution of free ranging wild ungulates and hence formulation of management strategy for a protected area necessarily requires adequate information on the food habits of different species deer (Chamrad and Box 1964; Fitzgerald and Waddington 1979; Holechek et al. 1982; Gill et al. 1983).. Equally important for sound management is the information on spatiotemporal variation in food availability, possibility of competition for certain food resources and hence food regulating the population.

Grasslands in the Southern part (Kachikhali, Katka, Nilkamal and Mandarbaria) of the SRF provide important foraging habitats for many native ungulates. Spotted Deer (Cervus axis Erxleben), congregate on that grassland after cutting and burning. Spotted Deer, the most abundant herbivore with estimated densities exceeding 100-150/ sq. km can be is classified as an intermediate feeding on a mixture of browse and grass. Throughout the year the Spotted Deer and Barking Deer are mostly associated with forest habitats, but they do utilize grassland qpportunistically when high quality forage is available there (Mishra, 1982; Moe and Wegge, 1994).

Johnsingh and Sankar (1991) recorded the food plants of Spotted Deer and Sambar on Mundanthurai wildlife sanctuary in Tamil Nadu and found the Spotted Deer in total used 162 plant species: 51 trees, 23 shrubs and 29 creepers/climbers, and 59 species of herbs.

Food plants of deer in the SRF were not identified in the past studies. From the conservation aspect of view, to identify the present status and distribution of the food plants of the Spotted Deer and Barking Deer is very important.

6. 2 Study Area

The study area for the food and food habit analysis of the Spotted Deer and Barking Deer was the Sundarbans Reserved Forests. Most of the PGC, LTC units and grids were used for this purpose.

6.3 Material And Methods

During the present study the following material and methods was used as presented in the Table-24.

Table-24: Data recording material and methods

Description of measurement	Methods and materials used
Location	GPS (Ground Position Survey) and Field maps
Vegetation type	ODA map, Sheet maps from direct observation within 50.m. radius (In case o the SRF)
Vegetation cover	Ocular estimate of percent cover by dominant and co-dominant species and with the help of ODA maps
Food plant species identification	Direct observation of he grazed and browsed plants and also laboratory identification of the unknown plants with the help of the National Herbarium experts
Experimental plot length	Chain and Tape (50m.)

6.3.1 Data collection

The food and food habit analysis was done only in the SRF both in free-ranging and captive condition. In captivity at the Karamjal WBC, different types of plants including their leaves, fruits and flowers were allowed to eat by the Spotted Deer and Barking Deer. In wild situation, the selected food plants of the Spotted Deer and Barking Deer were recorded by observing the plants and its parts eaten or browsed. Especially in forest condition the common deer tracks were selected for close observation following the deer movement. For unknown herbs and shrubs the plants including leaves, fruits and flowers were collected for laboratory identification with the help of the National Herbarium experts.

6.4. OBSERVATION AND RESULTS

6.4.1 Food and food plants in the SRF

Food and food plants of the Spotted Deer and the Barking Deer were recorded between the January/2001 and December/2002. A flora list has been made on the basis of palatability of the plant part like leaves, flower, fruits, bark, shoot, seedling and pnuematophores etc and presented in the Table-25.

Deer browsed Bean seedlings at the forest floor of the SRF

Deer browsed Kankra seedling at the forest floor of the SRF

Table - 25 : Food plants of the Spotted Deer and Barking Deer in the Sundarban

Plant parts: L= Leaves, S= stem, fl = Flowers, fr = Fruits, bk = Bark, s= Shoot, sl = Seedling, p= Pneumatophores

SL. no.	Plant species	Comon name of the plants	Spotted Deer	Barking Deer
	A. TREES:			
1.	*Sonneratia apetala* Ham.	Keora	L, fr, fl, p	L, fr, fl
2.	*Sonneratia caseolaris* Engl.	Chaila	L, fr, fl	L,fr,fl
3.	*Bruguiera gymnorhiza* Linn.	Kankra	L, fr, fl, sl	L, fr, fl, sl
4.	*Bruguiera parviflora* W & A.	Bhatlati	L, fr, fl, sl	L, fr, fl, sl
5.	*Avicennia alba* Bl.	Sada baen	L, fr, sl	L, fr, sl
6.	*Avicennia offidnalis* Linn.	Baen	L, fr, sl	L, rf, sl
7.	*Avicennia marina* Vieh.	Marisa baen	L, sl	L, sl
8.	*Xylocarpus mekongensis*	Passur	L, fr, sl	L, sl
9.	*Xylocarpus granatum* Koenig	Dhundal	L, fr, sl	L, sl
10.	*Amoora cucullata* Roxb.	Amur	L, fr, sl	L, sl
11.	*Lumnitzera racemosa* Willd.	Kirpa	L, fr,	L,fr
12.	*Rhizophora mucronata* Lam.	Garjan	L, fr,	L,fr
13.	*Aegialitis rotundifolia* Roxb.	Dhalchaka	L	L
14.	*Barringtonia racemosa* Spreng.	Kumba	L	L
15.	*Cerbera manghas* Linn.	Dagor	L	L
16.	*Eugenia fruticosa* Roxb.	Banjam	L, fr,	-
17.	*Pongamia pinnata* Merr.	Karanja	L	L
18.	*Kandelia candel* Druce.	Gura	L, fr,	L,fr
19.	*Salada chinensis* Dc.	Choytbarai	L	L
20.	*Thespesia populnea* Sol.	Parash	L	L

SL. no.	Plant species	Comon name of the plants	Spotted Deer	Barking Deer
	B. SHRUBS			
1.	*Aegiceras corniculatum* (L.) Blanco	Khalisha	L, fr	L
2.	*Caesalpinia crista* Linn.	Kutum Kanta	L	L
3.	*Caesalpinia nuga* Linn.	Shingrilata	L	L
4.	*Ceriops decandra* Ding.	Goran	sl, s	sl, s
5.	*Drypetes roxburghii* Hur.	Achet	L	L
6.	*Fluggea virosa* BI.	Sitka	L, s	L, s
7.	*Ipomoea pescaprae* R.Br.	Chagalkuri	s	s
8.	*Mallotus repandus* Muel.	Bonnotoy	L	L
9.	*Nypa fruticans* van Wurmb.	Golpata	sl,	s sl, s
10.	*Premna corymbosa* Roxb.	Setpoli	L, s	L, s
11.	*Premna mucro nata* Roxb.	Setpoli	L	L
12.	*Petunga roxburghii* Roxb.	arikili	s	s

C. CLIMBERS/ CREEPERS

1.	*Thumbergia grandiflora*	Jarmanilata	L, s	L,s
2.	*Derris trifoliata*	Kalilata	s	s
3.	*Derris scandens*	Noalata	L, s	L, s
4.	*Sarcolobus globosus*	Bawalilata	L, s	L, s
5.	*Flagellaria indica*	Abeta	L, s	L, s
6.	*Dalbergia spinosa*	Chanda kanta	L, s	L, s
7.	*Tetrastigma bracteolatum*	Golgotilata	L	L
8.	*Finlaysonia*	-	L, s	L, s
9.	*Sarcolobus carinatus*	Bowlilata	L, s	L, s

D. HERBS/ SEDGES

1.	*Imparata cylindrica*	Sungrass	L	L
2.	*Cynodon dactylon* Pers.	Durba ghas	L,S	L.S
3.	*Panicum repens* Linn.	Banda	L,S	L.S
4.	*Myriostachya wightiana* Hook	Dhanshi	L, S	L, S
5.	*Eriocloa procera* Hubb.	Nolghas	L	L
6.	*Fimbristylis polytrichoides*	-	L,S	L,S
7.	*Cyperus javanicus* Hout.	Malay	L,S	L, S
8.	*Cyperus cyperides* Kuntz.	Kusa	L	L
9.	*Cyperus procerus* Roxb.	-	L	L
10.	*Cyperus orientalis*	-	L	L

11.	*Phragmites karka*	Nolkhagra	L	L
12.	*Typha elephantiana*	Hogla	L	L
13.	*Cyperus exaltatus* Retz	-	L, S	L, S
14.	*Cyperus jukkubga*	-	L, S	L,S
15.	*Oryza rufipogon* Griff.	Bonodhan	L, S	L, S
16.	*Panicum paludosum*	Barati	L	L
17.	*Chrysopogon aciculatus* Trin.	Badaya	L,S	L,S
18.	*Desmostachia bipinata* Stilpf.	Kusha	L, S	L, S
19.	*Saccharum spontaneum* Linn.	Kash	L	L
20.	*Saccharum bengalense* Retz.	Munjaghas	L, S	L, S
21.	*Vetiveria zizanioides* Hash.	Bena	L, S	L,S
22.	*Potersia coarctata* Tak.	-	L, S	L, S
23.	*Arundo donix* Linn.	Gabanal	L,S	L, S
24.	*Cymbopogan nardus* Rendle.	-	L, S	L,S
25.	*Cymbopogan citratus* Stapf.	-	L, S	L, S
26.	*Bothriochloa intermedia* A. Camus.	-	L, S	L, S
27.	*Leptochloa chinensis*	-	L, S	L, S
28.	*Leetsia hexandra* Sw.	Arali	L, S	L, S
29.	*Aerva lanata* Juss.	Chaya	L, S	L, S
30.	*Hoya parasitica* Wall.	Pargacha	L,S	L, S
31.	*Heliotropium curassavicum* Linn.	Hatisur	L, S	L, S
32.	*Fimbristylis halophila* Linn.	-	L, S	L, S
33.	*Fimbristylis sub-bispicata* Fees.	-	L,S	L, S
34.	*Erythrea roxburghii* G. Don.	Gima	L,S	L,S
35.	*Tribulus tristis* Linn.	Gokhru	L, S	L, S
36.	*Suaeda maritima* Dumort.	-	L, S	L, S
37.	*Vigna loteola* Benth.	-	L, S	L, S
38.	*Hydrophilla plomoides* Nees.	-	L,S	L, S
39.	*Polycarpaea corymbosa* Lamk.	-	L, S	L, S
40.	*Solanum trilobatum* Linn.	-	L, S	L,S
41.	*Solanum surattensis* Burm.	-	L, S	L, S
42.	*Crataeva roxburghii* R. Br.	-	L,S	L, S
43.	*Narenga porphyrocoma*	-	L, S	L,S
44.	*Flocourtia indica* Merr.	-	L, S	L, S

The result shows that the Spotted deer and Barking Deer feed on 20 trees, 12 shrubs, 9 creepers/climbers and 44 herbs/ grasses. Among the trees the most palatable species were Keora *(Sonneratia apetala)*, Chaila (*Sonneratia caseolaris*), Kankra (*Bruguiera gymnorrhiza*), Baen (*Avicennia officinalis*) etc. Among the shrubs most palatable species were Khalisha (*Aegiceras corniculatum*), Kutum kanta (*Caesalpinia crista*) and seeding of Goran (*Ceriops decandra*) etc. Among the climbers most palatable species were Jarmanilata (*Thumbergia grandiflora*), Kalilota *(Derris trifbliata*) and Bowlilota (*Sarcolobus globosus*) etc. Among the herbs, the most important herbs were *Imperata. cylindrica, Cynodon dactylon, Panicum repens, Myristachya wightiana, Eriocloa pro cera, Cyperus javanicus etc.*

The field observation record shows that the Barking Deer preferred dense vegetation in tropical wet evergreen and Fresh water mangrove forest, and they are mixed feeder (browser and grazer). The Spotted Deer preferred Keora dominated mangrove forest and grassland, and they are also mixed feeder (browser grazer).

Rubbing injuries to a Baen tree by a buck Spotted Deer

A pair of young Spotted Deer in the Keora Forest (Photo Rubaiyat & Elisabeth Mansur)

CHAPTER-7

DEER CONSERVATION STATUS AND MITIGATION MEASURES

7.1 Deer Conservation Status

The shooting and killing of deer continued until the end of 1972, even though they have been declared as endangered and threatened animals by the IUCN. The Bangladesh Wildlife Preservation Ordinance was promulgated in 1973 and amended in 1974 to become the Bangladesh Wildlife (preservation) (amended) Act 1974 (Gani 2002). But there are hundreds of forest cases regardin~ illegal hunting, poaching and shooting of the Spotted Deer and Barking Deer throughout the country. The problem on the protection and preservation of the deer resources in the SRF is execrated by a number of factors that include rampant poaching, uncontrolled gathering of forest products and fishing, and natural disaster like severe storms or cyclones which destroy wildlife habitats and kill a considerable number of wildlife including deer. This problem is very serious in the SRF and coastal areas.

Cervid deer populations generally appear to have considerable resilience. In spite of human pressures, poaching and illegal hunting of the Spotted Deer population in the SRF, the status of the species still not threatened. Fishing and fishermen villages in the southern part of the SRF is also a conservation threat. The past offence records showed that illegal hunters and poachers are mixed with the fishermen, and they used drop net for hunting. The present study will be the bench mark for future conservation aspects and scientific study.

Poaching is a regular practice in the SRF except few places for longtime. Forest Department is trying hard to stop poaching. Especially Ganpara is a well known village near the Patharghata Upazilla under the Barguna district at the southeast comer of the SRF. This village community possesses lethal weapons, illegal fire arms and drop nets for hunting deer. Most of the poaching occur in the monsoon period and they frequently used drop nets. The main mode of the transport was engine boats and trawlers.

Ecological changes like increase of the salinity, vegetation and hydrological changes, Sundri top dying etc are also main conservation threats in the SRF.

7.2 Mitigation Measures

The following mitigation measures should be taken for the conservation of the Spotted Deer and the Barking Deer in the SRF:

i) establishment of strict protection management zone to be developed in the potential deer habitats in which all forms of extractive activities shall be totally banned/prohibited.

ii) strict enforcement of laws, rules and regulations with all logistic supports, staffing, fast moving vessels and field equipment with well equipped guards.

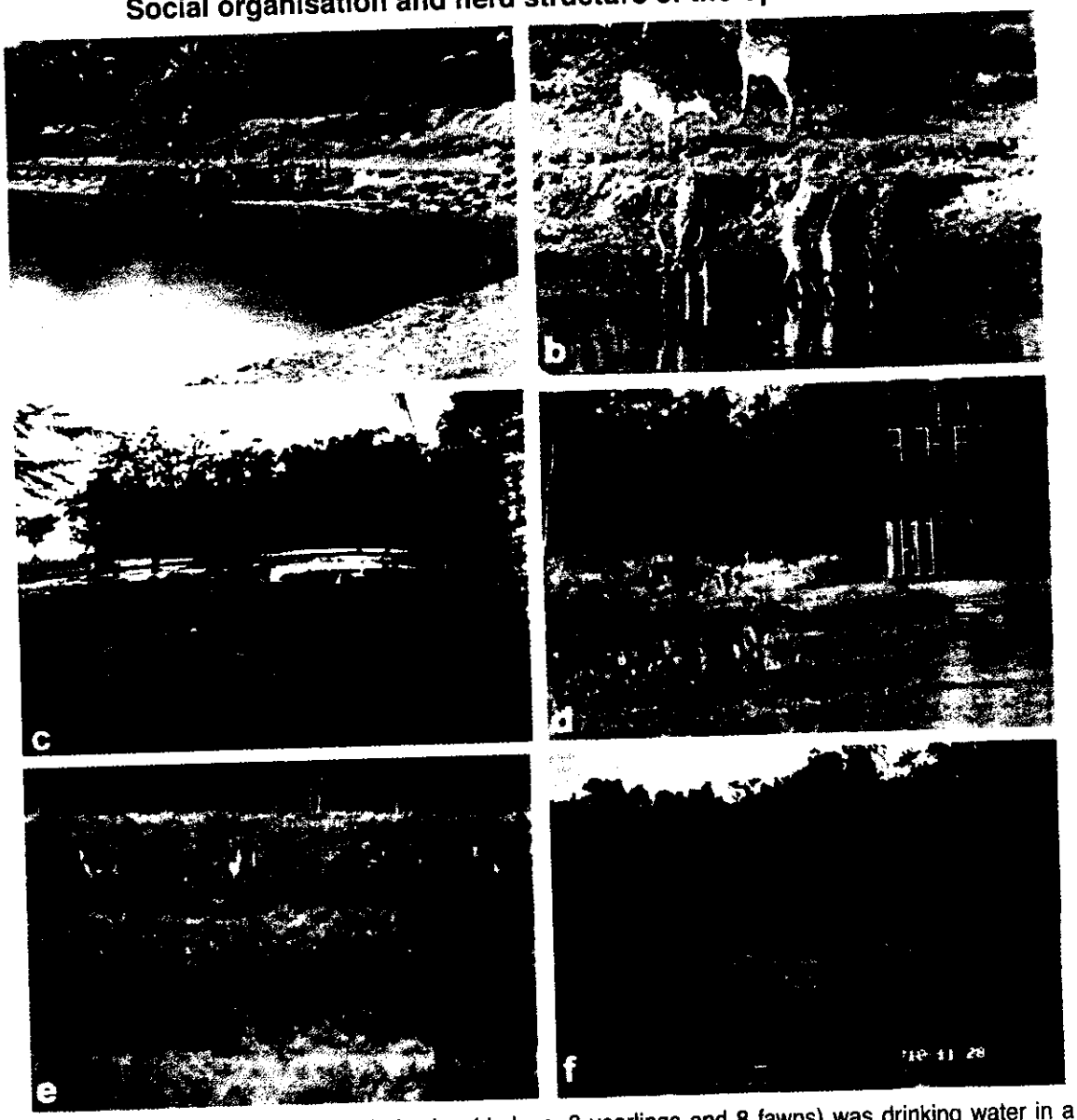
iii) construction of Killas on strategic potential deer habitats.

Bhawali Boats with Golpata *(Nypa fruticans)*

Local fisherman paddle their sailing boats (Dingi) at the Sundarban Delta (Photo – Sundarbans National Park and Tiger Reserve, West Bengal, India)

Keora *(Sonneratia apetala)* forest at Nilkamal WSC

Social organisation and herd structure of the Spotted Deer



a. A herd consisting of 30 deer (4 bucks, 11 does, 8 yearlings and 8 fawns) was drinking water in a sweet water pond at the Katka WSC
b. A herd consisting 6 deer (2 bucks, 2 does, 1 yearling and 1 fawn) was drinking water in a sweet water pond at the Nilkamal WSC
c. A herd of 42 deer (6 bucks, 19 does 10 yearlings and 7 fawns) was foraging with Keora leaves at the Katka Rest House premises
d. A heard of 18 deer (3 bucks, 9 does, 3 yearlings and 3 fawns) was grazing at the Jamtola Tower area
e. A herd of Spotted Deer become alert due to tiger call at the Kachikhali WSC.
f. A herd of 5 deer is grazing at the Nilkamal Keora-Suti area.

iv) construction of sweet water ponds for deer 011 strategic places.

v) grass cutting should be allowed on permit basis in the all wildlife sanctuary areas.

vi) at the end of grass cutting operation the refuges of the dry plant material should be burnt for rapid regeneration of new shoot and sprouting.

vii) illigal hunting and poaching in the fishermen villages in the southern part of the SRF should be stopped immediately.

viii) frequent entry of the unauthorized water vessels (trawlers, engine boats, speed boats and boats) inside the SRF is to be stopped.

ix) more sweet water ponds and holes to be excavated especially in the strong saline zones of the Khulna and Satkhira Range.

x) collaborative captive breeding program for the endangered Barking Deer can be taken for re- introduction in the SRF.

xi) local law and enforcing agencies like police, coastguard and naval forces to be included in the anti-poaching program.

xii) alternative job opportunities for the local poachers communities and fishermen to be created engaging as game guard on master roll basis before the permanent guard commenced his duties,

xiii) staffing levels to be increased.

xiv) communication system and equipments supply to be improved.

xv) community based wildlife conservation education program in response to human encroachment and poaching to be developed.

xvi) strengthening anti-poaching program.

xvii) all categories of fire arms in and around the SRF are to withdrawn immediately. xviii) long-term ecological studies to be initiated to determine conservation requirements. xix) continuous monitoring and research program to be developed.

xx) logging to be stopped in the deer habitats.

xxi) appropriate training opportunities for the field staffs and administrators to be developed.

xxii) contracting a mobile game guard to patrol the whole hinterland with close contract with local people.

xxiii) establishment of one animal clinic near the Mongla port.

xxiv) regular monitoring and recording deer sighting in the WSC.

xxv) habitat enhancement through enrichment planting.

xxvi) development of community participation in conservation activities through community education program.

A 50 meters long drop-net was seized by the Forest Department staffs from the poachers in the Katka WSC

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Appendix- I : List of flora of the Sundarbans Reserve Forest

Scientific Name	Local Name	Family	Type of Plant
Acanthus ilicifolius	Hargoza	Acanthaceae	Thorny shurb
Acrostichum aureum	Hoda, Hodo, Tiger fern	Pteridiaceae	Gregarious fern
Aegialitis rotundifolia	Dhalchaka/Sitali	Plumbaginaceae	Small tree
Aegiceras corniculatum (*A. majus*)	Khalisha	Myrsinaceae	Shrub of small tree
Amoora cuculata	Amur	Meliaceae	Small tree
Avicennia alba	Sadda baen	Avicenniaceae	Small tree
Avicennia marina	Mairsa baen	Avicenniaceae	Medium tree
Avicennia officinalis	Baen, Bara baen	Avicenniaceae	Medium tree
Barringtonia racemosa	Sumundraphal, Kumia	Lecythidaceae	Small or medium tree
Blumea lacera	Barakukshima	Compositae	Aromatic herb
Bouca burnancia	Muriam	Anacardiaceae	Small tree
Brownlowia tersa (*B. lanceolata*) Lota Sundri	Sundri lata	Tiliaceae	Scandent shrub
Bruguiera gymnorhiza	Kankra	Rhizophoraceae	Small to medium tree
Bruguiera parviflora	Bhat lati	Rhizophoraceae	Small tree
Bruguiera sexangula	Kankra	Rhizophoraceae	Small to medium tree
Caesalpinia crista	Kutum kanta	Leguminosae	Scandent, armed shrub
Caesalpinia nuga	Shingrilata, Letkanta	Leguminosae	Shrub
Cassia fistula (introduced)	Sonalo	Leguminosae	Medium tree
Cerbera manghas	Dagor, Dakur	Apocynaceae	Small tree
Ceriops decandra	Goran	Rhizophoraceae	Shrub or small tree
Clerodendrum inerme	Bhat, sitki, Banjui	Verbenaceae	Scandent shrub
Cynometra ramiflora	Shingra	Leguminosae	Shrub or small tree
Cyperus javanicus	Melay, Kusha	Cyperaceae	Grass like (sedge)
Dalbergia candenatensis	Canda lata	Leguminosae	Climbing shrub
Dalbergia spinosa	Kalilota, Chanda lata	Leguminosae	Scandent, armed shrub
Dendrophthoe falcata	Pargacha	Leguminosae	Woody parasite in the crown
Derris scandens	Noalata	Leguminosae	Large climber

Derris trifoliata (D. uliginosa)	Ghila lata, Gawalialota Pan lata	Leguminosae	Climber
Derris sinuata	Mahajanilata	Leguminosae	Climber
Disopyros peregrina	Gab	Ebenaceae	Tree found in formally inhabited areas.
Drypetes sp.	Achet	Euphorbiaceae	Scandent shrub
Eriochloa procera	Nol gash	Graminae	Grass
Eugenia fruticosa	Ban jam	Myrtaceae	Small tree
Excoecaria agallocha	Gewa	Euphorbiaceae	Medium tree
Excoecaria indica	Batla, Batul	Euphorbiaceae	Small tree
Ficus microcarp	Jir	Moraceae	Medium tree
Fimbristylis polytrichoides	-	Cyperaceae	Grass
Flagellara indica	Abethi, Banschand	Flagellariaceae	Climber
Flueggea virosa	Sitka, Sitki	Euphorbiaceae	Scandent shrub
Heritiera fomes	Sundari	Sterculiaceae	Tall tree
Hibiscus tilliaceous	Bhola	Malvaceae	Shrub
Holarrhena antidysenterica	Kuruz, Kurchi	Apocynaceae	Shrub
Hoya parasitica	Agacha, Pargacha	Asclepiadaceae	Climber
Imperata cylindrica	Ulu, Sungrass	Graminae	Grass
Intsia bijuga	Bhaela, bharal	Leguminosae	Small tree
Ipomoea pes-caprae	Chogalkuri	Convolvulaceae	Succulent,prostrate shrub
Ixora undullata	Bon bakul,Palakajui	Rubiaceae	Shrub
Kandelia candel	Gura, Gurae, Gurul	Rhizophoraceae	Small tree
Leea aequata	Kakjangha	Leeaceae	Shrub
Lepisanthes rubiginosa	Bon lichu, Nush	Sapindaceae	Small tree
Luminitzera racemosa	Kirpa, Kripa	Sapindaceae	Small tree
Lycopodium phlegmaria	-	Lycopodiaceae	Epiphytic Pteridophyte
Macrosolen cochinchinesis	Pargacha	Loranthaceae	Woody parasite in the crowns
Mallotus repandus	Bon notoy, Gunti	Euphorbiaceae	Scandent shrub
Mucuna gigantea	Doyal, Alkusi	Leguminosae	Climber, large seed pods have irritant hairs
Myriostachya wightiana	Dhanshi	Graminae	Grass, common on new accretion

Nypa fruticans	Golpatta	Palmae	Palm with underground steam
Oryza coaractata	Harkata, Dhanshi	Gramineae	Grass
Pandanus foetidus	Kewakatta	Pandanaceae	Prickly, Succulent Screw-pine
Paramignya citrifolia	Ban lebu	Rubiaceae	Shrub
Petunga roxburghii	Narikili, Jhijir	Rubiaceae	Small tree or shurb
Phoenix paludosa	Hantal	Palmae	Thorny palm
Phragmites karka	Nolkhagra	Graminae	Grass
Pongamia pinnata	Karanj, Karanja	Leguminosae	Small to medium tree
Premna corymbosa	Serpoli, Setpoli	Verbenaceae	Shrub or small tree
Rhizophora apiculata	Khamo, Bhara	Rhizophoraceae	Tree
Rhizophora mucronata	Garjan, Jhaanna	Rhizophoraceae	Tree with still roots
Saccharum spontaneum	Kash, khag, Kaicha	Gramineae	Tall Grass
Salacia shinesis	Choyt barai	Celastraceae	Small tree
Sarcolobus globosus	Bowli lota	Asclepiadaceae	Climber
Sonneratia apetala	Keora	Sonneratiaceae	Medium tree to tall tree
Sonneratia caseolaris	Choyla, Ora	Sonnertiaceae	Medium tree
Stenochlaena palustris	Dekilata	Blechnaceae	Climbing fern
Tamarix dioic (Acrostichum scandens)	Laljao	Tamaricaceae	Small tree
Tamarix indica	Nonajhao	Tamaricaceae	Small tree
Tetrastigna bracteolatum	Golgoti lata	Vitidiaceae	Climber
Thunbergia grandiflora	Jermani lata	Thunbergiaceae	Climber
Thespesia populnea	Parash	Malvaceae	Small tree
Typha elephantina	Hogla	Typhaceae	Tall herb
Viscum monoicum	Shamu lata	Loranthaceae	Woody parasite
Vitis lanata	Gode lata	Vitaceae	Climber
Xylocarpus granatum	Dhundul	Meliaceae	Samll tree
Xylocarpus mekongensis	Passur	Meliaceae	Medium tree

Source: Chaffey and Sandom, 1985; Prain,1903; Nasker and Bakshi, 1987; SBCP Documentation (Per. com)

Appendix-II : List of Mammals of the Sundarbans Reserved Forest

Common name	Scientific name	Order	IUCN Status
White taihed Shrew	*Suncus murinus*	Insectivora	NO
Flying Fox	*Pteropus giganteus*	Chiroptera	NO
Pipistrelle	*Pipitrellus coromandra*	Chiroptera	NO
Pygmy Pipistrelle	*Pipitrellus mimus*	Chiroptera	NO
Fulvous Fruit Bat	*Rousettus leschenaulti*	Chiroptera	NO
Shortnosed Fruit Bat	*Cynopterus sphinx*	Chiroptera	NO
False Vampire	*Megaderma lyra*	Chiroptera	NO
Lesser Rat-tailed Bat	*Rhinopma hardwickei*	Chiroptera	NO
Lesser Yellow Bat	*Scotophilus temminki*	Chiroptera	NO
Greater Yellow Bat	*S. heathi*	Chiroptera	NO
Yellow Bat	*S. luteus*	Chiroptera	NO
Tailess Leafnosed Bat	*Coelops frithi*	Chiroptera	NO
Rhesus Macaque	*Macaca mulatta*	Primate	VV
Bengal Tiger	*Panthera tigris*	Carnivora	EN
Fishing Cat	*Prionailurus viverrina*	Carnivora	NO
Jungle Cat	*Felis chaus*	Carnivora	EN
Jackal	*Canis aureus*	Carnivora	VU
Bengal Fox	*Vulpes bengalensis*	Carnivora	VV
Clawless Otter	*Aonyx cinerea*	Carnivora	EN
Smooth Indian Otter	*Lutra perspicillata*	Carnivora	EN
Large Indian Civet	*Viverra zibetha*	Carnivora	EN
Samll Indian Civet	*Viverricula indica*	Carnivora	VU
Common Plam Civet	*Paradoxurus harmaphorditus*	Carnivora	VU
Small Mongoose	*Herpestes auropunctatus*	Carnivora	NO
Common Mongoose	*Herpestes edwardsi*	Carnivora	VU
Spotted Deer	*Cervus axis*	Artiodactyla	NO
Wold Boar	*Sus scrofa*	Artiodactyla	NO
Barking Deer	*Muntiacus muntjac*	Artiodactyla	EN
Rufous tailed Hare	*Lepus nigricollis*	Langomorpha	EN
House Mouse	*Mus musculus*	Rodentia	NO
Common House	*Rat Rattus rattus*	Rodentia	NO
Fivestripped Palm Squirrel	*Funambulus pennanti*	Rodentia	NO
Indian Porcupine	*Hystrix indica*	Rodentia	NO
Lesser Bandicoot Rat	*Bandicota bengalensis*	Rodentia	NO

Farge Bandicoot Rat	*B. indica*	Rodentia	NO
Common Dolphin	*Delphinus delpins*	Cetacea	NO
Ganges River Dolphin	*Platanista gangetica*	Cetacea	EN
Malay Dolphin	*Stenella malayana*	Cetacea	EN
Plumbeous Dolphin	*Sotalia plumbea*	Cetacea	EN
Melon-headed Dolphin	*Peponocephala electra*	Cetacea	CR
Soft finned Pilot Whale	*Globicephala macrorhynchus*	Cetacea	EN
Little Porpoise	*Neophcaena phocaenoides*	Cetacea	EN

Source: Siddiqi, N. A. 2001; IUCN Bangladesh 2000 and field records during the present study.

IUCN Categories

EX-Extinct, CR-Critically Endangered, EN-Endangered, VU-Vulnerable, LR-Lower Risk, cd-Conservation Dependent, nt-Near Threatened, Ie-Least Concern, DD-Data Deficient, NO- Not Threatened

Appendix-III : List of Birds of the Sundarbans Reserved Forest

Common nante	Scientific name	Family	Present status as per IUCN
Masked Finfoot	*Heliopais personata*	Heliornithidae	EN
Little Grebe	*Podiceps ruficolis*	Podicipitidae	-
Little Cormorant	*Phalacrocorax niger*	Phalacrocoracidae	R
Great Cormorant	*Phalacrocorax carbo*	Phalacrocoracidae	R
Darter	*Anhinga rufa*	Phalacrocoracidae	VU
Indian Darter	*Anhinga melanogaster*	Phalacrocoracidae	
Grey Heron	*Ardea cinerea*	Ardeidae	R
Purple Heron	*Ardea purpurea*	Ardeidae	R
Little Green Heron	*Ardeola striatus*	Ardeidae	-
Pond Heron	*Ardeola grayii*	Ardeidae	R
Black Bittern	*Lxobrychus flavicollis*	Ardeidae	-
Black-crowed Night Heron	*Nycticorax nycticorax*	Ardeidae	R
Cattle Egret	*Bubulcus ibis*	Ardeidae	R
Little Egret	*Egretta garzetta*	Ardeidae	R
Intermediate Egret	*Egretta intermedia*	Ardeidae	R
Large Egret	*Egretta alba*	Ardeidae	R
Chestnut Bittern	*Ixobrychus cinnamometeus*	Ardeidae	-
Openbilled Stork	*Anastomas oscitans*	Ciconiidae	R
Painted Stork Ibis	*A. leucocephalus*	Coconiidae	-

Blacked-necked Stork	*Xenorhynchus asiaticus*	Coconiidae	R
Lesser Adjutant Stork	*Leptoptilos javanicus*	Ciconiidae	EN,R
White Ibis	*Threskiornis melanocephalus*	Threskiornithidae	EN,R
Barheaded Goose	*Anser indicus*	Anatidae	-
Pintail	*Anas acuta*	Anatidae	M
Spotbill Duck	*Anas poecilorhyncha*	Anatidae	-
Lesser Whisttling Teal	*Dendrocygria javanica*	Anatidae	-
Common Teal	*Anas crecca*	Anatidae	M
Gargany	*Anas querquedula*	Anatidae	-
Tufted Duck	*Authya fuligula*	Anatidae	M
Common Pochard	*Authya ferina*	Anatidae	M
Ruddy Shelduck	*Tadorna ferruginea*	Anatidae	M
Common Pochard	*Anas ferina*	Anatidae	M
Cotton Teal	*Nettapus coromandelianus*	Anatidae	M
Osprey	*Pandion haliaetus*	Anatidae	M
Blackwinged Kite	*Elanus caeruleus*	Accipitridae	-
Pariah Kite	*Milvus migrans*	Accipitridae	-
Brahminy Kite	*Haliaster indus*	Accipitridae	-
Blackeared Kite	*Milvus migrans lineatus*	Accipitridae	-
Shikra	*Accipter badius*	Accipitridae	-
Sparrow Hawk	*Accipter nisus*	Accipitridae	-
Crested Goshwk	*Accipter triciagatus*	Accipitridae	-
Honey Buzzard	*Pernis ptilorhynchus*	Accipitridae	-
Crested Serpent Eagle	*Spilornis cheela*	Accipitridae	-
Booted Hawk Eagle	*Heiraaetus pennatus*	Accipitridae	
Tawny Eagle	*Aquila rapax*	Accipitridae	-
Greater Spotted Eagle	*Aquila clanga*	Accipitridae	-
Lesser Spotted Eagle	*Aquila pomarina hastata*	Accipitridae	-
Black Eagle	*Ictinaetus malayensis*	Accipitridae	-
Whitebellied Sea- Eagle	*Haliaeetus leucogaster*	Accipitridae	EN
Pallas Fishing Eagle	*Haliaeetus leucoryphus*	Accipitridae	VU
Greyheaded Fishing Eagle	*Icnthyophaga ichthyaetus*	Accipitridae	-
Griffon Vulture	*Gyps fulvus*	Accipitridae	-
Whitebacked Vulture	*Gyps bengalensis*	Accipitridae	-
Kestrel	*Falo tinnunculus*	Accipitridae	-
Pale Harrier	*Citcus macrourus*	Accipitridae	-
Marsh Harrier	*Citcus aeruginosus*	Accipitridae	-

Red Jungle fowl	*Gallus gallus*	Phasianidae	-
Whitebreasted Water Hen	*Amourornis phoenicurus*	Rallidae	R
Water Cock	*Gallicrex cinerea*	Rallidae	-
Moorhen	*Gallinula chlopus*	Rallidae	-
Coot	*Fulica atra*	Rallidae	-
Bronze-winged Jacana	*Metapidius indicus*	Jacanidae	R
Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	Jacanidae	r
Oyster catcher	*Haematopodus ostralegus*	Haematopodidae	-
Redwatted Lapwing	*Vanellus indicus*	Charadriidae	-
Yellow-wattled Lapwing	*Vanellus malabaricus*	Charadriidae	-
Grey-headed Lapwing	*Vanellus cinerius*	Charadriidae	
Eastern Golden Plover	*Pluvialis fulva*	Charadriidae	-
Large Sand Plover	*Charadrius leschenaultii*	Charadriidae	-
Lesser Sand Plover	*Charadrius mongolus*	Charadriidae	-
Kentish Plover	*Charadrius alexandrinus*	Charadriidae	-
Little Ringed Plover	*Charadrius dubius*	Charadriidae	-
Great Stone Plover	*Esacus magnirostris*	Charadriidae	-
Whimbrel	*Numeneus phaeopus*	Charadriidae	M
Curlew	*Numeneus arquata*	Charadriidae	-
Stone Curlew	*Burhinus oedicnemus*	Charadriidae	-
Blacktailed Godwit	*Limosa limosa*	Charadriidae.	M
Common Redshank	*Tringa totanus*	Charadriidae	-
Greenshank	*Tringa nebularia*	Charadriidae	-
Common Sandpiper	*Tringa hypoleucos*	Charadriidae	-
Green Sandpiper	*Tringa ochropus*	Charadriidae	-
Marsh Sandpiper	*Tringa stagnatilis*	Charadriidae	-
Wood Sandpiper	*Tringa glareola*	Charadriidae	-
Turnestone	*Arenaria interpress*	Charadriidae	-
Curlew Sandpiper	*Calidris testacea*	Charadriidae	-
Sanderling	*Calidris alba*	Charadriidae	-
Little Stint	*Calidris minuta*	Charadriidae	M
Painted Snipe	*Gallinago steunura*	Charadriidae	-
Fantail Snipe	*Gallinago gallinago*	Charadriidae	-
Small Pratincole	*Glareola lactea*	Charadriidae	-
Herring Gull	*Lams argentatus*	Laridae	-
Great BlackheadedGull	*Lams ichthyaetus*	Laridae	-
Brownheaded Gull	*Lams burnnicephalus*	Laridae	-

Blackheaded Gull	*Lams ridibundus*	Laridae	-
Whiskered Tern	*Chlidonias hybrida*	Laridae	-
Little Tern	*Sterna albifrons*	Laridae	-
Blackbellied Tern	*Sterna acuticauda*	Laridae	-
Indian River Tern	*Sterna aurantia*	Laridae	-
Rosy Tern	*Sterna dougallii*	Laridae	-
Common Tern	*Sterna himndo*	Laridae	-
Gullbilled Tern	*Gelochelidon nilotica*	Laridae	-
Indian Skimmer	*Rynahops albicollis*	Laridae	EN
Green Imperial Pigeon	*Ducula aenea*	Columbidae	-
Blue Rock Pigeon	*Columba livia*	Columbidae	-
Yellowlegged Green Pigeon	*Treron phoenicoptera*	Columbidae	-
Imperial Pigeon	*Ducula badia*	Columbidae	-
Ring Dove	*Streptopelia decaocto*	Columbidae	-
Red Turtle Dove	*Streptopelia tranquebarica*	Columbidae	-
Spotted Dove	*Streptopelia cinensis*	Columbidae	-
Emerald Dove	*Chalophaps indica*	Columbidae	-
Roseringed Parakeet	*Psittacula krameri*	Psittacidae	-
Ried Crested Cockoo	*Clamator jacobinus*	Psittacidae	-
Indian Cuckoo	*Cuculus microptems*	Psittacidae	-
Brain Fever Bird	*Cuculus varius*	Psittacidae	-
Koel	*Eudynamys scolopacea*	Psittacidae	-
Large Greenbilled Malkoha	*Rhopodytes tristis*	Psittacidae	-
Crow Pheasant	*Centropus sinensis*	Psittacidae	-
Great Homed Owl.	*Babo bubo*	Strigidae	-
Barn Owl	*Tyto alba*	Strigidae	-
Jungle Owlet	*Glaucidium radiatum*	Strigidae	-
Brown Fish Owl	*Ketupa zeylonensis*	Strigidae	VU
Spotted Owlet	*Athena brama*	Strigidae	-
Common Indian Night jar	*Caprimulgus asiaticus*	Caprimulgidae	-
Langtailed Night jar	*Caprimulgus macrurus*	Caprimulgidae	-
Jungle Night jar	*Caprimulgus indicus*	Caprimulgidae	EN
Palm Swift	*Cypsiurus parvus*	Apodidae	-
Lesser Pied Kingfisher	*Ceryle rudis*	Alcedinidae	-
Common Kingfisher	*Alcedo atthis*	Alcedinidae	-
Brown-winged Kingfisher	*Pelargopsis amauroptera*	Alcedinidae	-
Storkbilled Kingfisher	*Pelargopsis capensis*	Alcedinidae	-

Ruddy Kingfisher	*Halcyon coromandra*	Alcedinidae	-
White-creasted Kingfisher	*Halcyon sinyrnensis*	Alcedinidae	-
Black-capped Kingfisher	*Halcyon pileata*	Alcedinidae	R
White-collared Kingfisher	*Halcyon chloris*	Alcedinidae	R
Green Bee-eater	*Merops orienta/is*	Meropidae	-
Chestnutheaded Bee-eater	*Merops leschenaulti*	Meropidae	-
Indian Roller	*Coracias benghalenisis*	Coraciidae	-
Hoopoe	*Ujpupa epops*	Upupidae	-
Lineated Barbet	*Megalamia /ineata*	Capitonidae	-
Coppersmit Barbet	*Megalaima haemacephala*	Capitonidae	-
Wryneck	*Junx torquilla*	Picidae	-
Large Yellownaped Woodpecdker	*Picus flavinucha*	Picidae	-
Lesser Goldenbacked Woodpecker	*Dinopium benghalensis*	Picidae	-
Indian Goldenbacked Threetoed Woodpecker	*Dinopium javanese*	Picidae	-
Large Goldenbacked woodpecker	*Chrysocolaptes lucidus*	Picidae	-
Blacknaped Green Woodpecker	*Picus canus*	Picidae	-
Little scaly bellied Green woodpecker	*Picus myremecophoneus*	Picidae	-
Fulvusbreasted Pied Woodpecker	*Picoides macie*	Picidae	-
Yellowfronted pied Woodpecker	*Picoides mahrattensis*	Picidae	-
Greycrowned Pigmy	*Picoides canicapillus*	Picidae	-
Woodpecker			
Pigmy Woodpecker	*Picoides nanus*	Picidae	-
Rufous Woodpecker	*Micropternus brachyurus*	Picidae	-
Bush lark	*Mirafra assamica*	Alaudidae	-
Cammon Swallow	*Hirundo rustica*	Hirundinidae	-
Wiretailed Swallow	*Hirundo smithii*	Hirundinidae	-
House Martin	*Delichon nipalensis*	Hirundinidae	-
Blackheaded Shirke	*Lanius schach tricolor*	Laniidae	-
Rufousbacked Shirke	*Lanius schach*	Laniidae	-
Brown Shrike	*Lanius cristatus*	Laniidae	-
Blackheaded Oriole	*Griolus xanthornus*	Oriolidae	-

Golden Oriole	*Griolus oriolus*	Oriolidae	-
Black Drongo	*Dicrurus adsimilis*	Diriolidae	-
Ashy Drongo	*Dicrurus leucophaeus*	Diriolidae	-
Bronzed Drongo	*Dicrurus aeneus*	Diriolidae	-
Hairy Crested Drongo	*Dicrurus hottentottus*	Diriolidae	-
Lesser Racket Tailed Drongo	*Dicrurus remifer*	Diriolidae	-
Greater Racket Tailed	*Dierurus paradiseus*	Diriolidae	-
Ashy Swallow Shrike	*Artamus fuscus*	Artamus fuscus	-
Starling	*Aplonis panayensis*	Stumidae	-
Pied Myna	*Sturnus contra*	Stumidae	
Common Myna	*Acridotheres tristis*	Stumidae	-
Jungle Myna	*Acridotheres fuscus*	Stumidae	-
Bank Myna	*Acridotheres ginginianus*	Stumidae	-
Greyheaded Myna	*Sturn us malabaricus*	Sturmdae	-
Indian Tree-Pie	*Dendrocitta vagabunda*	Cotvidae	-
House Crow	*Curvus splendenss*	Corvidae	-
Jungle Crow	*Corvus macrorhynchus*	Corvidae	-
Large Wood Shirke	*Tephrodornis virhatus*	Campephagidae	-
Common Wood Shrike	*Tephrodornis pondiceranus*	Campephagidae	-
Large Cuckoo Shrike	*Coracina novahol/andiae*	Campephagidae	-
Pied Flycatcher Shrike	*Hemipus picatus*	Campephagidae	-
Small Minivet	*Pericrotus cdnnamomeus*	Campephagidae	-
Scarlet Minivet	*Pericrotus flammeus*	Campephagidae	-
Common Iora	*Aegithina tiphia*	Irenidae	-
Goldenfronted Chloropsis	*Chloropsis aurifrons*	Irenidae	-
Goldmantled Chloropsis	*Chloropsis cochinchinensis*	Irenidae	-
Redwhiskered Bulbul	*Pycnonotus jocosus*	Pycnonotidae	-
Redvented Bulbul	*Pycnonotus cafer*	Pycnonotidae	-
Jungle Babbler	*Turtoides striatus*	Muscicapidae	-
Comtnon Babbler	*Turdoides caudatus*	Muscicapidae	-
Striated Babbler	*Turdoides earlei*	Muscicapidae	-
Abbots Babbler	*Trichastoma abbotti*	Muscicapidae	-
Yellowbreasted Babbler	*Macronous gularis*	Muscicapidae	-
Whitebrowed Fantail Flycatcher	*Rhipidura aureola*	Muscicapidae	-
Whitethroated Fantail Flycatcher	*Rhipidura albicolis*	Muscicapidae	-
Asian Paradise Flycatcher	*Terpsiphone paradisi*	Muscicapidae	
Little Pied Flycatcher	*Muscicapa westermanni*	Muscicapidae	-

Ferruginous Flycatcher	*Muscicapa ferruginea*	Muscicapidae	-
Redbreasted Flycatcher	*Muscicapa parva*	Muscicapidae	-
Bluethroated Flycatcher	*Muscicapa ribeculoides*	Muscicapidae	-
Verditer Flycatcher	*Musiciasa thabasina*	Muscicapidae	-
Greyheaded Flycatcher	*Muscicapa ceylonensis*	Muscicapidae	-
Blacknaped Flycatcher	*Hypothymis azurea*	Muscicapidae	-
Speaked Fantail Warbler	*Cisticola juncidis*	Muscicapidae	-
Tickls leaf Warbler	*Phylloscopus affinis*	Muscicapidae	-
Brown Bush Warbler	*Bradypterus luteoventris*	Muscicapidae	-
Franklin Wren Warbler	*Prinia hodgsoni*	Muscicapidae	-
Yellowbellied Wren Warbler	*Prinia jlaviventris*	Muscicapidae	-
Longtailed Grass Warbler	*Prinia burnesii*	Muscicapidae	-
Plain Leaf Warbler	*Phylloscopus inornatum*	Muscicapidae	-
Ashy Wren Warbler	*Prinia socialis*	Muscicapidae	-
Mangrove Whistler	*Panchycephala grisola*	Muscicapidae	-
Tailor Bird	*Orthotomus sutoris*	Muscicapidae	-
Chiffehaff	*Phylloscopus collybita*	Muscicapidae	-
Magpie Robin	*Copsychus saularis*	Muscicapidae	-
Shama	*Copsychus malabaricus*	Muscicapidae	-
Stone Chat	*Suxicola torquata*	Muscicapidae	-
Bule Rock Thrush	*Monticola solitarius*	Muscicapidae	-
Orangeheaded ground Thrush	*Zoothera citrina*	Muscicapidae	-
Grey Tit	*Parus majot*	Paridae	-
Velvet Fronted Nuthatch	*Sitta frontalis*	Sittidae	-
Chesttnutbilled Nuthatch	*Sitta castanea*	Sittidae	-
Paddyfield Pipit	*Anthus novaeseelandiae*	Motacillidae	-
Indian Tree pipit	*Anthus hodgsoni*	Motacillidae	-
Tawny pipit	*Anthus campestris*	Motacillidae	-
Grey Wagtail	*Motacilla cinerea*	Motacillidae	-
y ellow Wagtail	*Motacilla jlava*	Motacillidae	-
Yellowheaded W gtail	*Motacilla citreola*	Motacillidae	-
White Wagtail	*Motacilla alba*	Motacillidae	-
Large Pied Wagtail	*Motacilla maderaspatensis*	Motacillidae	-
Forest Wagtail	*Motacilla indica*	Motacillidae	-
Tickels Flowerpecker	*Dicaeum erythorohynchos*	Dicaeidae	-
Orangebellied Flowerpecker	*Dicaeum trigonostigma*	Dicaeidae	-
Scarletbacked Flowerpecker	*Dicaeum ceruntatum*	Dicaeidae	-

Purplerumped Sundbird	*Nectarinia zeylonica*	Nectariniidae	-
Purple Sunbird	*Nectarinia asiatic*	Nectariniidae	-
White-Eye	*Zosterops palpebrosa*	Zosteropidae	-
House Sparrow	*Passer domesticus*	Ploceidae	-
Weaver Bird	*Ploceus philippinus*	Ploceidae	-
Spotted Munia	*Lanchura malabaria*	Ploceidae	-
WhitebackedMunia	*Lanchura punctulata*	Ploceidae	

Source: Chowdhury *et al.* 1994; Blower 1985; Siddiqi, N. A. 2001; IUCN Bangladesh 2000 and field records during the present study.

IUCN Categories

EX-Extinct, CR-Critically Endangered, EN-Endangered, VU-Vulnerable, LR-Lower Risk, cd-Conservation Dependent, nt-Near Threatened, Ie-Least Concern, DD-Data Deficient, NO- Not Threatened

Appendix-IV : List of Reptiles of the Sundarbans Reserved Forest

Common Name	Scientific Name	Family	Present status as per IUCN
Lizards and Skinks:			
Garder Lizard	*Calotes versicolor*	Agamidae	VU
Common House Lizard	*Hamidactylus jlaviviridis*	Gekkonidae	NO
House Lizard	*Hamidactylus brooki*	Gekkonidae	NO
Wall Lizard	*Gecko gecko*	Gekkonidae	VU
Mouse Gecko	*Hamidactylus frenatus*	Gekkonidae	NO
Grey/Bengal Lizard	*Varanus bengalensis*	Varanidae	VU
Ring Monitor Lizard	*Varanus flavescens*	Varanidae	EN
Water Monitor Lizard	*Varanus salvator*	Varanidae	EN
Common Skink	*Mabuya carinata*	Agamidae	NO
Turtles and Tortoises			
Olive Ridley Turtle	*Lepidochelys olivacea*	Cheloniidae	VU
Green Turtle	*Chelonia mydas*	Cheloniidae	VU
Loggerhead Turtle	*Caretta caretta*	Cheloniidae	NO
Hawksbill Turtle	*Eretmochelys imbricata*	Cheloniidae	NO
Spotted Flapshell Turtle	*Lissemys punctata*	Trionychidae	VU

Ganges Softshell Turtle	*Aspidereles gangeticus*	Trionychidae	EN
Asiatic Softshell Turtle	*Chirtha indica*	Trionychidae	VU
Peacock Softshell Turtle	*Aspideretes hurum*	Trionychidae	EN
Pelochelys bibroni	*Trionychidae*	CR	
Roofed Turtle	*Kachuga tecta*	Emydidae	NO
River Terrapin	*Batagur baska*	Emydidae	EN
Yellow Turtle	*Morenia petersi*	Emydidae	NO
Threekeeled Land Tortorse	*Melanchelys Srisarinata*	Emydidae	NO
Snakes			
King Cobra	*Ophiophagus hannah*	Elaphidae	EN
Benglal Cobra	*Naja naja*	Elaphidae	EN
Hooknosed Sea snake	*Enhydrina schistosa*	Elaphidae	NO
Blackbacked Sea Snake	*Hydrophis nigrocinctus*	Elaphidae	NO
Common Krait	*Bungarus caeruleus*	Elaphidae	EN
Banded Krait	*B fasciatus*	Elaphidae	EN
Estuarine Sea Snake	*Hydrophis obscurus*	Elaphidae	NO
Malacca Sea Snake	*H. caerulescens*	Elaphidae	NO
Common Narrowheaded Sea	*Microcephalophis gracilis*	Elaphidae	NO
Snake			
Cantors Narrowheaded	*M. cantoris*	Elaphidae	NO
Checkered Keelback	*Xenochrophis piscator*	Natricidae	NO
Darkbellied Marsh Snake	*X. cerasogaster*	Natricidae	VU
Stripped Keelback	*Amphiesma stolata*	Natricidae	NO
Olive Keelback	*Atretium schistosum*	Natricidae	NO
Glossy Marsh Snake	*Gerardia prevostiana*	Homalopsidae	NO
Common Smooth Water	*Enhydris enhydris*	Homalopsidae	NO
Snake			
Whitebellied Mangrove	*Fordonia leucobalia*	Homalopsidae	NO
Snake			
Dogfaced Water Snake	*Cerberus rhynchops*	Homalopsidae	NO
Rat Snake	*Coluber mucosus*	Colubridae	VU
Common Vine Snake	*Ahaetulla nasustus*	Colubridae	VU
Common Sand Boa	*Eryx conicus*	Boidae	NO
Rock Pylhon	*Python molurus*	Boidae	EN
Russels Viper	*Vipera russelli*	Viperidae	CR
Spottailed Pit Viper	*Trimeresurus erythrurus*	Viperidae	EN
Slender Worm Snake	*Typhina porrectus*	Typhlopidae	NO

Common worm Snake	*T. bramina*	Typhlopidae	NO
Common Wolf snake	*Lycodon auricus*	Dipsadidae	VU
Wart Snake	*Acrochordus granulatus*	Acrochordidae	NO
Crocodilians			
Estuarine Crocodile	*Crocodylus porosus*	Crocodylidae	CR

Source: Chowdhury *et at.* 1994; Siddiqi, N. A. 2001; IUCN Bangladesh 2000 and field records during the present study.

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Appendix-V : List of Amphibians of the Sundarbans Reserved Forest

Common name	Scientific name	Family	Present status as per IUCN
Common Toad	*Bufo melanostictus*	Bufonidae	VC
Microhyla Ornata	*Microhyla ornata*	Microhylidae	VU
Skipper Frog	*Euphlyctis cyanophlyctis*	Ranidae	NO
Green Pond Frog	*Euphlyctis hexadactylus*	Ranidae	EN
Bull Frog	*Hoplobatracus tigrinus*	Ranidae	NO
Cricket Frog	*Limnonectes limnocharis*	Ranidae	NO
Boulengers Frog	*Rana alticola*	Ranidae	VU
Tree Frog	*Polypedates maculatus*	Rhacophoridae	NO
Red Frog	*Microhyla rubra*	Microhylidae	VU

Source: Rashid *et al.* 1994; Siddiqi, N. A. 2001; IUCN Bangladesh 2000 and field records during the present study.

IUCN Categories

EX-Extinct, CR-Critically Endangered, EN-Endangered, VU-Vulnerable, LR-Lower Risk, cd-Conservation Dependent, nt-Near Threatened, Ie-Least Concern