ECOLOGY AND CONSERVATION OF GREAT INDIAN ONE-HORNED RHINO (*Rhinoceros unicornis*) IN POBITORA WILDLIFE SANCTUARY, ASSAM, INDIA

A Thesis submitted to the Gauhati University for the Degree of Doctor of Philosophy in Zoology in the Faculty of Science

Submitted by

Ramesh Bhatta

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ECOLOGY AND CONSERVATION
OF
GREAT INDIAN ONE-HORNED RHINO
(*Rhinoceros unicornis*)
IN POBITORA WILDLIFE SANCTUARY,
ASSAM, INDIA

By

Ramesh Bhatta

2011

Guided by

Dr. P. K. Saikia

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This is to certify that Mr. Ramesh Bhatta has carried out this research work entitled **"Ecology and Conservation of Great Indian One-horned Rhino (*Rhinoceros unicornis*) in Pobitora Wildlife Sanctuary, Assam, India"** under my guidance and supervision which is being submitted to Gauhati University, for the Degree of Doctor of Philosophy.

This thesis is the result of his investigation on the subject. He has fulfilled all the requirements under Ph. D. regulation of Gauhati University. This thesis or any part of it has not been submitted by the candidate to any other University for any other degree.

Place: Guwahati University

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DECLARATION

I hereby declare that, this thesis is the result of my own research work, which has been carried out under guidance and supervision of Dr. Prasanta Kumar Saikia, Associate Professor, Animal Ecology and Wildlife Biology Lab., Department of Zoology, Gauhati University.

I would also like to declare that, neither the thesis nor any part of thereof was submitted to any other university / institution for any Degree or Diploma

(RAMESH BHATTA)

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Chapter-I:
CONTEXT AND RESEARCH OBJECTIVES

1.1 INTRODUCTION

The Great Indian One-horned Rhino (*Rhinoceros unicornis* Linn.1758) or Indian Rhino was widely distributed throughout the Indo-Gangetic and Brahmaputra flood plains (i.e. from Pakistan all the way through India, Nepal, Bangladesh, Bhutan and Myanmar (Laurie, 1978; Dinerstein, 2003). The Indian Rhino was a survivor, the product of at least 35 million years of evolution, but this species had under gone least morphological changes through the process of evolutionary changes (Dinerstein, 2003). This aspect itself makes the animal quite unique and an object of prime interest of science.

Though in the wild, this species has hardly any natural predator or enemy yet the species got dislodged and ultimately disappeared from most of the former distribution range, mainly being anthropogenic causes (Laurie, 1978; Choudhury, 1996; Dinerstein, 2003). There seems to be two basic reasons- firstly, the natural habitat of the species is most suitable for agriculture and human settlement, which leads to the encroachment of the Rhino habitat in the form of agricultural practices and push them out. Secondly, the superstitious belief on the magical power of Rhino horn and other body parts for human well being (and its high value in international market), is eliminating this species from most of the former ranges through poaching (Lauri, 1978; Dinerstein and Price, 1991; Bhattacharya, 1994).

By the turn of this century, this species had disappeared from the majority of its former ranges. By 1968, only two populations had more than 80 individuals, i. e. Kaziranga National Park and Royal Chitwan National Park (Dinerstein and Mecracken 1990; Dinerstein and Price, 1991). Today only about 2800 individuals survive in India and Nepal (Talukdar et al. 2010).

In this chapter of the study it has tried to review that- what is generally known about the- evolution and surviving species of Rhinos in the world? What do we know about the Ecology and Conservation of Indian Rhino? and then describe the context and objectives of the study.

1.2 BACKGROUND

1.2.1 EVOLUTION OF RHINOS

The earliest known Rhino like mammals belong to the genus *Hyrachys,* known from the late Eocene deposits in Asia, North America and Europe reassembles early horses with no horn (Prothero et al. 1993). The first true Rhino belonging to the family *Rhinoceratidae* also appeared in the late Eocene, but less dominant than *Hyracodontidae* (Running Rhinos) and *Amynodontidae* (Aquatic Rhinos). The *Hyracodontidae* divided in to two groups ie. *Hyracodontidae* (dog sized cursorial) and *Indricotherinae* (immense lineage). The later group included some truly spectacular Rhinos like Giraffe-Rhinos (*Paraceratherium granger*) of Mongolia and disappeared from Asia by middle Miocene (Osborn, 1923). The aquatic Rhinos had reached their maximum diversity in late Eocene and early Oligocene, especially in Asia and surviving until middle Miocene (Wall, 1989). The third family of Rhinos *Rhinocerotidae*

first appeared in the late Eocene and flourished in Oligocene in Eurasia. Due to climatic change at the end of Miocene, almost entire Rhino fauna was eliminated except two families in Eurasia (Martin and Wright, 1967). One of those, the *dicerorhinines* was the ancestors (wooly rhino) of today's Sumatran Rhino. Africa's Black Rhinos first emerged in the Pliocene and the other living species, the White Rhinoceros appeared more recently, in the middle Pleistocene resembles *Ceratotharium* that derives from *Diceros* lineage (Laurie, 1978). The Great Indian One-horned Rhinos and Javan Rhinoos also appear in middle Pleistocene.

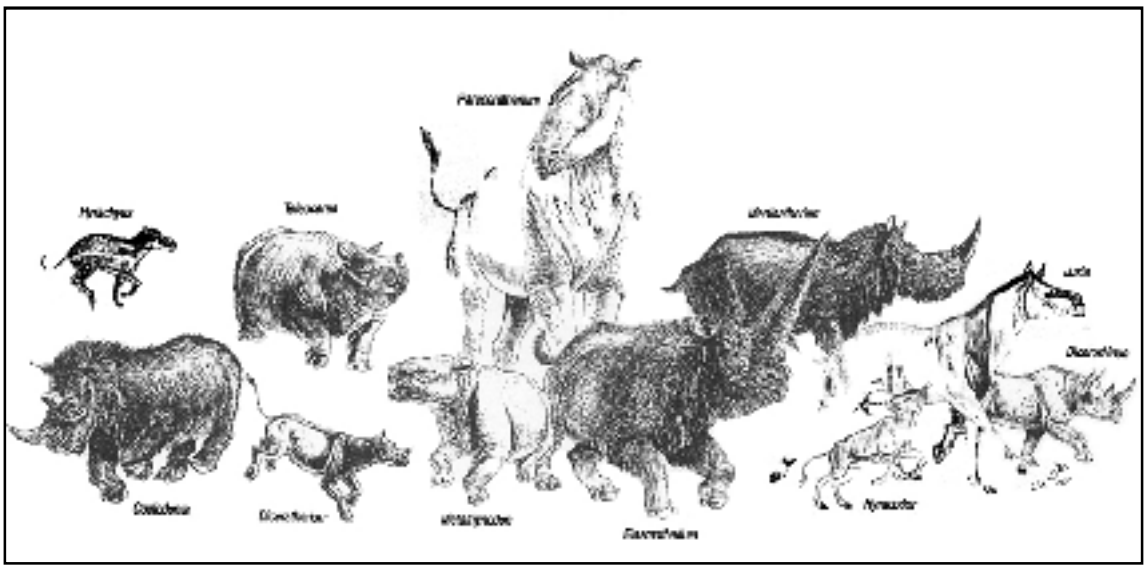


Figure-1.1: Various forms of Prehistoric ancestors of Rhinos (After Dinerstein, 1993)

1.2.2 LIVING RHINOS IN THE WORLD

Today only five species of Rhino grouped under four genera survive in the world that restricted in few protected areas of Africa and Asia (Table-1.1).

The White or Square-lipped Rhino (*Ceratotherium simum*) is the largest of all living Rhinos with two sub-species. The Northern White Rhinoceros (*Ceratotherium simum cottoni*) are found in Northern Uganda, Sudan, Central

African Republic & Republic of Congo. The other is Southern White Rhinoceros (*Ceratotherium simum simum*), found in Zambezi, Namibia and Angola. Unlike black rhino the back of this species is straighter and larger head with broad square lip. Skin is smooth with short hair and little developed skin folds. Two horns found in both male and female. Cheek teeth are high crowned and no incisors and canines (Dinerstain, 2003; Foose et al. 1993).

Black Rhinos or Prehensile-lipped Rhinos (*Diceros bicornis*) is almost hairless, smooth skin and skin not folded. Lips are triangular, prehensile and very mobile. Two horns with variable proportions and shape found in both male and female. Short crowned cheek teeth and no incisors and canines. Altogether four sub-species are found in different areas of Africa- *Diceros bicornis bicornis* (Namibia & south Africa), *Diceros bicornis longipes (*Cameroon), *Diceros bicornis michaeli* (Ethiopia, Kenya, South Africa and Tanzania) and *Diceros bicornis minor* (Malawi, South Africa, Swaziland, Tanzania and Zimbabwe) (Goddard, 1967, 68; Foose, 1993)

The Asiatic or Sumatran Two-horned Rhino (*Dierohinus sumatransis*) is the smallest of all surviving Rhinos and bear hair on the body. The species earlier distributed from Assam, India and southern Bhutan, south and east to the Indonesian island of Sumatra and Borneo. The last strongholds of the population all appeared to be in Borneo (*Diceros sumatrensis harrissoni*), Sumatra and Malaysia (*Diceros sumatransis sumatransis*). There are two distinct skin folds, one encircling the trunk just behind the foreleg and the other just anterior to the hind-leg which doesn't go over the back. There is one pair of incisor in each jaw and lower incisor modified as sharp forward pointing tusk.

Premolars are molariforms (Dinerstein, 2003; Foose et al.,1993; Talukdar et al., 2010)

Javan or Lesser One-horned Rhino (*Rhinoceros sondaicus*) is formerly widely distributed from North Eastern India across Indochina to the island of Java in Indonesia. Today only known population is in the rain forest Western Java (*Rhinoceros sondaicus sondaicus*) and in Vietnam (*Rhinoceros sondicus annamiticus*). This animal is with thick hairless skin, with three folds across the back and other around the neck and legs. The upper lip is pointed and single horned. Tusks are present in both sexes in the lower jaw. Single horn found in male only (Foose et al.,1993; Shebeare, 1953).

The Great Indian One-Horned Rhino (*Rhinoceros unicornis* Lin.) is the second largest living Rhino and the largest among all three Asian Rhinos. The animal is massive, large headed, well developed single horn and more developed skin folds around neck. The species was historically limited to floodplains and forest tract in the Brahmaputra, Ganges and Indus river valleys. Today the species is restricted in some pockets of India and Nepal (Laurie, 1978; Foose et al., 1993).

Table-1.1: Present status of Living Rhinos in world.

Species→ attribute↓	*Ceratotherium simum*	*Diceros bicornis*	*Diceros sumatransis*	*Rhinoceros sondaicus*	*Rhinoceros unicornis*
Sub-species	*C.s. cottoni, C.s. simum*	*D. b.bicornis, D.b. longipes, D. b. michaeli & D. b. minor*	*D.s.harrissoni*, *D. s. sumatransis*	*R. s. Sondaicus* *R. s. annamiticus*	Not applicable
Present Distribution	Northern Uganda, Sudan, Central African Republic, Republic of Congo, Zambezi, Namibia and Angola.	Namibia & south Africa; Cameroon; Ethiopia, Kenya, South Africa and Tanzania; Malawi, South Africa, Swaziland, Tanzania and Zimbabwe.	Borneo, Sumatra and Malaysia	Java & Vietnam	India & Nepal
Nos. Surviving in wild	DD	DD	130-180	30-40	~2800
Body Characters 1. Height (m)	1.7-1.8	1.6	1.2-1.4	1.4-1.7	1.6-1.8
2. Weight(kg)	2300	720-1300	800-900	1500-2300	1600-2200
3. Head size	Broad	Broad	Broad	Tapering	Tapering
4. Horn	Two(M,F both)	Two(M,F both)	Two (M,F both)	Single(M only)	Single(M,F

					both)
5. Skin type	Smooth and hairless	Smooth and hairless	Smooth and hairy	With Small tubercles & hairless	With Tubercles & hairless
6. Skin folds	Absent	Absent	Absent	Small folds behind shoulders & thighs	Prominent skin folds
7. Teeth	Incisors absent	Incisors absent	Incisors present	Incisors present	Incisors present
8. Lips	Upper lip (UL) square	UL pointed	UL pointed	UL pointed	UL pointed
9. Humps	Present	Absent	Absent	Absent	Absent

(Source- Bhattarharya, 1993; Foose et al., 1993 & 1997; Van et al., 1999; Talukdar et al., 2010)

1.2.3 ECOLOGY, BIOLOGY AND CONSERVATION OF INDIAN RHINO

Indian rhino was recorded from a number of habitats, including marshy lowland and reed beds, tall grass or bush with patches of savanna, thick tree and scrub riverine forest and dry, mixed forest. It was recorded throughout its range in alluvial plain habitats, riverine and marshy areas bordered by riverine woodlands, dry sal forest, or tropical almond forest also often uses cultivated areas, pastures, and modified woodlands (Laurie et al., 1983; Dinerstein and Price, 1991; Nowak, 1999).

An Indian rhino weights about 1600 -2200 kg. and average height is 1.6 - 1.8 meter (Laurie et al., 1983). A free ranging female Indian rhino is fully grown about 6-8 years whether males are fully grown and sexually matured at about 8-10 years of age. The age of first calving in Chitwan National Park, Nepal was recorded at 6 - 8 years *and average* gestation period was 16 months (462 - 491 days), females choose secluded areas to give birth. Mating takes place throughout the year (Laurie, 1978). One calf usually born at a time and the birth interval is commonly 3 - 5 years (Nowak, 1999). Calves are suckled frequently up to the age of 1-1.5years. Male calves leave their mothers at an average age of 3 year 3 months compared with 2 years 10 months for female calves (Laurie, 1978). The maximum age in captivity is recorded 47 years (Laurie et al., 1983).

Indian rhinos have observed to feed on 183 species of plants, with grasses making up between 70 - 89% of the diet depending on the season. Other foods included fruits, leaves and branches of shrubs and trees, sedges and ferns, submerged and floating aquatic plants, and cultivated crops (Laurie et al., 1983; Hazarika, 2007). The Indian rhino drinks from streams, rivers,

lakes, puddles, or wallows. Rhinos often drink very dirty water heavily contaminated with rhino urine (Laurie, 1978).

Smell is the strongest sense of Indian Rhino and has a good hearing, however rhinos have poor vision. The Indian rhino is active mainly at night, in early morning and in the late afternoon. The middle of the day is mainly spent resting, either in the shade or in wallows. There is often a rest period during the night, between midnight and 3:00 am. (Laurie et al., 1983)

Apart from cow-calf pairs, Indian rhinos rarely form groups. Adult males are usually solitary, but they sometimes occur in temporary associations of up to nine rhinos of various sex and age classes. These groups form at wallows and grazing grounds where the rhinos often feed or rest together but move independently of each other (Laurie, 1978, Hazarika, 2007). There is some degree of range exclusivity but no true territoriality in Indian Rhino. The home ranges of dominant bulls overlap with one another. When two dominant Indian rhino males meet, they may fight using their tusk-like lower incisor and horn, fight can even end in the death of one of the combatants (Lauri, 1978; Nowak, 1999). Female Indian rhinos have home ranges covering 9 - 15 km^2. in Chitwan and for breeding males, it varied from at least 2 - more than 8 km^2 (Laurie, 1978; Hazarika, 2007).

By the first decade of the 20^{th} century, the Indian rhino was close to extinction. In India there were only a few survivors, the main group comprised of a dozen individuals along the Brahmaputra River and another around 50 in Nepal. At that point there was a change in human perception in Indian towards conservation of Indian Rrhino; the sport hunting was halted, general legal

protection was established, and Kaziranga was made a reserve. In later years, protection had been upgraded and extended to all other areas having rhino population. Government of India had declared special project “Project Rhino” for conservation of the species in India (Dinerstein, 2003).

International Union for Conservation of Nature and natural resources (IUCN) included the species as “Vulnerable” in red data list in 1960. In 1970's IUCN categorized it as “Endangered” and continued the same status up to 2009. During this period due to the continuous efforts from local government, NGO and other concern the status of the animals have been improved and listed as “Vulnerable” again in Red data Book during evaluation of IUCN/SSC in 2009.

Government of India and Nepal had increased security against rhino poaching, 24 hour protection in Sanctuaries and National Parks by armed guards and national army is really appreciated. Both the country also started intelligence network against Poachers activity and an international consensus to stop the trade of Rhino horn and other body parts, which substantially decrease the poaching incidences (Martin et al., 1987; Vigne and Martin 1984; Martin, 1996).

Government of Nepal and India with the help of conservation organization translocated rhinos from Chitwan National Park to Bardia Conservation Reserve and Suklaphanta Conservation Reserve in Nepal and from Pobitora Wildlife Sanctuary and Kaziranga National Park to Dudhwa National Park in India. Recently (in 2005) Government of Assam has took an ambitious programme with conservation organization as “Indian Rhino Vision

2020" (IRV2020), where the goal was to attain a population 3000 wild Rhinos distributed over seven protected areas of Assam by year 2020. Under this programme 6 rhinos (from Pobitora Wildlife Sanctuary and Kaziranga National Park) have been translocated to Manas National Park and monitoring continuously.

1.3 PRESENT CONTEXT OF STUDY

The Great Indian One-horned Rhino or Indian Rhino (*Rhinoceros unicornis*) survive with only about 2800 individuals in India and Nepal (Talukdar et al., 2010). Out of which more than 80% of global population lives within the Indian subcontinent, specifically inside the protected areas of Assam like Kaziranga National Park, Pobitora Wildlife Sanctuary, Orang National Park and Manas National Park.

Pabitora Wildlife Sanctuary holds 84 rhinos in its 38.81 km^2 area. Rhino population in Pobitora Wildlife Sanctuary seems to be going beyond the ideal density as everyday animals move out of the park into agricultural areas extensively. The habitat of the sanctuary badly degraded as a result of extensive cattle grazing, and human disturbance from nearby villages. Around 40% of the total population of Rhino moves out of the sanctuary at dusk and return back to the sanctuary in the dawn (Talukdar et al., 2007) may be in search of food and space, which leads conflict with the people. The protection of Rhino from poachers outside the sanctuary is a challenging task for the wildlife authority. It is also impractical to guard the rhinoceros round the clock to

prevent their stray activity. Considering all these it is a matter of concern for the survival of Pabitoran Rhino population.

This scientific study on the Ecology and Conservation of Great Indian One-horned Rhino (*Rhinoceros unicornis*) at Pobitora Wildlife Sanctuary was carried out to know the habitat quality and to quantify the extent of different conservation threats to Rhino in the habitat, that using these findings wildlife authority of Pobitora Wildlife Sanctuary can adopt conservation and management strategy to conserve viable population of Rhino in the area.

1.4 OBJECTIVES

- To study the population status and demography of Indian Rhino in Pobitora Wildlife Sanctuary.
- To study the habitat suitability of Indian Rhino in Pobitora wildlife sanctuary.
- To investigate the ranging and habitat utilization pattern of Indian Rhino in Pobitora Wildlife Sanctuary.
- To investigate the movement of Rhino outside the Pobitora Wildlife Sanctuary.
- To investigate and quantify the conservation threats and review the management strategies of Rhino in Pobitora Wildlife Sanctuary, Assam.

Chapter-II:
REVIEW OF LITERATURE

2.1 BACKGROUND

The Great Indian One-Horned Rhinos (*Rhinoceros unicornis* Linn., 1758) described scientifically in detailed by Person during 1743 in London (Clarke, 1973). Prior to that the facts and figures about Indian Rhinos was mainly based on Religious Literatures, Historical Records, Hunters & Travelers Tales and very few observations on the species in captivity. Several Indian Rhinos were viewed in the zoos of Europe and North America from the 18th Century onwards and studied the animal in captivity, (Ali, 1926, 1956; Rookmaarker, 1973; Laurie, 1978). The first study of the species in wild was by Bengt Berg, a Swedish photographer in 1932 and later during 1972-1976 detailed study on Ecology and behavior of the species in the wild had done by William Andrew Laurie in Nepal (Laurie, 1978). Dr. S. R. Jnawali hade studied about the population ecology of Rhino with particular emphasis on habitat preference, food ecology and ranging behavior of reintroduced population in Royal Bardia National Park in Nepal and submitted his findings in 1995 (Jnwali, 1995). In India Dr. B. K. Bhattarya in 1991, studied certain aspects of biology of Indian Rhino (Bhattarchya, 1991) and Dr. Budhin Chandra Hazarika had studied in detail about the eco-behavioral aspects of Rhinos in Orang National Park during 1999-2007 (Hazarika, 2007)

2.2 HISTORICAL RECORDS ON INDIAN RHINO

Indian Rhino was an animal that had drawn interest of people since historical times and recorded in different Religious Literatures, Historical Records, Hunters and Travelers Tales. In Chandogya Upnishad, 900 BC the occurrence of Rhinoceros in India was recorded along with Elephant and Buffalo, it was described that the animal lived in marshes and had grazed on river banks (Rao, 1957; Laurie, 1978). Old carved seals excavated from the Indus valley (Mohan Jo Daro and Harappa) during 3000 BC-200 BC depicting Rhinoceros and Proto-Shiva ("Pasupati"-the Lord of Beasts) as protector of animals. (Lang, 1961; Ghose, 1991). During 300 BC- 200 BC Ctesian Alaxandria (Greece) mentioned this animal as "Indian Ass" from whose horn a poison detecting cup could be made. Cup carved from Rhinoceros horn were believed by many to be a protection against poison. The medicinal and magical properties were and still attributed to the Rhino horn and their other body parts. (Casal, 1933; Hoogerwref, 1970; Prater, 1971; Vanstrien, 1974). Indian Sages began to classify bounty of wildlife, their habitat and food preference of hundreds of species since 2000 BC, a notion of conservation was introduced in the preset of "AHINGSA" (Non- violence) to any living creature by Lord Buddha. The Fifth Pillar Edict of Emperor Ashoka during 273 BC-232 BC perhaps was the first conservation law in history- It was described that animals such as "Bat, Monkey, Rhinoceros, Porcupine and Tree-Squirrels were to be strictly preserved. (Ghose, 1991). During 200 BC- 100 BC Rhinos were exhibited in Alexandria and Rome (Perhaps those were African Rhinos) but during early years of Roman Empire the Indian Rhino was also exhibited in Rome (Gower,

1950; Ghose, 1991). During these periods several fantastic descriptions of Rhinos were made. Such descriptions were influenced by Ctesia's account and included imagination of fabulous 'UNICORN'. At that time in Europe tusks of Narwhal and Horn of Indian Rhinos were both attributed to the 'Unicorn' (Guggiberg, 1966; Laurie, 1978). During 1398 invader Taimur killed many Rhinos in areas near present day boarder of Kashmir (Guggisberg, 1966). The record of first exportation of live specimens of Indian rhino from India to Portugal (Europe) was during 1513 (Dutta, 1991). In 1515 a Western India King sent a Rhino as gift to King Manuel of Portugal, The same Rhino was gifted to Pope X Leo but died the animal by drowning on the way (Laurie, 1978). In 1519 Moghul Emperor Babur hunted Rhinos near Peshawar (Pakistan), he also wrote during 1505-1530 about the distribution of Rhino (Leyden, 1826; Ali, 1927). In 1554 Akbar hunted Rhinos near Delhi. A Turkish traveler from Lahor to Constantinople in 1556 reported sighting of Rhinos near Peshwar (Guggesberg, 1966). Moghul Kings were all keen hunters and naturalists, during Jehangir's time (1605- 1627 AD) record of hunting Rhino was plenty, (Ali, 1927). In 1847 Bulter noted an abundance of Rhinos in Assam during the early 19th Century. He had mentioned tamed Rhinos been grazed with domestic cattle in Assam and sold for Rupees three hundred each only (Ghose, 1991). Pollok and Thorn in 1900 reported that a washer man in Gauhati (Assam) had a tamed Rhino that carried the laundry on his delivery rounds (Laurie, 1978; Ghose, 1991). Schenkel and Lang (1969) quoted that Rhinos being used to pull ploughs in Assam and there are reports that Rhinos were used in war by the Indian monarchs (Guggisberg, 1966). Maharaja of Kooch Bihar killed 207 Rhino during

1871 and 1907 in west Bengal and Asssam, then the Government of India prohibited Rhino hunting in 1910 (Laurie, 1978)

2.3 ECOLOGY AND BEHAVIOUR

The status and distribution of Indian Rhino in India, Pakistan and Nepal was done by Manner (1909), Straey (1957), Gee (1959, 1963 and 64), Rookmaaker (1980, 1982), Choudhury (1985, 1996) and Bist, (1994). Lwin, (1998) reported the past distribution of Indian Rhino in Mynmar. Choudury, (1985, 1986, 1989, 1994, 1997a, 1997b) presented the distribution of Indian Rhinos and grassland habitat in and outside protected areas and about the historic presence of Sumatran Rhino in Northeast India. Rookmaaker (2002) describe the historical records of Indian Rhinos in Northern India and Pakisthan. Hussain (2001) describe the status of Indian Rhinos in Orang National Park.

Intensive studies on Ecology and Behavior of this species have been carried out in Nepal (Laurie, 1978; Blanford, 1980; Dinerstein, 1979a, 1979b, 1991a, 1991b and 1992; Dinerstein and Wemmer, 1988; Dinerstein and McCracken, 1990; Dinerstein and Price, 1991; Blanford & Price, 1991; Ghose, 1991; Jnawali, 1995; Hazarika, 2007; Hazarika and Saikia,2007, 2009, 2010 and 2011). In the detailed study of behavioural ecology of Indian rhino, W.A. Laurie (1978) evaluated the food selection and dietary diversity, movements social behavior and other behavioural status, population status, age and sex structure by means of direct observation in Chitwan National Park. Ghose (1991) studied the ecological status of Indian Rhino in an altered habitat due to human interference in Jaldapara Wildlife Sanctuary, India. Jnawali (1995)

determined diet selections by Indian Rhinos through micro-histological techniques and observed ranging behavior and habitat preference by putting radio-collar. Dinerstein & Wemmer (1988) examined seed dispersal and germination of *Tiwa nudiflora* in Chitwan NP by testing the seeds after passing through rhino's gut. Hazarika (2007) and Hazarika and Saikia (2007, 2009, 2010 and 2011) studied the food selection, home range and conservation prospective of Indian Rhino by direct observation in Orang National Park, Assam, India.

Gee (1953a, 1953b had studied the life history of the Great Indian One-Horned Rhinoceros, Ulrich (1964) studied the social behavior and social organization in Rhinos of Kaziranga (Assam). Lahan and Sonowal (1973) and Lahan (1974) gave an account of social behavior in Indian Rhinos. Bhattacharya and Paul (1982) and Bhattacharya (1993) did some work on population and habitat use by Rhinos in Kaziranga National Park. Brattacharya R. (1983) had studied the habitat of Indian Rhino in Orang National Park.

Brahmchari et al. (1971), Patar (1977), Marry et al. (1998), Deka (2003) have studied feeding behavior of Indian Rhino in India and Nepal. Lang (1961) and Lang and Leutenegger (1977), Buchner et al. (1975), Mackler & Buchner (1978), Bhattarcharya & Goswami (1987) and Bhattarcharya (1991) had studied some biological aspect of Indian Rhino and also presented reproductive behaviour and mother-young relationship in captivity. Apart from all above there are some recent studies on the species which are referred in a different section below.

2.4 CONSERVATION AND MANAGEMENT

Stracey (1949) had raised the issue about the vanishing status of the Indian rhinos from the wildlife sanctuaries of Assam. Ahmed (1985), Choudhury (1996), Kandel (2003), Takulkdar et al. (2007) had studied the migration and straying movement of the species and status of wildlife corridors in India and Nepal. Bhattacharya and Acharyya (1993) have studied Identification of Great Indian one-horned Rhinoceros by foot impression. Mishra (1982), Nepal & Weber (1993) and Jnawali (1989) and Jnawali & Wagge (1991) had studied and documented the Park people relationship, balance of human needs and prospects for conservation of endangered big mammals in developing countries. Martin (1989 and 1996), Martin and Vigne (1987, 1994), Talukder (1995), Menon et al.,(1998) and Menon (1996a,b) had presented different conservation crisis with special reference to poaching of Indian Rhino and international trade of their horn and other body parts. Bhattacharjee and Halder (1971), Arora (1986), Bordoloi et al. (1990), Chakravorty (1993) and Islam (1994) had studied about the health problems of Indian Rhino with special reference to Helminthic infection in captive and Gastro-intestinal parasites in free ranging animals. Nandi and Deb (1972) had reported on horn cancer in Indian Rhino.

Foose et al. (1993) have presented population and habitat viability analysis for Indian Rhinos in India and Nepal. Van et al. (1999) had reported the finding of regional meeting of IUCN/ SSC Asian Rhino Specialist describing the present threat and conservation action plan for Indian Rhino in India and Nepal. Sale and Sing (1987), Aziz et al. (1988), Bauer (1988) and Sinha et al.

(2001) had reported about the behavior and reintroduction success of Indian Rhinos in Dudhuwa National Park, India and Bardia Wildlife Reserve Nepal. Menon et al. (2005) had studied about the standard for wildlife rehabilitation.

2.5 RECENT STUDIES IN ASSAM

Kushwaha et al. (2000) had studied land area change and Rhino habitat suitability analysis in Kaziranga National Park, Assam. Banerjee et al. (2001) had studied the habitat used by Indian and other sympatric species in Kaziranga National Park. Talukdar (2002) had studied tiger predation of Rhino Calves at Kaziranga National Park. Hazarika (2007) had worked on the Eco-behavioral aspects of Indian Rhino in Orang National Park, India.

Bairagee et al. (2002-2004) had done some short studies on grassland status, utilization of grassland by fringe villagers, population status of Indian Rhino and their conservation approach involving local community in Pobitora Wildlife Sanctuary, Assam. Deka and Baruah (2003) had compared Forages/ Feed consumed by the Indian Rhino in free-ranging and in captivity. Talukdar (1999, 2000) and Talukdar and Baruah (2006) documented the current status of the sanctuary.

Pobitora Wildlife Sanctuary is a very small area (38.81 km^2) with crowded rhino numbers and tremendous human pressure leading to quick degradation of habitat of Indian Rhino and also found repeated incidence of Rhino human conflict. Therefore to manage the population of Indian Rhino and protect the small isolated area, there is a need of comprehensive systematic study on

Ecology and Conservation of the species. The present study is aimed to fulfill the said need.

Chapter-III:
STUDY AREA AND GENERAL METHODS

3.1 POBITORA WILDLIFE SANCTUARY

3.1.1 LOCATION AND HISTORY

The study was carried out in Pobitora Wildlife Sanctuary and its periphery during the year 2005-2010. Pobitora Wildlife Sanctuary is situated in the south bank flood plains of river Brahmaputra at a distance of about 50 kilometers east from the capital city of Guwahati. The sanctuary is located in the Mayang Civil Circle (Former Mayang Kingdom; the land of BLACK MEGIC) area in the Western end of Morigaon District bordering with Kamrup district of Assam. The sanctuary has an area of about 38.81 km^2 and extends between latitude 26º12/ 0// N to 26º16/48// N and 91º58/48// and 92º05/24// East longitude (Fig-3.1). River Brahmaputra forms the northern boundary of the sanctuary (north of Mayang Hills), Revenue Villages numbering 37 lies along the east, south and western boundaries.

Regarding the name of the Sanctuary it is believed that the 10th King of Mayang Kingdom, “Sarasha Singha” named this grassland after his loving daughter “Pobitora” who died at a tender age (Rajagharia Gaid). But some believed that the name had been derived from two Assamese words i.e. “PURVA” meaning Eastern and “TARA” meaning Star, which was the eastern Star of ancient Assamese Kingdom “PRAGJYOTISHPUR”.

The Connectivity of Pobitora Wildlife Sanctuary was observed by road network from three sides. From northwestern side to Guwahati through

Chandrapur and Narengi, it's about 47 km to the heart of the Guwahati city. From the southern side the sanctuary can be approached from Samata at NH 37 crossing Kolongpar and Kamarpur (52 km from Guwahati City). From the eastern side sanctuary is connected with Marigaon and Jagiroad through Jhargaon and Manaha.

The management structure of Pobitora Wildlife Sanctuary has been changed recently. The sanctuary was braught under the jurisdiction of newly created Guwahati Wildlife Division having its office at Santipur, Guwahati-09. Earlier it was under Nagaon Wildlife Division. The Range officer based at Pobitora Wildlife Range covers the whole ground management of the sanctuary.

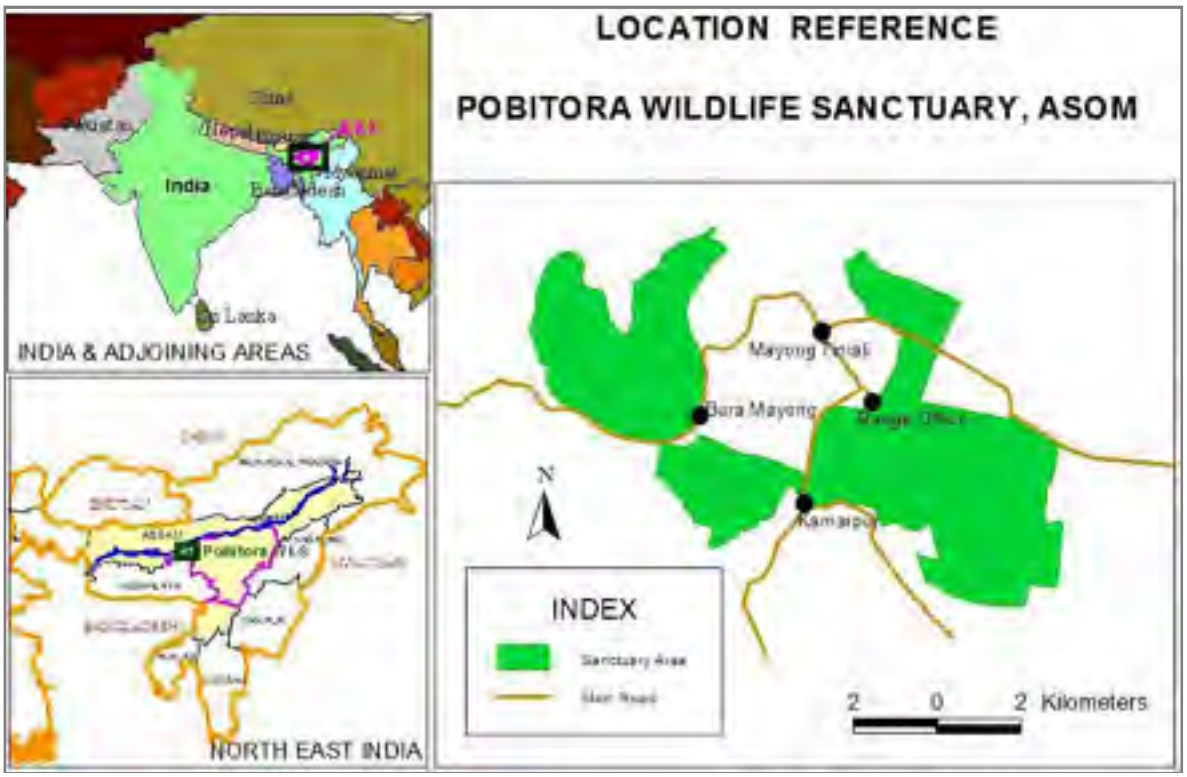


Figure-3.1: Location Map of Pobitora Wildlife Sanctuary.

3.1.2 GEOGRAPHY & GEOLOGY

The sanctuary comprised the alluvial plains and hilly ranges between the river Brahmaputra in the North and its tributary Kolong towards the South (Bora, 2003; Bora and Kumar, 2003). The sanctuary was observed having a good network of wetlands and many of these were perennial and as such very favoured areas for the Biota, viz. Garanga, Haduk, Sitalmari, Pagladova, Duboritoli, Dholi etc. were some of the major wetlands in the sanctuary. A number of small Hillocks (Kasasila Hill, Hatimuria Hill, Kukuri Hill, Boha Hill, Kardia Hill, Kamarpur Hill, Mitoni Hill, Gobordhan Hill, Panbari Hill etc.) were observed to be scattered along/ outside the boundary of the sanctuary (Plate-1). The altitude of the area was recorded from about 50 meters to 260 meters above MSL. The surrounding areas of the sanctuary towards East, West and South were mainly private agricultural land and scattered human settlement and towards North there were sand bars (Scrub land) and rocky hills on the banks of River Brahmaputra.

Geologically the study area was found of recent origin and belongs to *Archaean* Group. The geological formation consists of low level alluvium of clay, coarse sand, and gravel and boulder deposits. The soil structure was found clay loam in the plain and sandy loam in the hilly forest of the sanctuary. The soil of swampy area was rich in peat deposition. The soil was acidic in nature and pH varies from 5.34-5.95 (Bora and Kumar, 2003).

3.1.3 THE CLIMATE

The climate of the area can be treated as subtropical monsoon type with four distinct seasons like other parts of the state i.e.- Winter (December–February), Pre-monsoon (March–May), Monsoon (June- September) and Retreating-monsoon (October-November) (Borthakur, 1986). During the study period the Maximum & minimum temperature were recorded 12ºc. to 38ºc. The average annual rainfall was ranges from 1600 to 2000 mm.

3.1.4 FLORA, FAUNA & PEOPLE

The vegetation type of the sanctuary is broadly of two types- i.e. a) Tropical alluvial plain vegetation and b) Tropical moist semi evergreen hilly forest (Bora and Kumar, 2003).

The alluvial plain vegetation is found around 50m above the mean sea level (MSL) and inundated during the monsoon. It can be grouped in to- i) Moist deciduous forest and woodland, ii) Grassland & savannah, and iii) swampy vegetation. The first group is dominated by deciduous trees, middle shrubs and herbaceous canopy, and the ground vegetation found to be rich during monsoon. The dominant top canopy trees are- *Albizia procera, Bombax ceiba, Legerstromia reginae, Trewia nudiflora, Lannea coromandelica, Streblus asper, Litsea monopetala, Baringtonea acutangula, Bombex ceiba, Syzygium cumini etc.* The middle canopy is not dense and continuous mainly composed of – *Antidesma acidum, Ardisia solanacea, Catunaregam uliginosa, Leea indica, Litsea monopetla, Zizyphus mauritiana etc.* and tall Rhizomatus herbs like *Alpinia nigara and Costus speciosus.* The climbers like *Cissus repanda,*

Ichnocarpus frutescens, Mikania micrantha, meriopteron paniculatum, Simlex perfoliata etc. climbs on shrubs and tree. The ground vegetation is mainly composed by the herbaceous families, terrestrial Pteridophytic ferns, terrestrial orchids and some weeds- like-*Abutilon indicum, Cassia occidentalis, Cssia tora, Melocia corchorifolia, Sida rombifolia, Solanum torvum, Urena lobata, Croton bonplandinus, Helitropium indicum, Polygonum barbatum* etc. (Bora and Kumar, 2003; Bairagee and Kalita, 2003).

The grassland vegetation occupies the major part and plays vital role in the sanctuary as an ideal habitat for Indian Rhino and other herbivores (Plate-1 and Plate-2). The seasonal forest burning, intensive grazing and browsing are keeping the grassland in a successional stage. The grasses are low to tall (ca 3meter) and dense. The dominant grasses are- *Imperata cylindrica, Cynodon dactylon, Vetiveria zizanioides*, *Sclerostachya fusca, Saccharum spontaneum, Paspalum scorbiulatum, Phragmitis karka, Arundo donax, Echinochloa crusgalli, Panicum auritum, Politoca digitata, Setaria glauca, Paspalidium flavidum* etc. The ground flora of the grassland is mainly dominated by herbaceous leguminous plants like- Al*ysicarpus vaginalis, ami\mania multiflora, Atylosia goensis, Atylosia scarabaeoides, Crotalaria humifusa, Desmodium gangeticum, Desmodium triflorum, Flemingia lineate, Euphorbia hirta, Mimosa pudica* etc. The shrubs, *Antidesma acidum*, *Barringtonia acutangula, Bridelia stipularis, Catunaregam uliginosa, Mallotus philipensis, Zizyphus mauritiana* etc. are scattered in the grassland and form the savannah in the sanctuary (Bora and Kumar, 2003; Bairagee and Kalita, 2003)

Number of water bodies and lowing marshy areas localy known as Beel, Duba, Jan, Nala etc. are scattering throughout the sanctuary and forming aquatic and swampy vegetation. The common species found in swampy areas are-*Alpinia nigra, Antidesma acidum, Barringtonia acutangula, Costus specious, Ficus heterophylla, Glochidion multiloculare, Saccharum spontaneum, Phragmitis karka, Syzygium cumini, Panicum spp., Cyperus spp.*etc. Somme common aquatic vegetation found in the water bodies are-*Eichhornia crassipes, Euryale ferox, Hydrilla verticillata, Ipomoea auatica, Ludwigia adscendens, Monochoria hasata, Pistia stratiotes, Trapa natans, Vallisaneria spiralis* etc. (Bora and Kumar, 2003; Bairagee and Kalita, 2003)

Tropical Semi-Evergreen Hilly Forest was found in the sanctuary in an altitude range around 50 -260 meters above MSL. This type of the forest mainly composed of deciduous as well as evergreen species of trees and shrubs like-*Artocarpus lokoocha, Careya arborea, Celtis tetranda, Diospyros variegate, Ficus benghalensis, Ficus geniculata, Harpullia arborea, Lagerstroemia parviflora, Melia azedarch, Oroxylum indicum, Pterospermum acerifolium, Sapindus mukorossi, Sterculis villosa, Terminalia bellirica, Zanthoxylum rhetsa* etc. The trees were clothed with epiphytes and the forest was rich in lianas. Different species of bamboo forms discontinuous patch with undergrowth like-*Costus speciosus, Curcuma aromatica* etc. The woody climber like-*Bauhinia scandens, Butea paviflora, Byttneria grandifolia, Cayratia pedata,* etc. were found climbing on tree shrubs and hilly rocks. *Helixanthera ligustrina, Marosolen cochinchinesis, Viscum monoicum* etc. were commonly found semistem-parasitic plant on trees. The herbs mainly found as undergrowth were-

Phrynium pubinerve, Zingiber chrysanthum, Zingiber zerumbet, Amorphophallus bulbifera, Colocasia esculenta, Rhaphidophora hookeri, Biophytum sensitivum, Chlorophylumarundinaceum, linum asitatissimum, Murdannia elata, Plantago erosa etc. (Bora and Kumar, 2003).

Pobitora Wildlife Sanctuary though small in extent has a very rich collection of faunal species. In 1999 census, more than 20,000 waterfowl species were recorded in the winter season (Bora, 2003). It was observed as a home to a large number of amphibian, reptiles and fish species in addition to the Great Indian one-horned Rhinoceros (Plate-2), Asiatic Water Buffalo, Wild Boar, Leopard, Jungle cat, Jackal etc.

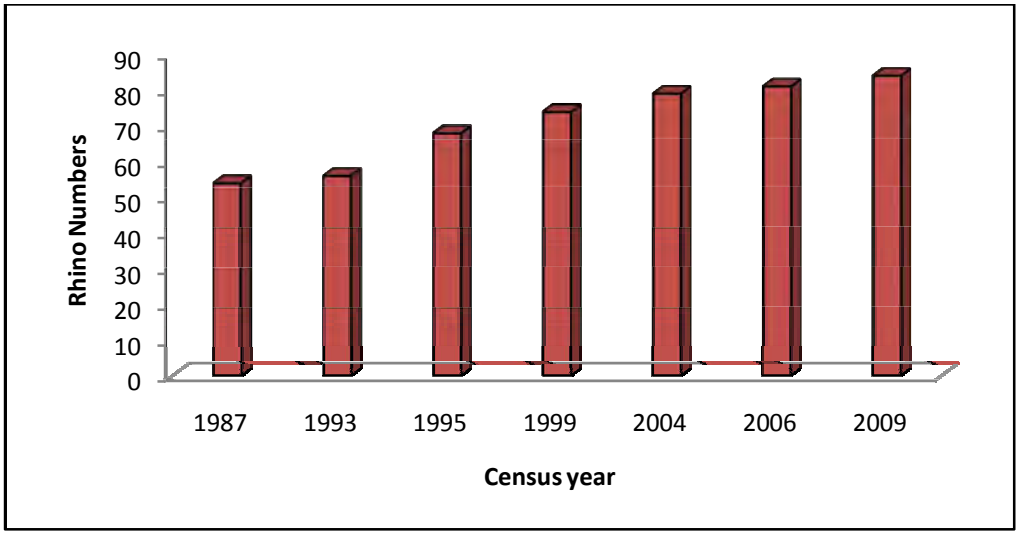


Fig-3.2: Rhino Population of The sanctuary during 1987-2009

3.1.5 CURRENT INFLUENCE OF MAN AND ADAPTATION OF INDIAN RHINO

The human activities are the most influencing biotic factor to the habitat and the rhino population of the sanctuary. The surrounding villagers were mostly used to graze their cattle inside the sanctuary leading a competition for

fodder with wild herbivores and finally degradation of habitat. The villagers were also entered illegally into the sanctuary for collection of thatch, fire wood, wild vegetables, fishes etc. and accelerated the process of habitat degradation. Importantly unregulated tourism had also disturbed the habitat and wild population as the sanctuary had no core area/ non tourism zone. Developmental activities carried out and intensive agricultural practices just along the border also had affected the habitat and the behavior of wild animal including Rhino. Poaching of Rhinos for its horn by man is one of the important factors that affected the rhino population of the sanctuary.

The rhinos of the sanctuary were found to be adapted themselves to share the habitat with domestic cattle; it was commonly observed that rhinos grazed together with cattle. Straying of Rhinos out of the sanctuary in search of food to private agricultural areas, scrub areas and sandbars of the River Brahmaputra was became daily incidence. It was also observed that the rhinos at Pobitora showed lesser reaction when approached by Tourist, Protection Staff or Researcher unlike Kaziranga NP.

3.2 GENERAL METHODS

The study was conducted during 2004- 2009 in Pobitora Wildlife Sanctuary. Various methods like Scan animal sampling, Focal count, Direct observation, Photographic technique, Geographic Information System (GIS) and Remote Sensing Technique etc. (Wallmo and Neff, 1970; Field, 1972; Laurie, 1978; Hobbs et al. 1981; Butts et al. 1982; Bhattarchyya, 1991; Jhala,

1997; Hooge, 1997; Patton and Martin, 2007; Hazarika 2007; Hazarika and Saikia,2007, 2009, 2010 and 2011) were followed to collect data on population and selected behavior of Indian Rhino in the study area. For study of habitat parameters, suitability of habitat for Indian rhino and habitat utilization pattern of the species in the habitat were studied using Grid based transect survey technique, Linear Survey Technique and Remote Sensing and GIS Technique (Kelker, 1972; Seidensticker, 1976; Patridge, 1978; Burroughs, 1986; Lilesand and Kiefer, 1989; Litvaitis, 1996; Porwal et al., 1996; Kushwah et al., 1998-200; Gibson and Power, 2000; Kandel, 2006). Conservation aspects like emerging threats, conservation and management measures and conservation successes were studied using Rapid Survey, Questioner survey and Informal Discussion Technique, (Jonwali, 1989; Talukdar et al., 2007; Jhala et al., 2008).

The area of interest was divided in to 1" interval grid (Figure-3.3) for convenience of data collection. Data for different aspects was intensively collected during the period from September 2004 to August 2009 after three months pilot survey to finalization of methodologies as per the ground feasibility. During the data collection it had been taken care to get at least one set of data for each season i.e. Winter, Pre-monsoon, Monsoon and Retreating monsoon.

Season	Winter	Pre-monsoon	Monsoon	Retreating monsoon	Total
2004-2005	12	21	30	22	85
2005-2006	28	20	31	13	92
2006-2007	16	12	20	21	69
2007-	18	15	14	13	60

2008					
2008-2009	23	18	24	19	84
Total	97	86	119	88	390

Table-3.1 Field days in different seasons and years

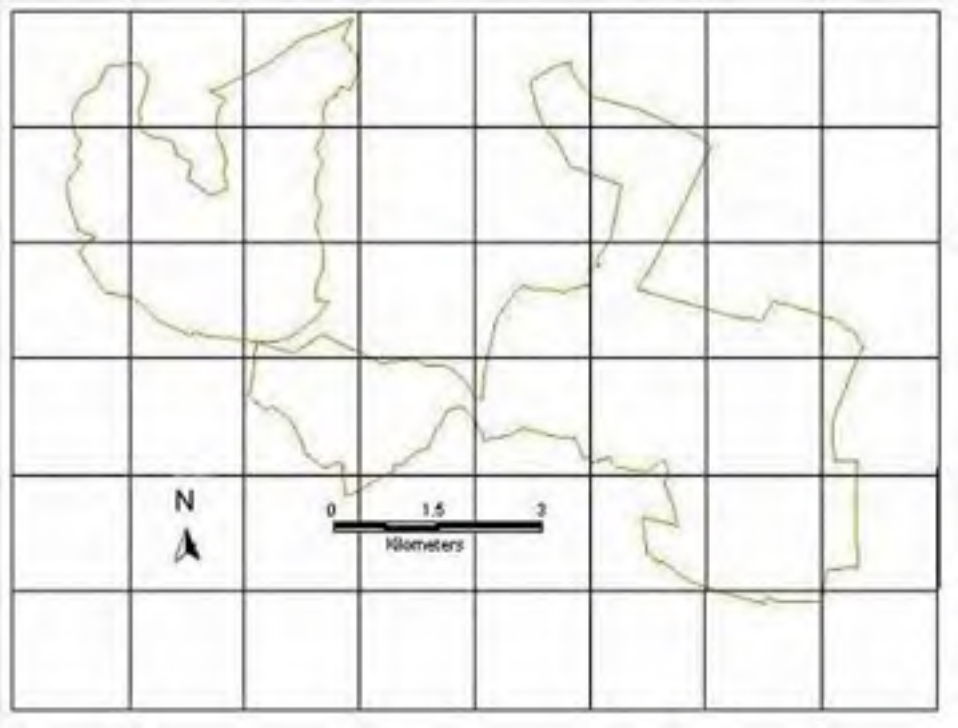


Figure-3.3: Study area showing survey grids layout.

Departmental captive Elephant have been used for most of the surveys/ search carried out inside the sanctuary and during dry season some surveys carried out on foot. High raised Anti-poaching camps were often used for long observation of Rhinos. During monsoon country boat was extensively used and convenient to observe Rhinos because soundless movement which is not possible in case of Elephant. Most of the surveys outside the sanctuary were carried out on foot, vehicle and boat (Plate-3). High resolution (Nikon10X40) binocular have been use for prominent view of individual identity markings, observe feeding preference etc. Global Positioning System (Garmin etrex GPS)

have been use to collect all data with geo-reference. A Sony digital camera (8mega pixel, 15X optical & 40X digital zoom) with a tele-conversion lens (1.7X zoom) had been used for taking photographs and videos. Night time photographs had been taken using high beam search light. Photographs and videos had been transferred to IBM laptop in a day to day basis. Notebook and pencil were used to collected the data and transmit the data to MSXL spread sheet in IBM laptop computer for necessary analysis. Detail about different techniques used and analysis of data were described in concerned chapters.

a view of grassland, wetland & woodland mixing

a view of grassland & woodland mixing

a view of plain & Hillock mixing of Pobitora WLS

a view of wetland crowded with water hysinth and Sabhana grass

a view of Grass land during high flood

a view of animals on high land during high flood

View of the only location that found *Phragmitis karka* Retz.

Migratory birds in the sanctuary during winter

Plate-1 View of the study area

Iesser Adjutent stork in the sanctuyary

Wooly necked stork in the sanctuary

Monitor Lizared found in the sanctuary

a Python Found in the sanctuary

a view of Rhino mating in the sanctuary

Water buffalos wallowing in the sanctuary

Some Rhinos in the sanctuary

Plate-2: Some amimals in study area

Author Searching for Rhinos on elephant back

Author Collecting data on Rhino straying

author during survey of rhino on boat during flood

Discussing with front line staff

Consulting with the managers of the different Rhino habitat of Assam

Moments with community

Plate-3: The Author in the study area

Chapter-IV:
POPULATION SIZE AND DEMOGRAPHY

4.1 INTRODUCTION

An animal Population is a dynamic system reacting to the change in the environmental situation. A careful and continuous monitoring over several years would be most desirable to analysis the reactive mechanism (Schenkel and Hulliger, 1969). An ecological survey of a population is not satisfactory without a statement as to its size and composition. The ecological evaluation of the actual status of a population requires information like- age at sexual maturity in male and age at first calving in female, inter-calving intervals, length of life phase of reproduction (Lang, 1961; Schenkel and Hulliger, 1969). The Great Indian One-Horned Rhino is one of species ranked as “vulnerable” by International Union for Conservation of Nnature (IUCN)/ Species Survival Commission (SSC) is a grassland dweller and need continuous attention for their survival (Talukder et al, 2010).

The wildlife authority conducts census of Rhino for each population in an interval of 3-5 years (Mukhargee & Sengupta, 1999). They followed the head count method dividing the park in to blocks. In this process large numbers of volunteers and captive elephants are needed. The limitations of the process observed from last few census experiences were that- 1. The big exercise itself is a disturbance to the rhino and other wildlife population especially for small area like Pobitora Wildlife Sanctuary. 2. It is done neither seasonal nor yearly basis which is very important to study the demography and health of a small

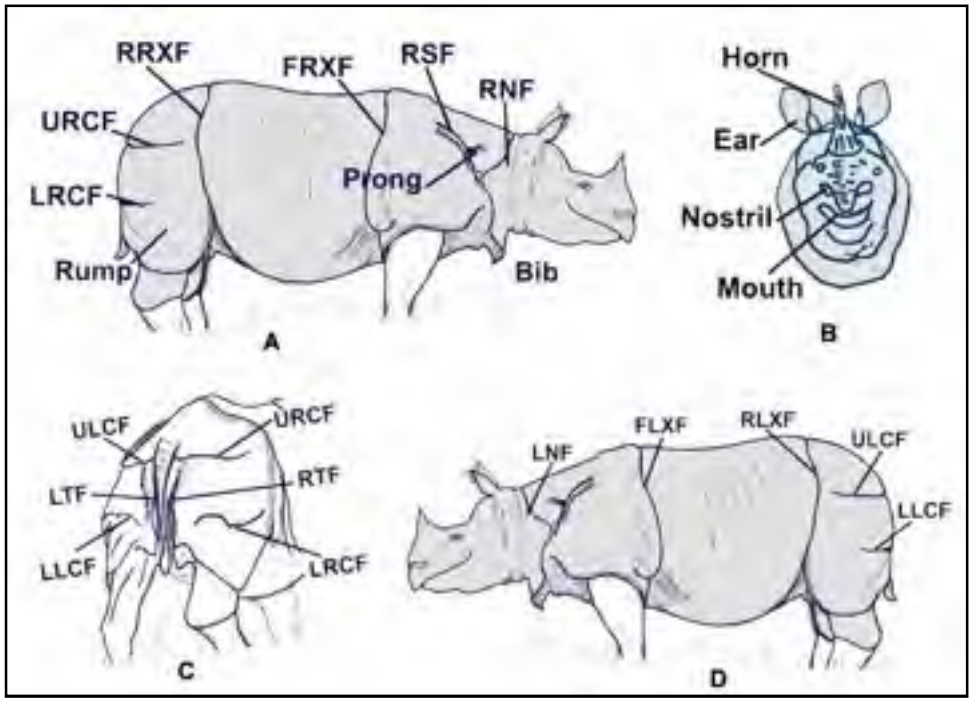
fragmented population of big mammals. 3. Very difficult to avoid repeat count along the border of the blocks (Laurie, 1978) 4. Only certain numbers volunteers were practically efficient/ experienced for proper observation of the species.

Apart from this the frontline staff of the sanctuary maintains duty register in each anti-poaching camp to record their every day sightings of animal, habitat condition and illegal activities (Bora, 2003). But as per the observation the ground records were not uniform, not consistent, not compiled for the entire sanctuary, not analyzed nor produce report (annual, half yearly or quarterly) for management strategy in a regular basis. Therefore the present study was aimed to develop a basic database of each individual rhinos with photographic evidences to make a best estimates of minimum current rhino population in the sanctuary and formulation of “RHINO REFERENCE CARD” for each individual animal which will be useful to estimate population and regular monitoring of the population, that the wildlife authority can take informed management decision.

4.2 METHODS

4.2.1 POPULATION ESTIMATION

Direct observation (Laurie, 1978) and photographic technique (Patton and Martin, 2007; Patton, 2007) were used for identification of rhinos considering certain numbers of characters in their body. Some of the important characters



LRCF- Lower Right Corner Fold, LLCF- Lower Left Corner Fold, URCF- Upper Right Corner Fold, ULCF- Upper Left Corner Fold, RRCF- Rare Right Cross Fold, RLCF-Rear Left Cross Fold, FRCF-Front Right Cross Fold, FLCF- Front Left Cross Fold, RSF- Right Sholder Fold, LSF- Left Sholder fold, LSF- Left Sholder Fold, RNF- Rjght Neck Fold, LNF- Left Neck Fold, P-Prong and B-Bib.

Figure-4.1 showing skin folds and other important body parts of Rhino for identification

considered during this study were – 1) Differences in sex (Male, Female); 2) Age Classes (Calf-up to 4 years and attached to the mother; Sub Adult- up to 6 years, body size small and smooth, Horn, skin folds and tubercles not well developed, 3rd neck fold not distinct, ribs not distinctly visible and found in small groups; Adult- Greater than 6 years, Body massive, horn well developed, skin folds prominent including 3rd neck fold, Shoulder and lower ramp folds down to the elbow and knee, tubercles on ramps distinctly visible, ribs distinctly visible and back slightly lowered); 3) Horn shape (length, shape, curvature, rings and grooves); 4) Arrangement of skin folds (number, size, length, irregularities in folds); 5) Skin (permanent injury mark over body White patches / other irregularity on skin); 6) Tail (Length, bands, irregularities, loss of tail parts); 7)

Ear (size, shape, acquired nicks presence/absence of hair on ear); 8) Arrangement of tubercles on the rump (as per Laurie, 1978, 82; Bhattacharyya, 1991; Blanford and Price, 1991; Dinerstein, 1991; Lehner 1996; Hazarika, 2007) (Figure-4.1)

Searching effort had been made in both day and night time using elephant back (Dinerstein and price, 1991), on foot, on vehicle and on boat in respect to the season and terrain. A high resolution (Nikon10X40) binocular had been used for observation of body characters (Lauri, 1974). A Sony digital camera (8mega pixel, 15X optical & 40X digital zoom) with a Tele-conversion lens (1.7X zoom) had been used for taking photographs and videos. Night time photographs had been taken using high beam search light. Photographs and videos have been transferred to IBM laptop in a day to day basis and observed carefully for identifying character. After careful observation, important photographs were coded and arranged for each individual rhinos (Patton and Martin, 2007). Observations in every sighting of individual were recorded in a pre-designed field format (Annexure-1) with required sketch of the animal and continuously updated for several identifying features from every angle with photographic evidences to reduce the possibility of two Rhinos with same recorded characters (Laurie, 1978). The collected information along with the codes of identifying photographs were continuously fed to Microsoft Excel database (Annexure-2). Using all observed characters and the photographic evidences, a “RHINO REFERENCE CARD” had been generated for each individual rhinos to make the quick and spot identification of rhinos. In this way the database was build up and minimum population demography of Greter One-

horned Rhino for Pobitora Wildlilife Sanctuary was determined. Reference Card for dependent individuals i.e. that attached to the mother was not prepared separately but incorporated them referring mother's identity.

4.3 RESULT

During the study period all total 2779 rhino sightings had made, out of which 1057 were complete sightings and 1722 were incomplete sightings. New sightings were recorded from the first field trip i. e. in the months of September 2007 and steadily increased in next two conjugative field visits i. e. in the months of October-November, 2007 and December- January, 2007-2008 (Fig-4.2). After that the number of new sightings had been decreased sharply and fell to zero after 7 conjugative field visit in the early part of the second year of the study. No new sighting was recorded in three conjugative field visits in the latter part of the second year i.e. December-February, 2008-2009; April-May, 2009 and June-August, 2009. Because of the small area of the sanctuary, isolated habitat and open in nature almost all rhinos had been recorded in the first year of the study. Only one new sighting recorded in the early part of the 2nd year of the study. The number of re-sighting of recorded rhinos in different field visits was found in an increasing trend from the beginning to end of the study (Figure-4.3). Highest number of rhino re-sighting was recorded during December- February, 2008-2009. The visibility of rhinos during winter after burning and extensive grazing of grasses was increased considerably and had reduced the searching effort to re-sight almost all the animals within a week (Figure-4.4). The chance of sighting/ re-sighting of Individuals were also

considerably increase during high flood as all the animals had taken shelter on high land without much movement in the sanctuary.

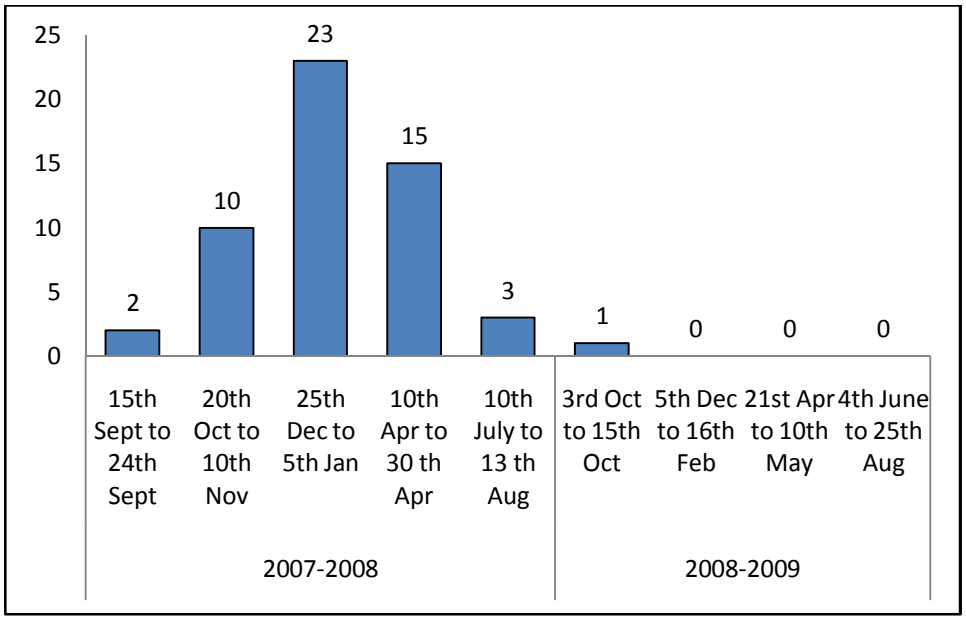


Figure-4.2: Sighting of new individuals in different field visits.

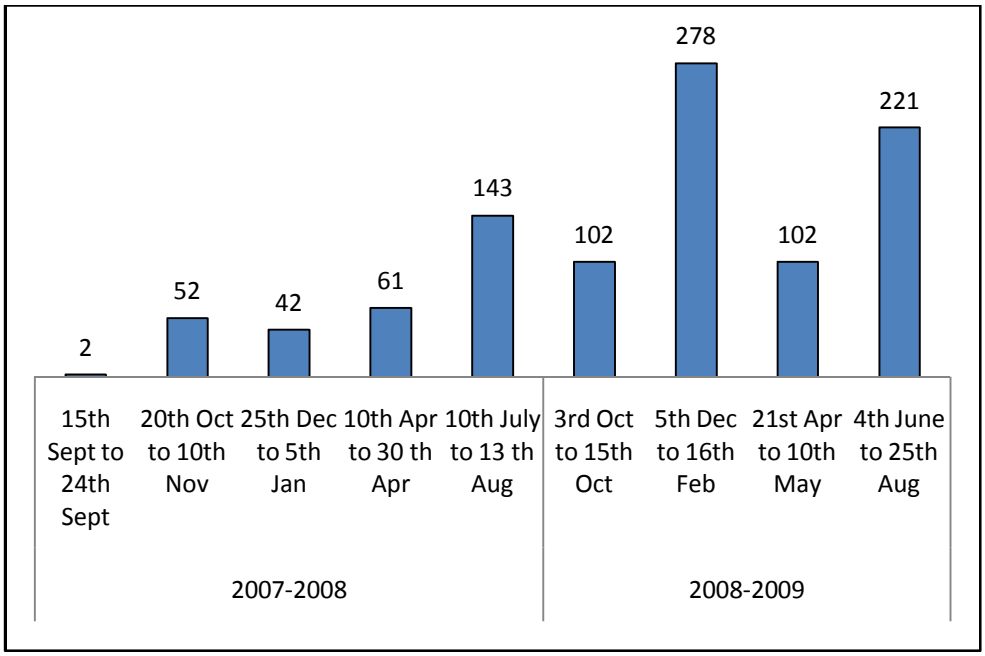


Figure-4.3: Re-sighting of individuals in different field visits.

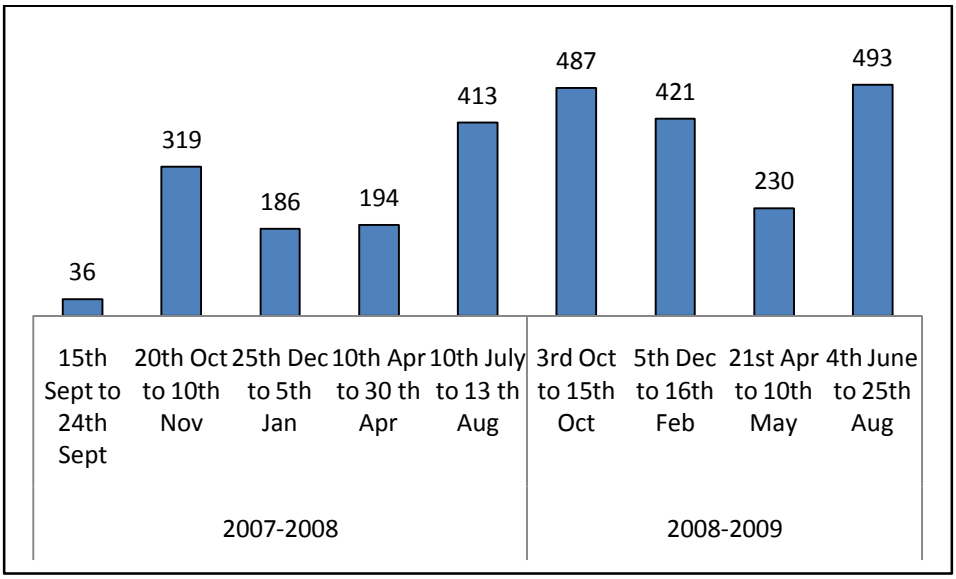


Figure-4.4: Total sightings of Rhinos in different field days

Collection of rhino reference cards had suggested that, there were at least all total 74 numbers of rhinos in Pobitora Wildlife Sanctuary comprising 59 numbers independent rhinos and 15 numbers dependent calf that attached to the mother (Table-4.1, Table 4.2 & Table-4.3). The minimum population demography concluded during the study was 29%-Adult Female(22), 21%-Adult Male(16), 10%-Sub Adult Female(8), 10%- Sub Adult Male(8), 10%-Male Calf (8), 7%-Female Calf(5) and 13%-Calf that Sex is not sure(10).

Sl. No.	Class	Numbers
1	Adult Female	22
2	Adult Male	16
3	Sub-Adult Male	8
4	Sub-adult Female	8
5	Male Calf	8
6	Female Calf	5
7	Un sexed calf	10
8	Death of referred Rhino within study period	-3
Total:		74

Table-4.1: Numbers of rhinos recorded different age and sex classes.

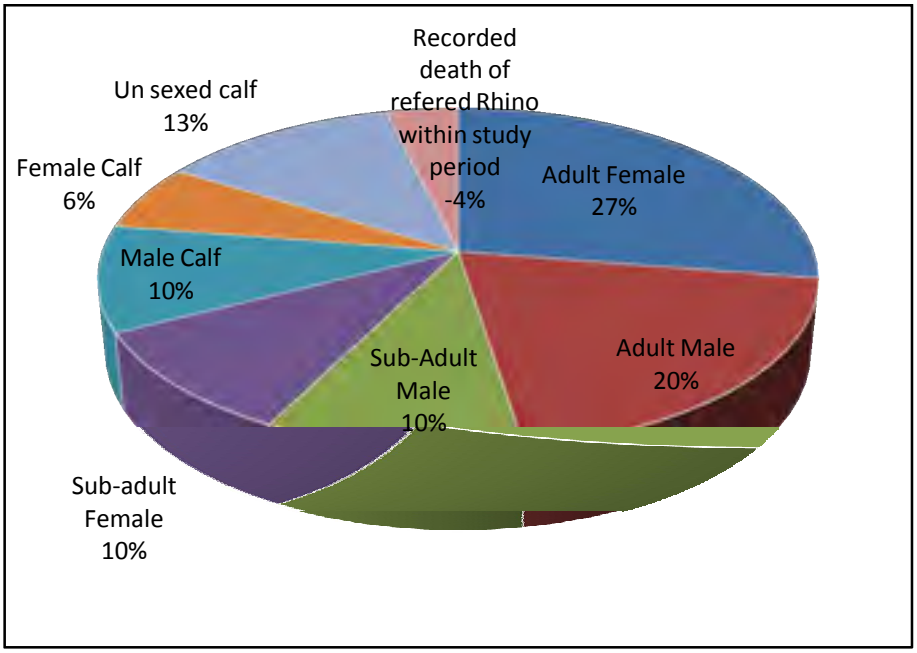


Figure-4.5: Population demography of rhinos at Pobitora Wildlife Sanctuary

Table-4.2: Rhino Demography at Pobitora WIdlife Sanctuary during the study.

Sl. No.	Reference No.	sex	Age	Identifying Characters	Dependent-Calf		
					No.	sex	Age
1	M01	M	A	*Lumpy outgrowth in the lower left abdomen.*	-	-	-
2	M02	M	A	*Base of the tail is depressed and banned*	-	-	-
3	M03	M	A	*Left ear possess an acquired nicks*	-	-	-
4	M04	M	A	*Tip of the horn is broken and URCF is "{" shaped*	-	-	-
5	M05	M	A	*Left ear is distinctively smaller to the right ear.*	-	-	-
6	M06	F	A	*RLXF possess a "V" shaped cut mark*	1	U	<1
7	M07	M	SA	*Tail is elongated and heavy degeneration on the base of the tail*	-	-	-
8	M08	F	A	*Right ear loss one part, skin possess pink pigmentation*	1	F	2 -3
9	M09	F	A	*Prominent cut mark on RLXF between ULCF & LLCF*	1	U	<2
10	M10	M	A	*Horn broken, tail is very short*	-	-	-
11	M11	F	A	*Horn bend backward and tip of the horn is like fish tail fin*	1	F	<1
12	M12	M	A	*Possess a very small cut mark at right year*	-	-	-
13	M13	F	A	*Tip of the horn is bulb like and right year loss one part*	1	M	3-4
14	M14	M	A	*Left ear is looking like a newly developed ear from the original one that cut at base.*	-	-	-
15	M15	M	A	*Right ear posses a cut mark also posses pigmentation at neck fold*	-	-	-
16	M16	F	A	*Base of the tail is bulging and tail is shorter in length*	1	M	3-4

17	M17	F	A	*Left ear loss one part, RRXF possess one small cut mark between URCF & LRCF*	1	U	>1
18	M18	F	A	*"V" shaped cut mark in RRXF near URCF*	1	F	2-3
19	M19	F	SA	*Two prominent cut mark in RRXF*	-	-	-
20	M20	M	A	*Left ear posses small cut mark, tubercle on left ramp form a line like "L"*	-	-	-
21	M21	F	A	*V' shaped cut mark in RLXF*	1	U	1-2
22	M22	F	A	*Tubercle pattern in the right ramp is "J" shaped, tail is shorter and the base oval shaped*	1	U	2-3
23	M23	F	A	*Folds over the left hind leg posses additional fold, body is large, tail of the calf posses two bands*	1	U	<1
24	M24	F	A	*Cut mark on RRXF near URCF*	1	M	2-3
25	M25	M	A	*RLXF possess a cut mark near LLCF*	-	-	-
26	M26	M	SA	*Tail base is depress and tail posses a band*	-	-	-
27	M27	F	A	*RLXF possess a cut mark near ULCF*	1	U	<1
28	M28	M	SA	*RLXF possess a cut mark near ULCF*	-	-	-
29	M29	F	SA	*RRXF posses a saw like edge near ULCF & LLCF*	-	-	-
30	M30	F	A	*Tail loss the end part **	1	F	>3
31	M31	F	A	*Tail posses zigzag bands**	1	M	<2
32	M32	M	SA	*both the ear posses cut mark**	-	-	-
33	C01	F	SA	*Horn tip is small blub like, horn body is screw like*	-	-	-
34	C02	F	SA	*Horn is not developed only the base plate developed*	-	-	-
35	C03	M	SA	*Horn is short and oval shaped, ear posses long and dense hair.*	-	-	-
36	C04	M	A	*Horn is elongated approximately 12 inch long, slender and both the ear posses long hair.*	-	-	-
37	C05	F	SA	*Horn triangular , ear posses thick short hair*	-	-	-
38	C06	F	A	*Horn is sharp looking like attached on a base plate, a small calf attached*	1	U	<2
39	C07	F	SA	*Horn is not developed fully 2.5 inch approx, base is thick blunt*	-	-	-
40	C08	M	SA	*Horn is 3-4 inch approx triangular, band backward, posses a ring on tip, both the ear posses long hair*	-	-	-
41	C09	M	SA	*Horn triangular, two ring found , ear posses thick short hair from base to tip*	-	-	-
42	C10	F	A	*Tip of the horn is sharp, pointed 2 inch aprox, a calf of around 2 year of age*	1	U	2-3
43	C11	F	A	*Horn posses a notch from front side, a male calf attached*	1	M	2-3
44	C12	M	A	*Horn very long sharp pointed band backwards, ear posses long hair*	-	-	-
45	C13	M	A	*Very long horn, tip is blunt, ears posses short hair*	-	-	-

46	C14	M	SA	*Horn not developed , no hair on ear*	-	-	-
47	C15	F	A	*Short horn, big female calf of 2-3 years of age*	1	F	2-3
48	C16	F	A	*Short horn, big male calf of >3 years of age*	1	M	>3
49	C17	F	A	*Short pointed horn with a male calf of 1-2 years of age*	1	M	1-2
50	C18	F	A	*Horn is elongated slender with number of small rings like structure, attached a male calf of 2 year aprox.*	1	M	2-3
51	C19	F	A	*Horn elongated on a base plate with an un identified calf of 2-3 years.*	1	U	2-3
52	C20	M	A	*Horn is 3-4 inch aprox, thick base*	-	-	-
53	C21	M	A	*Horn is degenerating, ear posses long hair*	-	-	-
54	C22	F	SA	*Horn not developed , no hair on ear, tail base is thick*	-	-	-

*(RRXF:Rear right cross fold; RLXF: Rear left cross fold; URCF: upper right corner fold; ULCF:upper left corner fold; LLCF: lower left corner fold ; LRCF: lower right corner fold; M:male; F: Female; U:unconfirmed sex; A:adult; SA:sub adult; *: Rhino died during the study period)*

Table-4.3: Sighting records of identified rhinos in different field visits

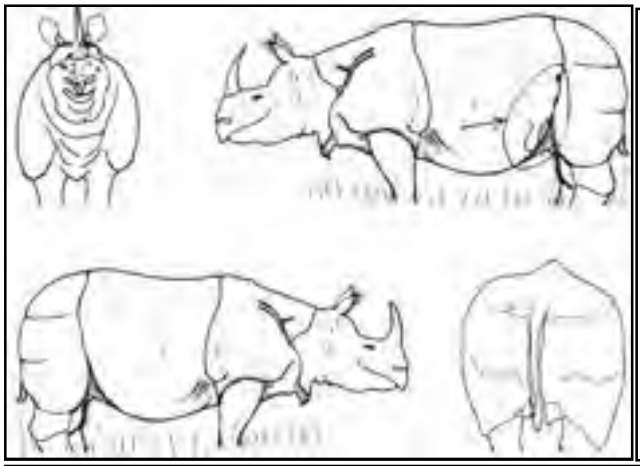
Animal ID	2007-2008								2008-2009						
	Monsoon		Retreating moonsoon		Winter		Pre- moonsoon		Mon-soon		Retreating-monsoon		Winter	Pre-moon soon	Mmonsoon
	First Sighting	Resighting	First Sighting	Resighting	First Sighting	Resighting	First Sighting	Resighting	First Sighting	Resighting	First Sighting	Resighting	Resighting	Resighting	Resighting
M01	*1	1	0	9	0	0	0	2	0	6	0	5	10	2	5
M02	*1	1	0	9	0	6	0	1	0	6	0	7	8	3	5
M03	0	0	*1	7	0	2	0	4	0	4	0	2	8	3	4
M04	0	0	*1	6	0	1	0	2	0	6	0	3	10	4	8
M05	0	0	*1	5	0	1	0	2	0	3	0	5	16	3	6
M06	0	0	*1	6	0	1	0	2	0	1	0	2	13	2	7
M07	0	0	*1	3	0	5	0	0	0	2	0	4	5	1	5
M08	0	0	*1	3	0	2	0	2	0	5	0	2	5	5	3
M09	0	0	*1	0	0	2	0	3	0	8	0	1	8	3	6
M10	0	0	*1	0	0	0	0	0	0	0	0	0	0	0	0
M11	0	0	*1	3	0	4	0	2	0	10	0	4	18	4	5
M12	0	0	*1	1	0	1	0	0	0	2	0	3	3	2	6
M13	0	0	0	0	*1	2	0	0	0	1	0	2	5	1	6
M14	0	0	0	0	*1	0	0	2	0	2	0	3	10		7
M15	0	0	0	0	*1	0	0	1	0	1	0	5	9	2	7
M16	0	0	0	0	*1	1	0	2	0	1	0	7	5	1	8
M17	0	0	0	0	*1	1	0	0	0	0	0	2	3	3	5

M18	0	0	0	0	*1	0	0	2	0	5	0	3	15	6	8
M19	0	0	0	0	*1	0	0	1	0	4	0	3	8	3	4
M20	0	0	0	0	*1	0	0	1	0	2	0	2	8	2	4
M21	0	0	0	0	0	0	*1	1	0	2	0	2	11	1	8
M22	0	0	0	0	0	0	*1	0	0	5	0	1	11	2	7
M23	0	0	0	0	0	0	*1	0	0	3	0	2	7	5	4
M24	0	0	0	0	0	0	*1	1	0	6	0	1	7	2	2
M25	0	0	0	0	0	0	*1	0	0	5	0	3	4	3	4
M26	0	0	0	0	0	0	*1	1	0	1	0	2	7	2	4
M27	0	0	0	0	0	0	*1	0	0	1	0	1	5	1	4
M28	0	0	0	0	0	0	*1	2	0	2	0	2	3	4	9
M29	0	0	0	0	0	0	*1	0	0	4	0	5	5	5	5
M30	0	0	0	0	0	0	*1	0	0	0	0	0	0	0	0
M31	0	0	0	0	0	0	*1	0	0	0	0	0	0	0	0
M32	0	0	0	0	0	0	*1	0	0	0	0	0	0	0	0
C01	0	0	0	0	*1	0	0	2	0	3	0	0	3	0	2
C02	0	0	0	0	0	0	*1	0	0	2	0	0	1	1	4
C03	0	0	0	0	*1	0	0	2	0	2	0	0	2		1
C04	0	0	0	0	0	0	*1	1	0	1	0	0		2	4
C05	0	0	0	0	0	0	*1	0	0	3	0	2	3	2	4
C06	0	0	0	0	*1	0	0	0	0	2	0	0	1	1	1
C07	0	0	0	0	*1	1	0	1	0	1	0	0	2	1	1
C08	0	0	0	0	*1	0	0	1	0	1	0	0	1	2	1
C09	0	0	0	0	*1	0	0	2	0	2	0	1	4	1	6
C10	0	0	0	0	*1	2	0	2	0	1	0	0	3	2	4

C11	0	0	0	0	*1	1	0	3	0	3	0	1	5	2	4
C12	0	0	0	0	0	0	0	0	*1	4	0	2	3	1	2
C13	0	0	0	0	*1	2	0	2	0	1	0	2	3	0	3
C14	0	0	0	0	*1	2	0	3	0	3	0	2	3	3	3
C15	0	0	0	0	0	0	0	0	0	0	*1	1	4	2	2
C16	0	0	0	0	*1	2	0	2	0	2	0	1	3	1	3
C17	0	0	0	0	*1	1	0	1	0	2	0	1	0	0	2
C18	0	0	0	0	*1	0	0	2	0	3	0	1	0	0	1
C19	0	0	0	0	0	0	0	0	*1	1	0	1	3	0	2
C20	0	0	0	0	0	0	0	0	*1	0	0	0	1	2	6
C21	0	0	0	0	*1	1	0	1	0	5	0	0	1	2	3
C22	0	0	0	0	*1	1	0	2	0	3	0	3	5	2	6

** First sighting of individuals.*

4.3.1RHINO REFERENCE CARDS



Reference No.M001

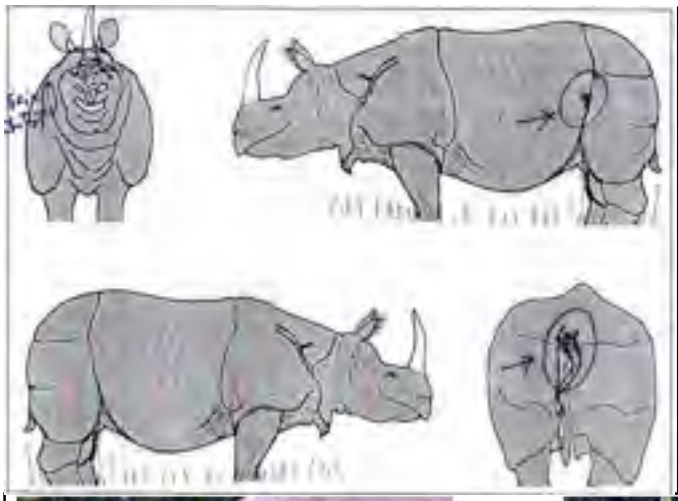
Sex- M Age- Adult (>10years)

Calf Position- NA

Remarks- Dominant Male

Last updated- 27.07.2008

Key Identity-	*Lumpy outgrowth in the lower left abdomen present.*
Horn-	*Elongated slightly bend backward and more than 10 inch in length.*
Ear-	*Ears are clean and short hair present.*
Skin Folds-	*RLXF possess two small outgrowth in the middle and a bigger outgrowth seen in the abdomen*
Tail-	*Tail is normal smooth and elongated.*
Remarks-	*Dominant Male.*



Reference No. M02

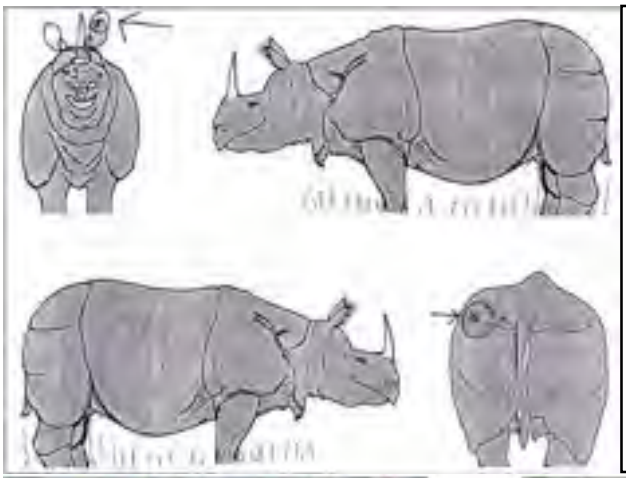
Sex- M Age- Adult (>10years)

Calf Position- NA

Remarks-

Last updated- 29.07.2009

Key Identity-	*Base of the tail is compressed and banded.*
Horn-	*Elongated >10 inch in length a backward bend in 2/3 position from the base.*
Ear-	*Ears are clean and short hair present.*
Skin Folds-	*RLXF is slightly torned in the mid position of LLCF and ULCF.*
Tail-	*Base of the tail is depressed and banded.*
Remarks-	



Reference No. M03

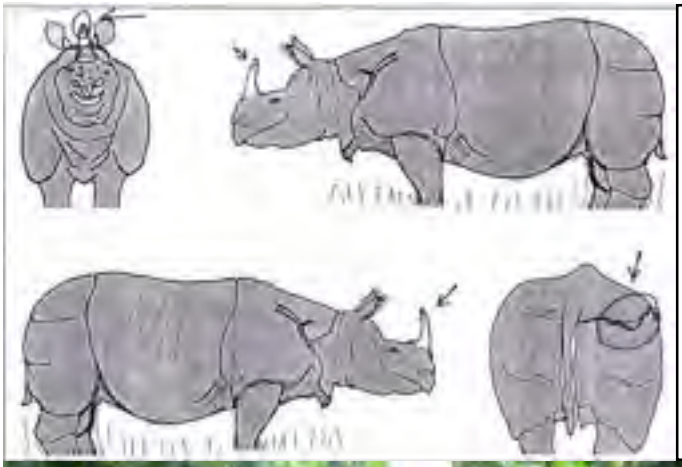
Sex- M Age- Adult (>10years)

Calf Position- NA

Remarks-

Last updated- 03.04.2009

Key Identity-	Left year bears a cut mark.
Horn-	*Elongated and slender.*
Ear-	*Ears are clean and short hair present.*
Skin Folds-	*ULCF is flattened towards RXLF on LLCF posses tubercles.*
Tail-	*Tip of the tail is slender from the middle point.*
Remarks-	



Reference No. M04

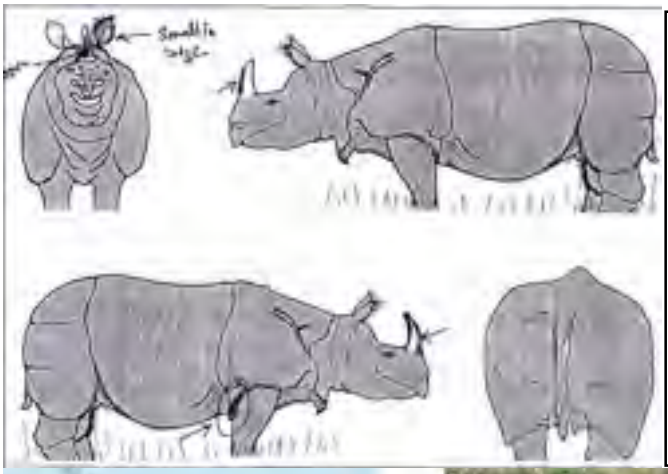
Sex- M Age- Adult (>10years)

Calf Position- NA

Remarks-

Last updated- 12.09.2009

Key Identity-	*Tip of the horn is broken and URCF is like "{" shaped.*
Horn-	*Horn is thick 5-7 inch in length and the tip is broken.*
Ear-	*Both the Ears are clean and short hairy.*
Skin Folds-	*URCF is "{" shaped LTF and RTF are mot bold.*
Tail-	*tail is elongated and normal.*
Remarks-	



Reference No. M05

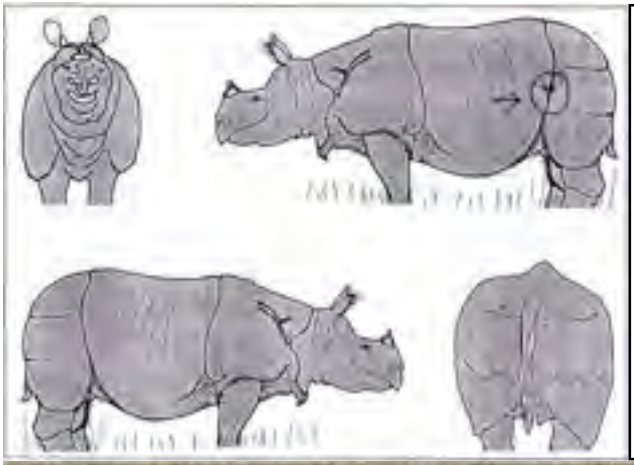
Sex- M Age- Adult (>10years)

Calf Position- NA

Remarks-

Last updated- 06.05.2009

Key Identity-	*Left ear is small compared to right ear and observed pointing forwards most of the time.*
Horn-	*Horn is thick , Blunt and possess a groove in the front side.*
Ear-	*Left ear is small and observed pointing forwards most of the time.*
Skin Folds-	*are prominent; Right front leg shown extra fold from the main fold.*
Tail-	*tail is elongated thicker base and slender tip.*
Remarks-	



Reference No. M06

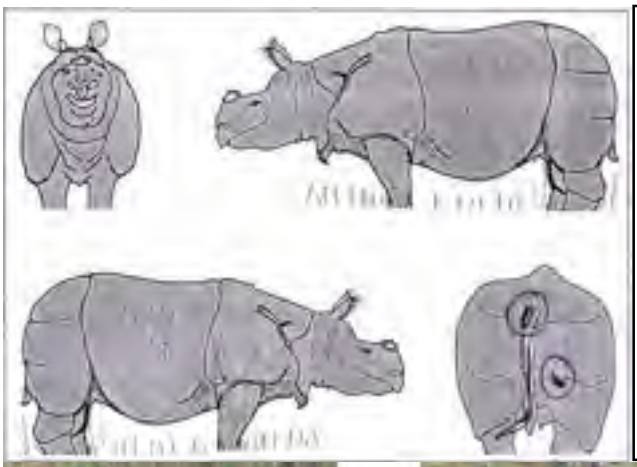
Sex- F Age- Adult (7-9 years)

Calf Position- <1 year calf

Remarks- Calf sex unidentified

Last updated- 05.05.2009

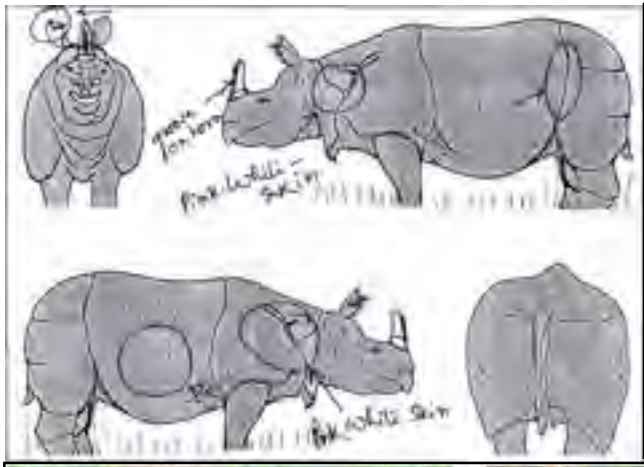
Key Identity-	A *"V" shaped cut mark found on RLXF at ULCF position.*
Horn-	*Horn is very short, less than 3 inch and slender.*
Ear-	*Both the ears are clean and no hair.*
Skin Folds-	*RLXF posses a "V" shaped cut mark at ULCF position.*
Tail-	T*ail is shorter with thick base and slender tip.*
Remarks-	



Reference No. M07

Sex-M Age- SA (3-6 years)
Calf Position- NA
Remarks- Heavily injured and weak
Last updated- 17.05.2008

Key Identity-	*Deep wound found on the base of the tail.*
Horn-	*Horn is not developed much.*
Ear-	*Both the ears are clean and no hair.*
Skin Folds-	*Not developed. LRCF injured by other rhino.*
Tail-	*tail is extraordinarily long and slender, reaching up to base of the leg fold.*
Remarks-	



Reference No. M08

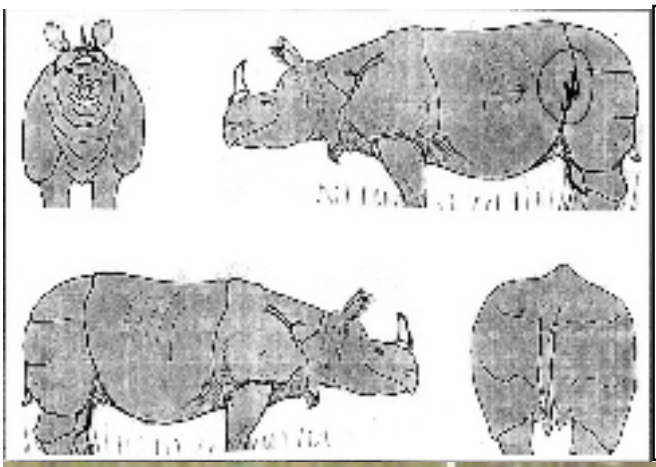
Sex-F Age- A (>10 years)

Calf Position- F Calf of 2-3 years

Remarks- Seems very old

Last updated- 12.09.2008

Key Identity-	Right ear *loss one part, Pink pigmentation over skin found in whole body.*
Horn-	*Horn thick and blunt, groove fond in front side.*
Ear-	Right ear *loss one part, left ear is clean with long and dense hair.*
Skin Folds-	*Pigmentation found beneath the skin folds.*
Tail-	*tail is short and slender.*
Remarks-	*Seems very old age, health condition is bad, and calf is clean.*



Reference No. M09

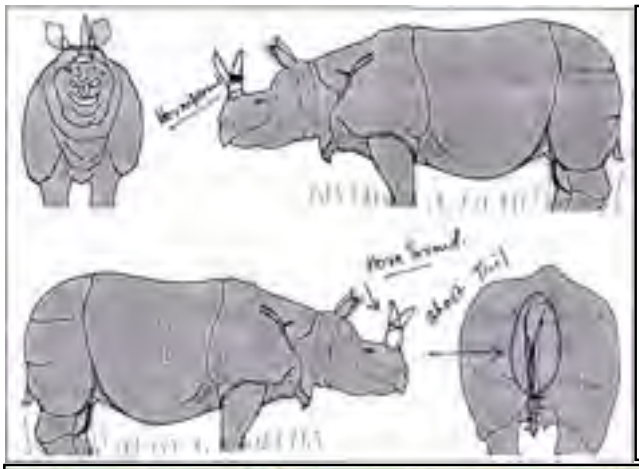
Sex-F Age- A (>10 years)

Calf Position-Calf of <2 years

Remarks- Sex of calf not known

Last updated- 14.07.2009

Key Identity-	*Prominent cut mark found on RLXF skin folds between ULCF and LLCF.*
Horn-	*Horn is slender and 6-7 inch in length.*
Ear-	Both the ears are *clean with long and dense brown hair.*
Skin Folds-	*Prominent cut mark found on RLXF.*
Tail-	*tail is elongated and base is thick.*
Remarks-	Calf is clean.



Reference No. M10

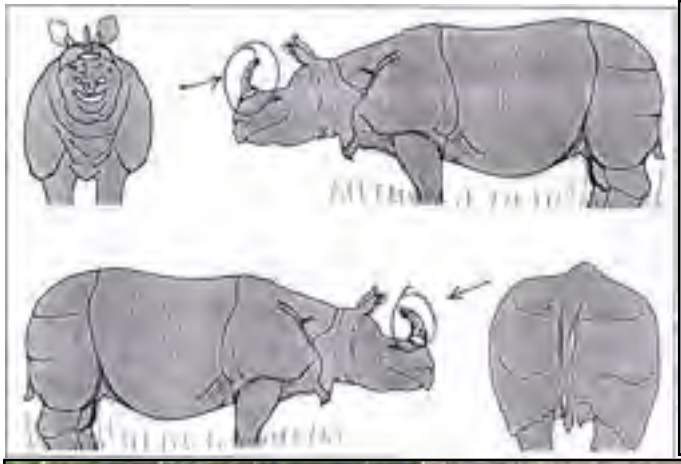
Sex-M Age- Adult (>10 years)

Calf Position-NA

Remarks- Dominant Male

Last updated- 06.11.2008

Key Identity-	*Tail is very short, the base is thick around 2 inch rest 6inch is slender, Horn Broken.*
Horn-	*Horn broke, was well developed and around 8-12 inch in length.*
Ear-	Right ear *loss one part, left ear is clean with short hair.*
Skin Folds-	*Prominent and clean.*
Tail-	*is extreamly short; the base is thick around 2 inch rest 6inch is slender.*
Remarks-	*Dominant male.*



Reference No. M11

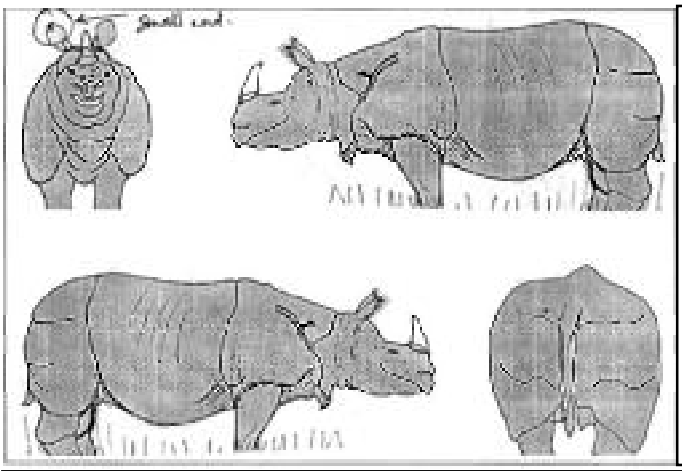
Sex-F Age- A (>10 years)

Calf Position-F calf of <1 year

Remarks- Very aggressive

Last updated- 08.05.2009

Key Identity-	*Horn is bend backward, Tip of the horn is like fish tail, groove present both side of the horn.*
Horn-	*Horn is bend backward, Tip of the horn is like fish tail, groove present both side of the horn.*
Ear-	Both the *ears are clean with no hair.*
Skin Folds-	*clean.*
Tail-	*is normal.*
Remarks-	Very aggressive in nature.



Reference No. M12

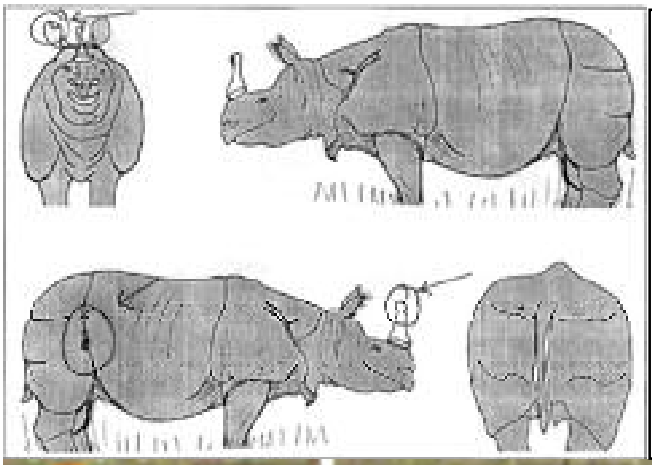
Sex-M Age- A (>10 years)

Calf Position-NA

Remarks-

Last updated16.05.2009

Key Identity-	*Small cut on Right ear*
Horn-	*Horn is thick blunt and 6-7 inches in length.*
Ear-	Right ear possess a small cut mark, left is clean and hairless.
Skin Folds-	*clean.*
Tail-	*is normal.*
Remarks-	



Reference No. M13

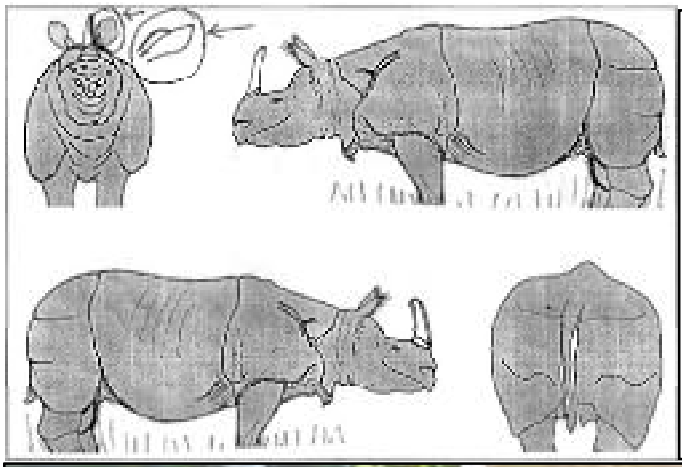
Sex-F Age- A (>10 years)

Calf Position-M calf of 3-4 years

Remarks-

Last updated-23.12.2009

Key Identity-	*Tip of the horn is Bulb like, straight; Right ear loss one part; RRXF possess small outgrowth.*
Horn-	*Horn is straight and the end is bulb like.*
Ear-	Right ear loss one part, left is clean and brown hair found.
Skin Folds-	*RRXF possess small outgrowth between URCF and LRCF.*
Tail-	*is normal.*
Remarks-	*calf is clean*



Reference No. M14

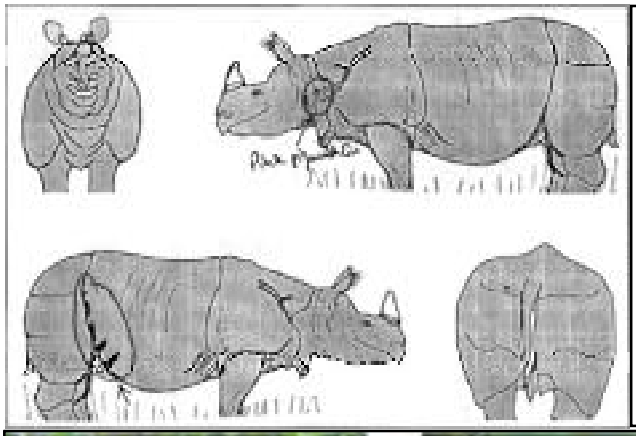
Sex-M Age- A (>10 years)

Calf Position-NA

Remarks-

Last updated-11.09.2008

Key Identity-	*Left ear looking like a newly growing ear after cutting the original one.*
Horn-	*Horn is straight and slightly band backward.*
Ear-	*Left ear looking like a newly growing ear after cutting the original one.*
.Skin Folds-	*prominent and smooth..*
Tail-	*Elongated and thick base.*
Remarks-	*calf is clean*



Reference No.M15

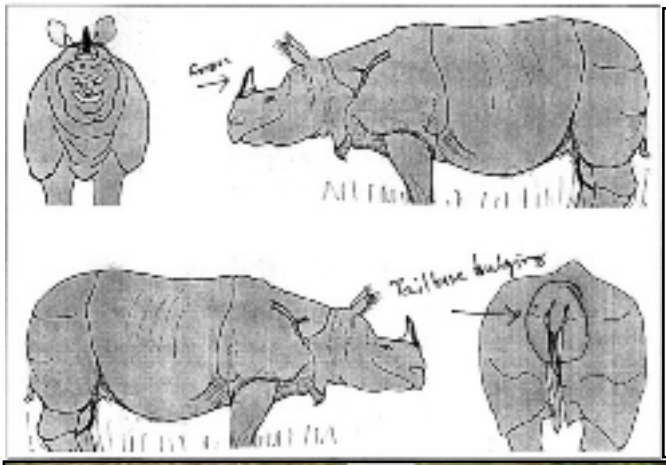
Sex- M Age- Adult (>10years)

Calf Position- NA

Remarks- old age

Last updated- 11.03.2008

Key Identity-	*Right ear possess a cut mark and pink pigmentation near neck folds.*
Horn-	*is thick blunt and 5-6 inch in length.*
Ear-	*Left Ear is clean with short brown hair present and right ear posses a cut mark.*
Skin Folds-	*RRXF have some swelling like irregularities, neck folds are prominent.*
Tail-	*Tail is short with thick base.*
Remarks-	*old age horn degenerating*



Reference No.M16

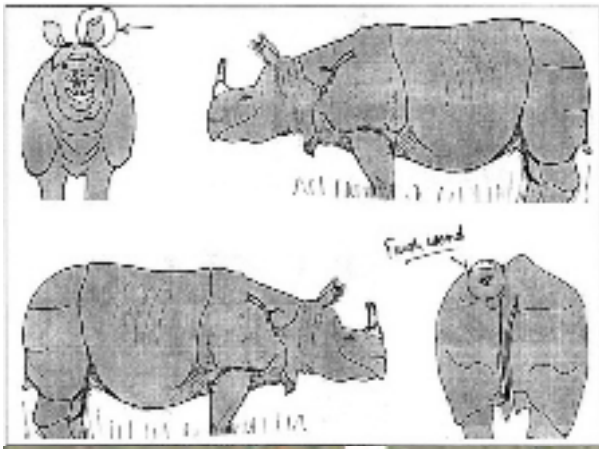
Sex- F Age- Adult (>10years)

Calf Position- M of 3-5 years

Remarks- injured by villagers

Last updated- 29.03.2009

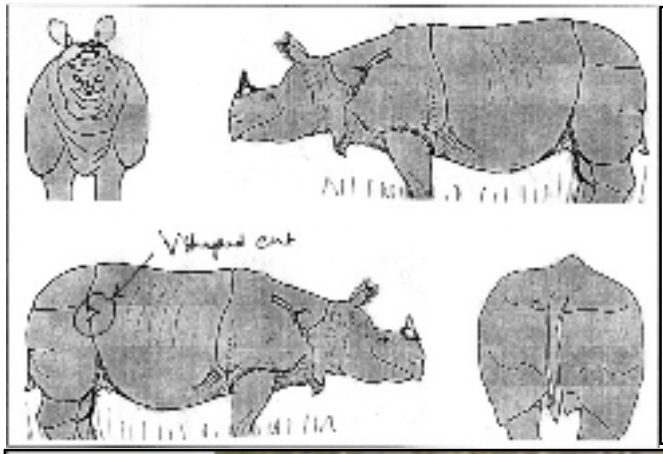
Key Identity-	*Base of the tail is bulging and tail is short.*
Horn-	*is 5-6 inch in length and possess distinct groove from front side.*
Ear-	*Both the Ears are clean with brown hair present (Not dense).*
Skin Folds-	*RLXF Possess a depression over ULCF.*
Tail-	*Tail base is bulky looking like a swelling and the rest of the tail is slender and short.*
Remarks-	*Injured by villager during stray.*



Reference No.M17

Sex- F Age- Adult (>10years)
Calf Position- <1 years calf
Remarks- Sex of the calf is unknown
Last updated- 06.05.2009

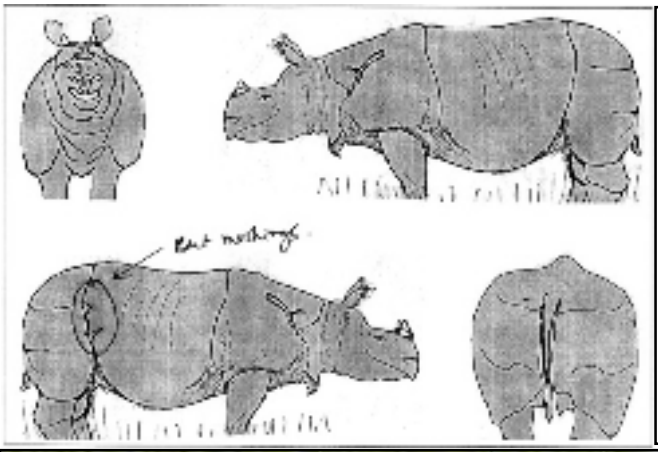
Key Identity-	*Left ear loss one part; RLXF possess one small cut mark between the URCF & LRCF.*
Horn-	*is slender elongated 7-8 inch in length, surface is ruff and tip is blunt.*
Ear-	*Left ear loss one part in the upper inner side, right ear is clean with short brown hair.*
Skin Folds-	*RLXF possess one small cut mark between the URCF & LRCF.*
Tail-	*tail is elongated with thick base and uniformly pointing towards tip.*
Remarks-	



Reference No.M18

Sex- F Age- Adult (>10years)
Calf Position- F, 2-4 years calf
Remarks- Calf is clean
Last updated- 05.05.2009

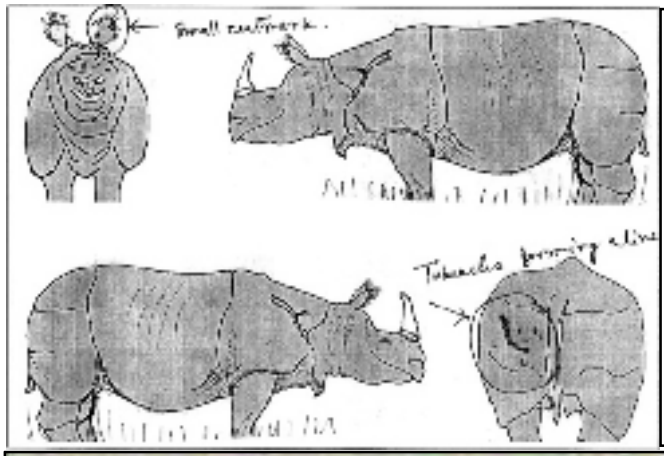
Key Identity-	*V shaped cut mark on RRXF near URCF.*
Horn-	Horn *is slender and short (2-3 inch in length).*
Ear-	*Both the ears are clean.*
Skin Folds-	*V shaped cut mark on RRXF near URCF.*
Tail-	*Tail is normal in length and clean.*
Remarks-	Female calf and clean



Reference No.M19

Sex- F Age- Adult (>10years)
Calf Position- No Calf attached
Remarks- Ready for first calving
Last updated- 28.02.2009

Key Identity- *Two prominent cut marks near URCF and LRCF.*
Horn- Horn *is short 2-3 inches over the base plate.*
Ear- *Both the ears are clean with thick brown hair.*
Skin Folds- *Two prominent cut marks near URCF and LRCF.*
Tail- *Tail is normal in length and clean.*
Remarks- Ready for first calving



Reference No.M20

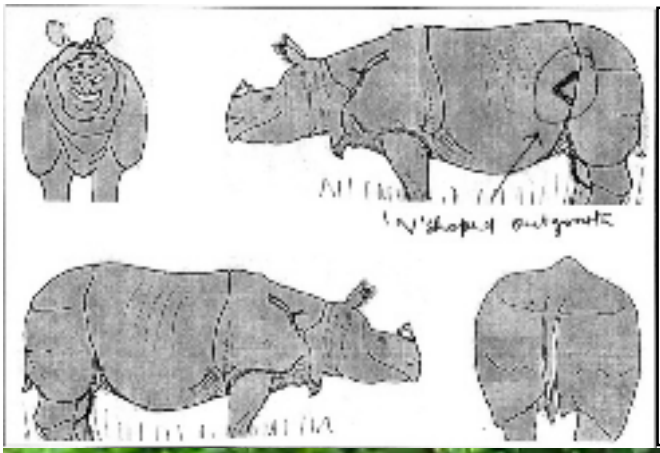
Sex- M Age- Adult (>10years)

Calf Position- NA

Remarks-

Last updated- 28.02.2009

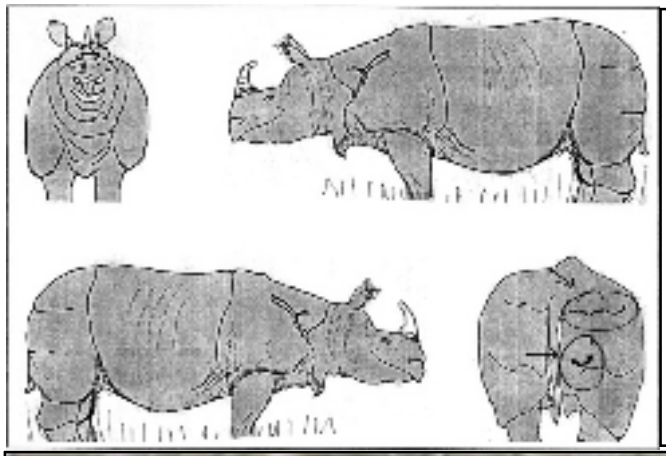
Key Identity-	*Left ear have small cut mark.* Tubercles on left ramp formed a "L" shaped line.
Horn-	Horn is slender and elongated (7-9 inches in length); surface of the horn is screw like.
Ear-	*Left ear have small cut mark, right is clean, ears possess long dense brown hair.*
Skin Folds-	*prominent and clean, Tubercles well developed.*
Tail-	*Tail is Thick and elongated.*
Remarks-	



Reference No.M21

Sex- F Age- Adult (7-9years)
Calf Position- 1-2 years
Remarks- Sex of the calf not known
Last updated- 21.07.2009

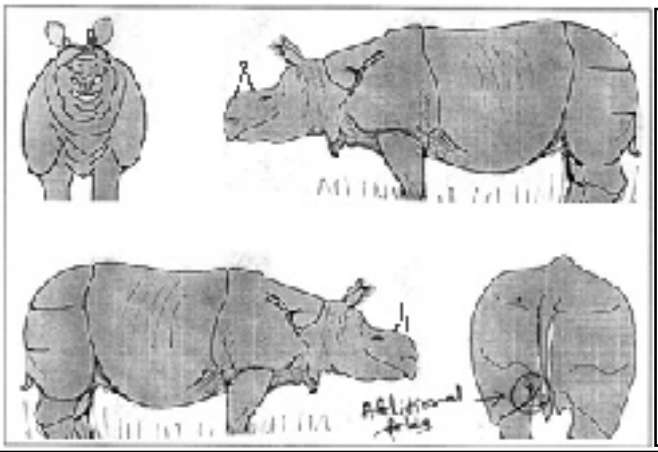
Key Identity-	*A "V" shaped stricter on left abdomen touching RLXF, FLXF extend up to left front leg forming rounded shape.*
Horn-	Horn is short and slender 2-3 inches in length.
Ear-	*Both the ears are clean and no hair.*
Skin Folds-	*A "V" shaped stricter on left abdomen touching RLXF, FLXF extend up to left front leg.*
Tail-	*Tail is elongated and clean.*
Remarks-	



Reference No.M22

Sex- F Age- Adult (7-9years)
Calf Position- 1-3 years
Remarks- Sex of the calf not known
Last updated- 05.05.2009

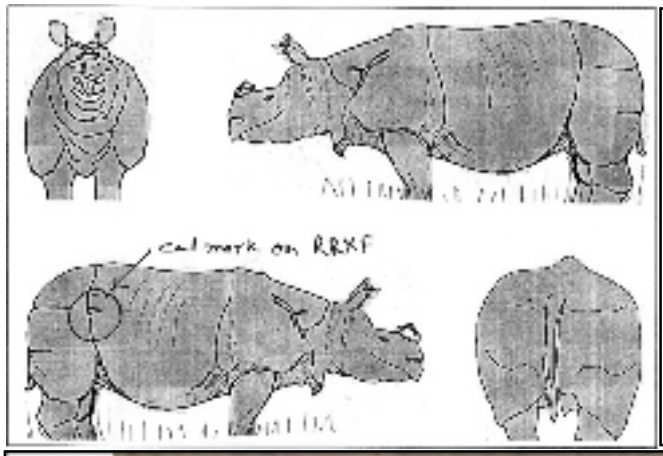
Key Identity-	*Tubercle pattern in the right ramp is "J" shaped over RLXF, tail bas is oval shaped, URCF is identical bands.*
Horn-	Horn is short and slender 2-3 inches in length.
Ear-	*Both the ears are clean.*
Skin Folds-	*Prominent.*
Tail-	*Tail is shorter and base is oval shaped in structure.*
Remarks-	*Calf is clean.*



Reference No.M23

Sex- F Age- Adult (>10 years)
Calf Position- <1years
Remarks- Sex of the calf not known; tail is crowling
Last updated- 14.04.2009

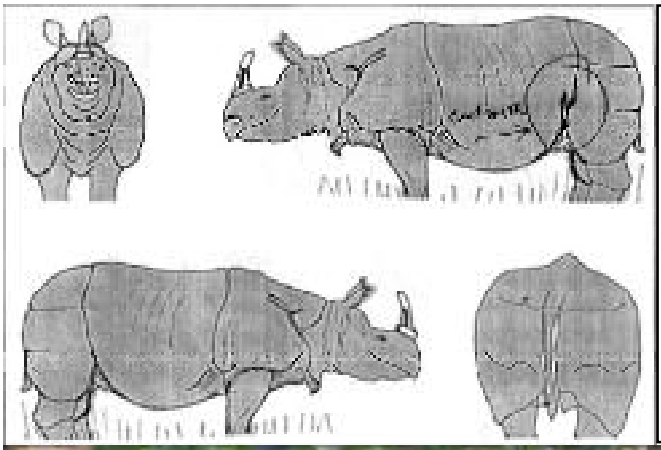
Key Identity-	*Body is large and bally is protruding; folds over the left hind legs possess additional folds; Tail of the calf is crowling.*
Horn-	Horn is slender but the base is thick forming a neck between the base and the horn.
Ear-	*Both the ears are clean.*
Skin Folds-	*Fold over left hind leg possess additional fold, rest are clean.*
Tail-	*Tail base is slightly oval shaped and tip is slender.*
Remarks-	*Calf tail is crawling*



Reference No.M24

Sex- F Age- Adult (7-9 years)
Calf Position- M ; 2-4years
Remarks- Sex of the calf not known; tail is crawling
Last updated- 28.03.2009

Key Identity- *Cut mark on RRXF near URCF.*
Horn- *Horn is not well developed base is plate like.*
Ear- *Both the ears are clean.*
Skin Folds- *Cut mark on RRXF near URCF.*
Tail- *Tail clean and uniformly slender from base to tail.*
Remarks-



Reference No.M25

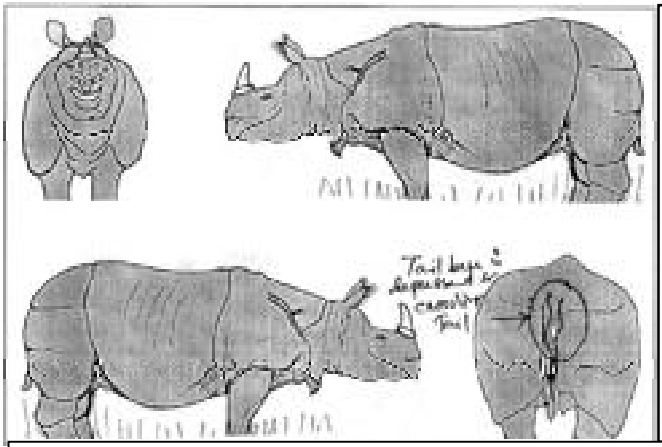
Sex- M Age- Adult (>10 years)

Calf Position- NA

Remarks-

Last updated- 12.09.2009

Key Identity-	*RLXF received cut near LLCF from down to up.*
Horn-	*Horn elongated thick and possess grooves from either side.*
Ear-	*Both the ears are clean and bears brown hair.*
Skin Folds-	*RLXF received cut near LLCF from down to up.*
Tail-	*Tail clean and elongated.*
Remarks-	



Reference No.M26

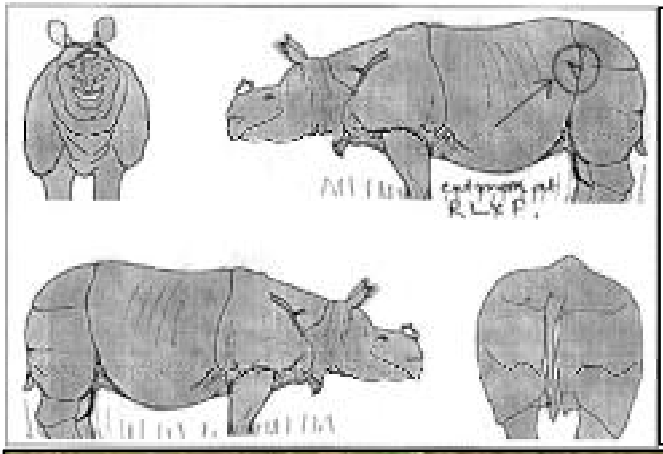
Sex- M Age-Sub- Adult (7-9 years)

Calf Position- NA

Remarks-

Last updated- 28.03.2009

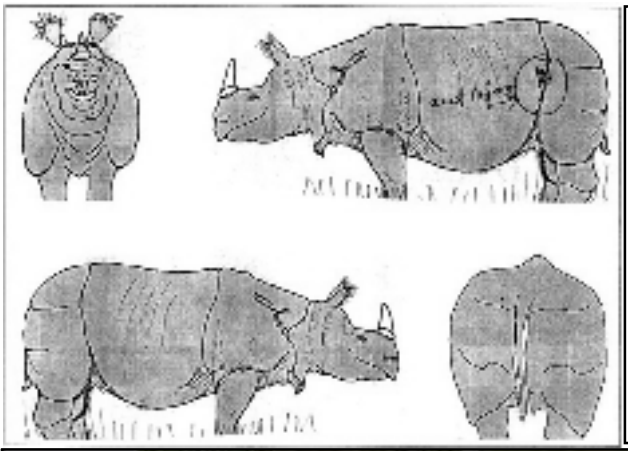
Key Identity-	*Base of the tail possesses a band and depressed.*
Horn-	*Horn is thick and grown approximately 4-5 inches in length*
Ear-	*Both the ears are clean and bear dense brown hair.*
Skin Folds-	*Folds are clean.*
Tail-	*Tail crawling and base is depressed.*
Remarks-	



Reference No.M27

Sex- F Age-Adult (7-9 years)
Calf Position- <1 years
Remarks- sex of the calf unknown; First calf.
Last updated- 27.02.2009

Key Identity- *RLXF have a cut injury near ULCF.*
Horn- *Horn not developed (1-2 inches)*
Ear- *Both the ears are clean.*
Skin Folds- *RLXF have a cut injury near ULCF.*
Tail- *Tail base is thick and tip is slender.*
Remarks-



Reference No.M28

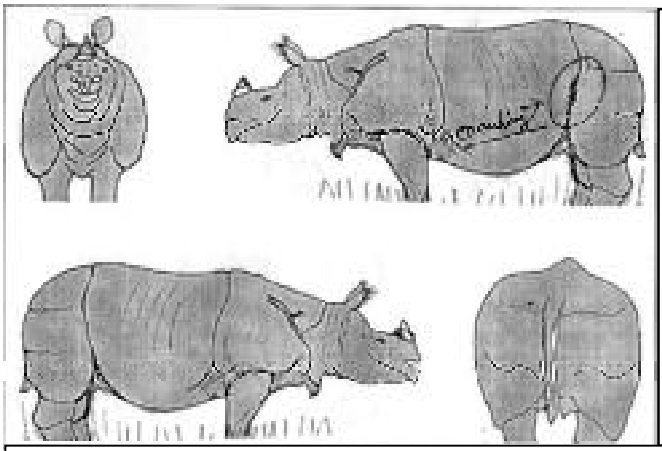
Sex- M Age-Sub-Adult (7-8 years)

Calf Position- NA

Remarks-

Last updated- 28.02.2009

Key Identity-	*RLXF have a cut injury near ULCF.*
Horn-	*Horn is thick and developed around 4-6 inches*
Ear-	*Both the ears are clean with dense long brown hair.*
Skin Folds-	*RLXF have a cut injury near ULCF.*
Tail-	*Tail is elongated.*
Remarks-	



Reference No.M29

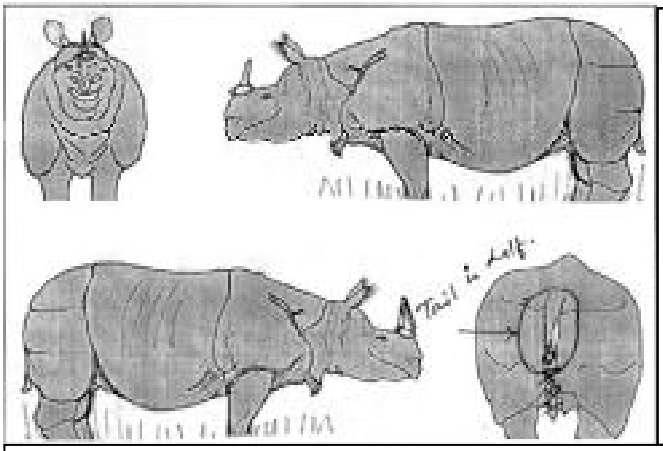
Sex- F Age-Sub-Adult (4-6 years)

Calf Position- No calf attached

Remarks-.

Last updated- 27.07.2009

Key Identity-	*RLXF have a saw like edge near ULCF &LLCF.*
Horn-	*Horn is slender and 4-6 inches in length.*
Ear-	*Both the ears are clean with dense long brown hair.*
Skin Folds-	*RLXF have a saw like edge near ULCF &LLCF.*
Tail-	*Tail is normal and clean.*
Remarks-	



Reference No.M30

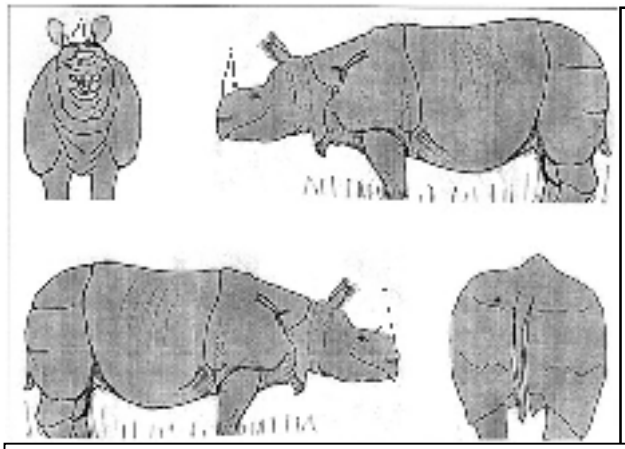
Sex- F Age-Sub-Adult (>10 years)

Calf Position- F, of 3-4 years

Remarks-.Died on 10.10.2008

Last updated- 10.10. 2008

Key Identity-	*Tail losses at its half length and the tip of the tail is bulblike.*
Horn-	*Horn elongated and slender, 5-7 inches in length*
Ear-	*Both the ears are clean with dense long brown hair.*
Skin Folds-	*Prominent and clean.*
Tail-	*Tail losses at its half length and the tip of the tail is bulblike.*
Remarks-	Died during the study



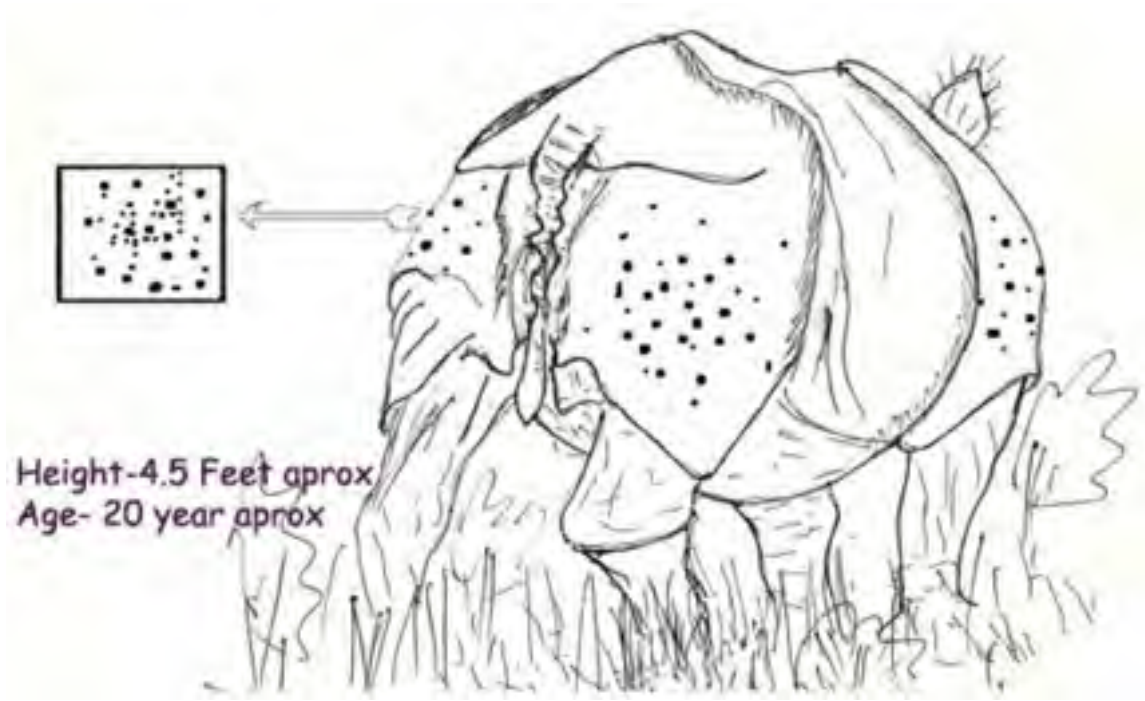
Reference No.M31

Sex- F Age-Adult (>10 years)

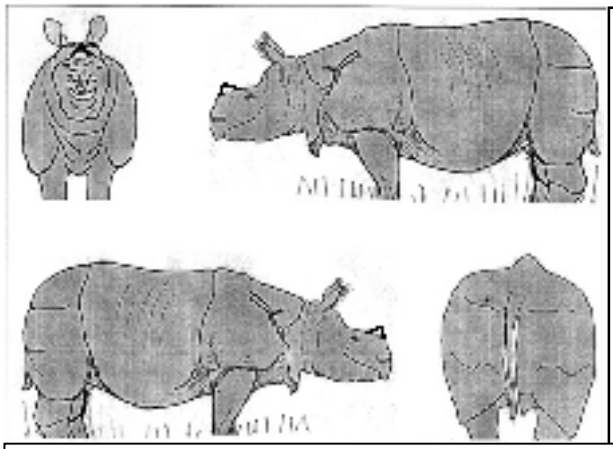
Calf Position- M calf of >2 years

Remarks- Died on 09.02.2007

Last updated- 09.02.2007



Key Identity-	*Tail is crawling, on left rump tubercles are arranged like a letter "4".*
Horn-	*Horn is thick and elongated 5-7 inches in length*
Ear-	*Both the ears are clean with brown hair.*
Skin Folds-	*Prominent and clean.*
Tail-	*Tail is crawling.*
Remarks-	Died during the study on 09.02.2007



Reference No.M32

Sex- M Age-Sub-Adult (6-8 years)

Calf Position- NA

Remarks- Died on 31.07.2008

Last updated- 31.07.2008

Key Identity- *Both the ear possess cut mark*

Horn- *Horn is short.*

Ear- *Both the ears possess cut marks.*

Skin Folds- *Prominent and clean.*

Tail- *Tail is normal and clean.*

Remarks- Died during the study on 31.07.2008

Reference No.C01

Sex- F Age-Sub-Adult (6-8 years)

Calf Position- No calf attached

Remarks-

Last updated- 15.07.2009

Key Identity-	*Tip of the Horn is bulb like; Surface of the horn is not smooth.*
Horn-	*Tip of the Horn is bulb like, Surface of the horn is not smooth and about 3 inch in length*
Ear-	*Both the ears are clean with dense hair.*
Skin Folds-	Skin Folds are *clean.*
Tail-	*Tail is normal and clean.*
Remarks-	Ready for breading.

Reference No.C02

Sex- F Age-Sub-Adult (6-8 years)

Calf Position- No calf attached

Remarks-

Last updated- 17.07.2009

Key Identity- *Horn not developed only base plate developed.*

Horn- *Horn not developed*

Ear- *Both the ears are clean.*

Skin Folds- Skin folds are *clean.*

Tail- *Tail is normal and elongated.*

Remarks-

Reference No.C03

Sex- M **Age-Sub-Adult (5-6 years)**

Calf Position- NA

Remarks-

Last updated- 18.07.2009

Key Identity-	*horn is short and oval shaped, ear possess long and dense hair*
Horn-	*horn is short and oval shaped*
Ear-	*Both the ears are clean and possess long and dense hair.*
Skin Folds-	*clean.*
Tail-	*Tail is normal and elongated.*
Remarks-	

Reference No.C04

Sex- M **Age-Adult (>10 years)**

Calf Position- NA

Remarks-

Last updated- 18.07.2009

Key Identity-	*horn is slender Elongated and sharply pointed,*
Horn-	*horn is short and oval shaped*
Ear-	*Both the ears are clean and possess long and dense hair.*
Skin Folds-	Prominent and *clean*
Tail-	*Tail is normal and elongated.*
Remarks-	

Reference No.C05

Sex- F Age-Sub-Adult (>10 years)

Calf Position- No calf attached

Remarks- ready for first calfing

Last updated- 18.07.2009

Key Identity-	*Horn Triangular,*
Horn-	*Horn Triangular just emerge from the base plate.*
Ear-	*Both the ears are clean and possess long and dense hair.*
Skin Folds-	*Not bold and clean*
Tail-	*Tail is normal and elongated.*
Remarks-	No Calf attached, ready for first calving

Reference No.C06

Sex- F Age-Adult (>10 years)

Calf Position- calf <1 year

Remarks- Sex of the calf not known

Last updated- 14.07.2009

Key Identity-	*Horn is sharp Looking like attached on the base plate, a small calf attached.*
Horn-	*Horn Triangular just emerge from the base plate.*
Ear-	*Both the ears are clean.*
Skin Folds-	*are clean*
Tail-	*Tail is normal and elongated.*
Remarks-	Small calf (<1 year) attached.

Reference No.C07

Sex- F Age-Sub-Adult (>10 years)

Calf Position- calf <1 year

Remarks- Sex of the calf not known

Last updated- 14.07.2009

Key Identity-	*Horn not developed fully,2.5 inches approx., base of the horn thick and tip is blunt.*
Horn-	*Horn not developed fully,2.5 inches approx., base of the horn thick and tip is blunt.*
Ear-	*Both the ears are clean.*
Skin Folds-	skin folds *are clean*
Tail-	*Tail is normal and elongated.*
Remarks-	No calf attached.

Reference No.C08

Sex- M **Age-Sub-Adult (6-7 years)**

Calf Position- NA

Remarks-

Last updated- 29.03.2009

Key Identity-	*Horn is 3-4 inches approx.; Triangular band backward, possess ring on the tip.*
Horn-	*Horn is 3-4 inches approx.; Triangular band backward, possess ring on the tip.*
Ear-	*Both the ears possess long hair.*
Skin Folds-	Skin folds are *clean*
Tail-	*Tail is normal and elongated.*
Remarks-	Small calf (<1 year) attached.

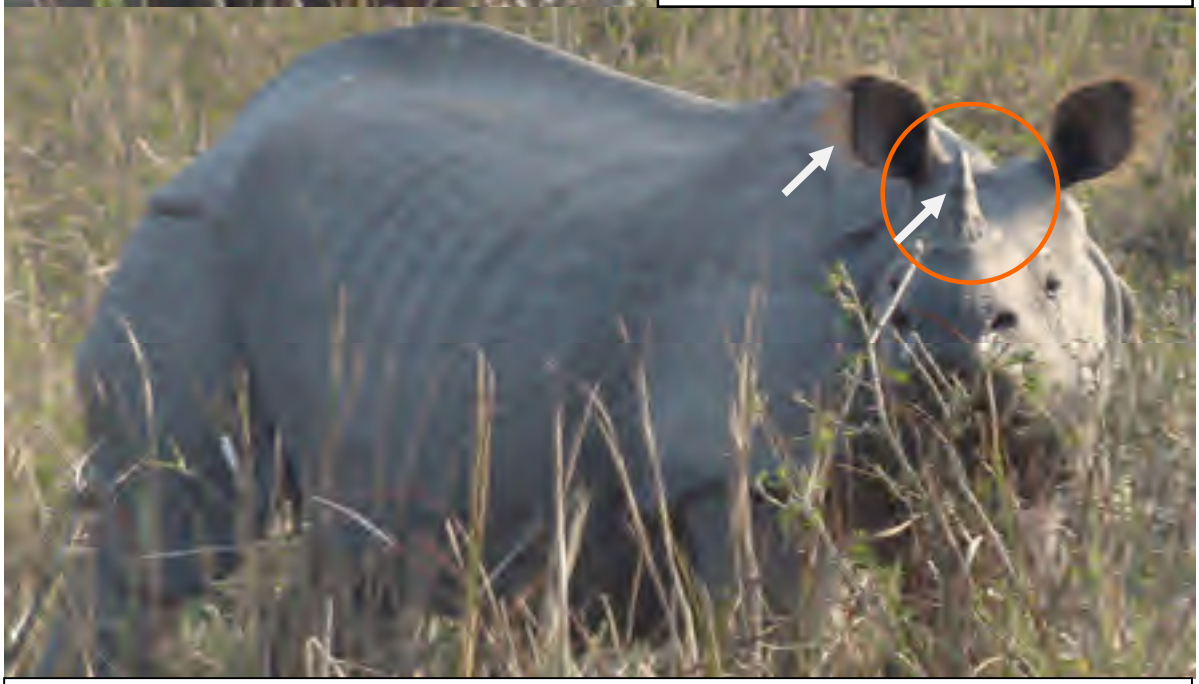
Reference No.C09

Sex- M **Age-Sub Adult (7-9 years)**

Calf Position- NA

Remarks-

Last updated- 21.05.2009



Key Identity-	*Horn Triangular, three rings found; ears possess short dense hair*
Horn-	*Horn Triangular, three rings found*
Ear-	*Both the ears possess short dense hair.*
Skin Folds-	Skin folds are bold and *clean*
Tail-	*Tail is normal and elongated.*
Remarks-	

Reference No.C10

Sex- F Age-Adult (8-10 years)

Calf Position- calf 2-3 year

Remarks- Sex of the calf not known

Last updated- 21.05.2009

Key Identity-	*Horn is sharp, pointed and 2 inches approx., a calf around two years of age attached.*
Horn-	*Horn is sharp, pointed and 2 inches approx in length.*
Ear-	*Both the ears are clean with long hair.*
Skin Folds-	Skin folds *are clean*
Tail-	*Tail is normal and elongated.*
Remarks-	Calf is clean.

Reference No.C11

Sex- F Age-Adult (>10 years)

Calf Position- M calf 2-3 years

Remarks-

Last updated- 21.05.2009

Key Identity-	*Front side of the horn possess a distinct groove, a male calf attached.*
Horn-	*Horn Triangular just emerge from the base plate.*
Ear-	*Both the ears are clean.*
Skin Folds-	*are clean*
Tail-	*Tail is normal and elongated.*
Remarks-	*calf is clean.*

Reference No.C12

Sex- M Age-Adult (>10 years)

Calf Position- NA

Remarks-

Last updated- 12.09.2009

Key Identity-	*Horn very long (12-13 inches) sharp pointed and bend backward.*
Horn-	*Horn very long (12-13 inches) sharp pointed and bends backward.*
Ear-	*Both the ears are clean with long hair.*
Skin Folds-	*Skin folds are clean and bold*
Tail-	*Tail is normal and elongated.*
Remarks-	*Dominant male.*

Reference No.C13

Sex- M Age-Adult (>10 years)

Calf Position- NA

Remarks-

Last updated- 12.09.2009

Key Identity-	*Horn is Very long, tip is blunt, ear possess very short*
Horn-	*Horn is Very long(12-14 inch in length), tip is blunt.*
Ear-	*Both the ears are clean and possess very short hair.*
Skin Folds-	*skin folds are prominent and clean*
Tail-	*Tail is normal and elongated.*
Remarks-	

Reference No.C14

Sex- M Age-SubAdult (5-7 years)

Calf Position- NA

Remarks-

Last updated- 28.03.2009

Key Identity-	*Horn not developed no hair on ears.*
Horn-	*Horn Triangular just emerge from the base plate.*
Ear-	*Both the ears are clean, no hair found.*
Skin Folds-	Skin folds a*re clean and not prominent.*
Tail-	*Tail is normal and elongated.*
Remarks-	

s unicornis)
in Pobitora Wildlife Sanctyary, Assam, India.

Reference No.C15

Sex- F Age-Adult (8-10 years)

Calf Position- F calf 2-3 years

Remarks- first calving

Last updated- 28.02.2009

Key Identity-	*Short horn with a big female calf.*
Horn-	*Horn just emerges from the base plate.*
Ear-	*Both the ears are clean possessing very short hair.*
Skin Folds-	*are clean*
Tail-	*Tail is normal and elongated.*
Remarks-	Big calf (2-3 year) attached.

Reference No.C16

Sex- F Age-Adult (>10 years)

Calf Position- M calf >3 year

Remarks-

Last updated- 28.02.2009

Key Identity-	*Horn is triangular and very short, a Big Male calf attached.*
Horn-	*Horn Triangular and short.*
Ear-	*Both the ears are clean with long dense hair.*
Skin Folds-	Skin folds a*re moderately developed and clean.*
Tail-	*Tail is normal and elongated.*
Remarks-	Big Male calf (>3 year) attached.

Reference No.C17

Sex- F Age-Adult (8-10 years)

Calf Position- M calf 1-2 years

Remarks-

Last updated- 05.05.2009

Key Identity-	*Short pointed horn with a male calf attached.*
Horn-	*Horn short Triangular and pointed.*
Ear-	*Both the ears are clean.*
Skin Folds-	*Skin folds are clean*
Tail-	*Tail is normal and elongated.*
Remarks-	Male calf (1-2 years) attached.

Reference No.C18

Sex- F Age-Adult (>10 years)

Calf Position- M calf of 2-3 years old.

Remarks-

Last updated- 05.05.2009

Key Identity-	*Horn is elongated slender with number of small ring like stricter, a male calf of 2-3 years age attached.*
Horn-	*Horn is elongated slender with number of small ring like stricter.*
Ear-	*Both the ears are clean with long hair.*
Skin Folds-	Skin folds are clean.
Tail-	*Tail is short and triangular in shape.*
Remarks-	A *male calf of 2-3 years age attached calf is clean*.

Reference No.C19

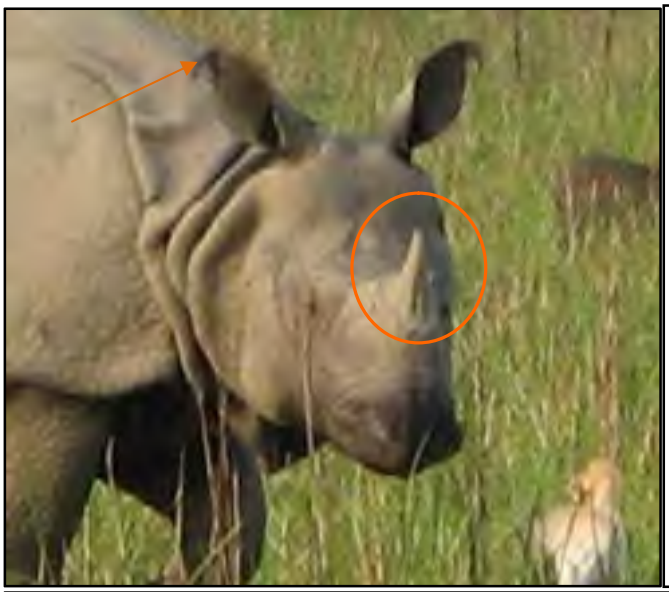
Sex- F Age-Adult (>10 years)

Calf Position- Calf of 2-3 year

Remarks- Sex of the calf not known

Last updated- 29.03.2009

Key Identity-	*Horn is elongated on the base plate, a calf of 2-3 years of age attached.*
Horn-	*Horn is elongated on the base plate.*
Ear-	*Both the ears are clean with very short hair.*
Skin Folds-	*Skin folds are moderately developed and clean.*
Tail-	*Tail is normal.*
Remarks-	*Sex of calf is unknown.*



Reference No.C20

Sex- M Age-Adult (10-12 years)

Calf Position- NA

Remarks-

Last updated- 26.04.2009

Key Identity-	*Horn is 3-4 inches in length, triangular and thick base.*
Horn-	*Horn is 3-4 inches in length, triangular and thick base.*
Ear-	*Both the ears are clean with long and dense hair.*
Skin Folds-	*Skin folds are bold and clean*
Tail-	*Tail is normal and elongated.*
Remarks-	

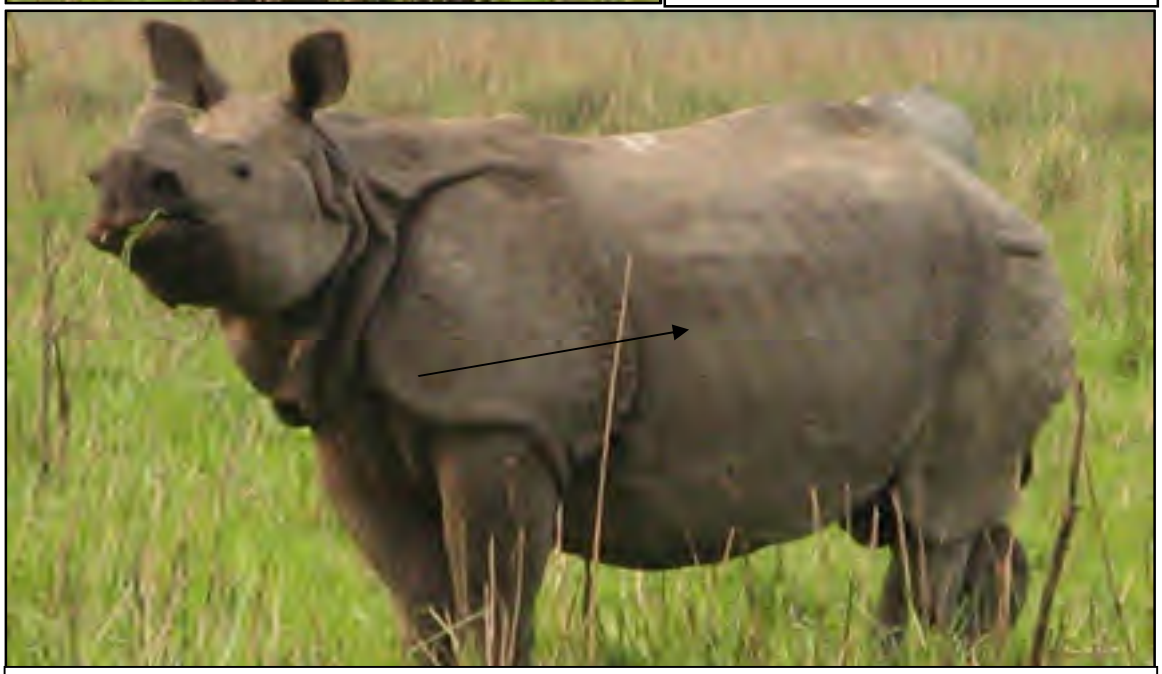
Reference No.C21

Sex- M Age-Adult (>10 years)

Calf Position- NA

Remarks- Body colour is brownish

Last updated- 26.04.2009



Key Identity-	*Horn is degenerating looking like horn of younger male.*
Horn-	*Horn is degenerating looking like horn of younger male.*
Ear-	*Both the ears are clean long hair present.*
Skin Folds-	*Skin folds are well developed and clean*
Tail-	*Tail is normal and elongated.*
Remarks-	Old age, Body colour become brownish

Reference No.C22

Sex- F Age-Sub-Adult 5-6 years)

Calf Position- No calf attached

Remarks-

Last updated- 05.05.2009

Key Identity-	*Horn is Triangular, not developed; no hair on ears and tail base is thick.*
Horn-	*Horn is Triangular, not developed.*
Ear-	*Both the ears are clean, no hair present.*
Skin Folds-	*Skin folds are clean*
Tail-	*Tail base is thick.*
Remarks-	

4.4 DISCUSSION

The skill of identification of individual Rhino accurately needed lot of practice, onsite records of characters and photographs from all possible angles were found very essential for verification of spot identification during analysis. Patton (2007) was also suggested the same after his study on minimum population demography of black rhino in Salient of Aberdare National Park, Kenia. It was observed that some of the key indentifying characters was overlooked during direct observation, but rerecorded during the analysis of photographic evidences which can be easily re-verified in the next re-sighting of the individual.

As the study was progressing at pobitora wildlife sanctuary it became more interesting as the searching effort and time taken for identification of individuals were reducing due to use of standard description in the form of rhino reference card. Prior to the study rhinos in the sanctuary were classified on the basis of age, sex and attachment of calf except some irregular naming of rhinos by some of the front line staff.

In Pobitora wildlife sanctuary it was observed that the study took only one year to make the sighting of new individual fell to zero. Whereas, in Chitwan National Park W. A. Laurie (1978) had taken two and half years to make the registration of new individuals fall to zero. That may be because of dense forest, thick grass cover and vast nature of his study area. It was also noted that the time could be reduced to month in case of Pobitora Wildlife Sanctuary if continued the effort of the study. Therefore, Monitoring of rhino in isolated habitat like Pobitora Wildlife Sanctuary was thought to be the most efficient and

reliable by making individual reference card, as it would overcome the main disadvantage of this techniques of taking longer period to complete a cycle during which new born and deaths may occur without knowing. This was earlier described by W.A. Laurie, 1978 after his study on Rhino population by registering individual rhinos at Chitwan National Park. A possible hypothesis was that conservation threats to the species like- poaching or epidemic outbreak could be minimize by a systemic monitoring system in the level of each and every individual combining the existing park patrol with monitoring may called as patrol based monitoring system. Monitoring of a population in individual level is one of the prime requisite for a true sense meta-population management.

CHAPTER-V:
HABITAT SUITABILITY OF RHINO

5.1 INTRODUCTION

Each species requires a particular habitat, food shelter and other survival needs to the extent of the species are said to be a product of their habitat (Smith, 1974). Wild animal never uses the entire habitat homogenously, only selected zones of the habitat utilization may be determined by the availability of food and other resources (Fjellstad & Steinheim, 1996). Analysis of habitat is an important aspect of wildlife ecology for batter understanding, how an animal makes use of environment (Jethva, 2002). Evaluation of any habitat for its suitability for a particular species requires information on parameters pertaining to the biotic and abiotic components of the habitat, in particular the food, water and shelter (Kushwasha, 2000). Human influence on the habitat has an alarming impact and threatening to the majority of wildlife habitat around the world (Panwar, 1991).

In this chapter the habitat suitability of Pobitora Wildlife Sanctuary for Greater One-horned Rhinos and availability of food plants for the species was observed.

5.2 METHODS

5.2.1 HABITAT SUITABILITY

5.2.1.1 Habitat Map Generation

For this study geo-database of different layers of information has been generated after generating the base maps from Survey of India topomaps (of 1967-68), Single season Indian Remote sensing satellite (IRS LISS III) standard False Color Combination (FCC) image of 2005 on a 1: 50000 scale and the forest department sketch maps on census blocks roads map etc. were used. The 2005 IRS LISS III data was obtained in geo-referenced and projected format based on WGS 84 datum in one scene covering the area. The image processing works had been done using Erdas Imagine and ArcView Image Analyst software to obtain the land cover status for the area (Porwal et al., 1996; Kushwah et al., 1986, 1990). The standard processes for the analyses of satellite data such as extraction, rectification, enhancement and classification were applied for the study. A normal False Color Composite (FCC) was created by applying appropriate band combinations Band 4 (near-infrared), 3(red) and 2(green) for the data (Gibson PJ & Power CH, 2000). Unsupervised classification in the different subset imageries for each of the land cover classes were performed (Lilesand TM and Kiefer RW, 1989). Ground verification of the classified map was done through field surveys covering the whole length and breadth of the area. The field based information was generated mainly using GPS surveying techniques (Burroughs PA, 1986). Garmin Etrex models were

used for the field surveys. Based on the results of the groundtruthing the classification was modified to obtain the present output (Annexure-4).

5.2.1.2 Database Creation

Satellite image was classified as per the important habitat parameters i. e. food, water and shelter through visual interpretation. Proximity to food, water and suitable shelters were taken as positive factors. Proximity to roads (PWD, tourist) human settlements/ agricultural areas were considered as negative factors (Kushwah et al., 1986, 2000). All parameters (i.e. habitats, water body, settlement, roads, agriculture) were digitized and transferred to GIS (Arg info) domain for necessary suitability analysis. Complete analysis was done in two stages. First four maps (habitat, water body, roads & settlements) were generated then merge the layers for final output. The overall habitat suitability was categorized in 4 classes' i. e. suitable, moderately suitable, less suitable and unsuitable (Table-5.1).

Sl No.	Parameters	Suitability(after Kushwah et al., 1986, 2000 with modification)
A. LAND COVER		
1.	Short Grassland	Suitable
2.	Tall Grassland	Moderately suitably
3.	Woodland/ degraded grass land (plain)	less suitable
4.	Woodland (hills)/ area under agricultural activities	Unsuitable
B. WATER BODY		
1.	Within 500 meters	Suitable
2.	Within 1 km	Moderately suitable
3.	Within 2 km	Less suitable
4.	Beyond 2 km	Unsuitable

C. ROAD		
1.	Within 500 meters	Unsuitable
2.	Within 1 km	Less suitable
3.	Within 2 km	Moderately suitable
4.	Beyond 2 km	Suitable
D. SATTLEMENT		
1.	Within 500 meters	Unsuitable
2.	Within 1 km	Less suitable
3.	Within 2 km	Moderately suitable
4.	Beyond 2 km	Suitable

Table-5.1 Prioritizations of various habitat parameters for habitat suitability of Rhinos.

5.2.2 FOOD AVAILABILITY

The vegetation of Pobitora Wildlife Sanctuary has been well studied by different botanist (Bora & Kumar, 2003; Bairagee et al. 2005) including diversity, abundance, and assemblage of difference species. Considering the findings of all the earlier studies this study had been confined to the availability of plant species found in the sanctuary, physically verified in the field and focused specifically on feeding of different plant species by Greater one Horned Rhinos in Pobitora Wildlife Sanctuary.

For plant diversity grid based transect methods had been used, along the transact 4 nos 1 meter circular plot within a 10 m circular plot was randomly selected and recorded the vegetation (Jalha et al. 2007).

For record of rhino food plants in various habitats attempt was made to record observations on bite of different plant species and parts (Annexure-5). This was permitted in most of the cases since rhino permitted closer approach on elephant back (Wallmo and Neff, 1970; Laurie, 1978; Hobbs et al. 1981; Dinerstein, 2003; Jnawali, 1993-1995; Jhala 1997). Most of the species could be identified from elephant back observation with assistance from local botanist.

Observations were followed by onsite inspection of consumed plans in order to verify identification (Kanjilal,1940; Champion & Seth,1986; Bora A., 2003, Bora & Kumar, 2003)

. However when in doubts various field based techniques like collection of herbarium , onsite inspection and discussion with local people , were adopted in order to identify the plants fed on by the animals. Help from locally available plant texonomiest was helpful in identifying food plants.

5.3 RESULTS

5.3.1 LAND COVER IN POBITORA WILDLIFE SANCTUARY

The topography of Pobitora Wildlife Sanctuary 38.81 km2 as notified by the government of Assam(Assam Gazette, 1998) was found mainly of two types i. e. a) plain riverine grassland with scattered wetlands (26.37 km^2) and b) woody hills covered by tropical moist deciduous forest (12.44 km^2).

The land cover of the sanctuary as estimated in the study from the satellite imagery of 2005 was 38.81 km^2. Majority of the park area (54.8%) was occupied by grass land out of which around 10.23% area was found tall grass land and 17.44% area was found short grassland and interestingly a large portion of the sanctuary (26.73%) inside the notified sanctuary boundary was found to be degreded due to extensive human activity/ agricultural practice by the surrounding villagers. The woodland cover of the sanctuary was found 32.05% on hills and 8.23% in plain area. Wetland (Water source) was found to be occupied an area about 4.92% of the total area of the sanctuary (Table-5.2,

Figure-5.1 and Figure-5.2). The area under grassland and the wetlands were found interchangeable in different seasons of the year because the water level recedes during winter and the area of the grassland increase on the other hand during summer inundation of more areas shrink the grass land area.

Sl. No.	Land Cover Type	Area (km^2)	Area (%)
1.	Wood land (Hill)	12.44	32.05
2.	Wood land (Plain)	3.19	8.23
3.	Tall Grass Land	4.13	10.63
4.	Short grass land	6.77	17.44
5.	Wetland	1.91	4.92
6.	Degreded/ aggricultural	10.38	26.73
Total:		38.81	100.00

Table-5.2 Different land cover types in Pobitora Wildlife Sanctuary based on visual interpretation of satellite imagery.

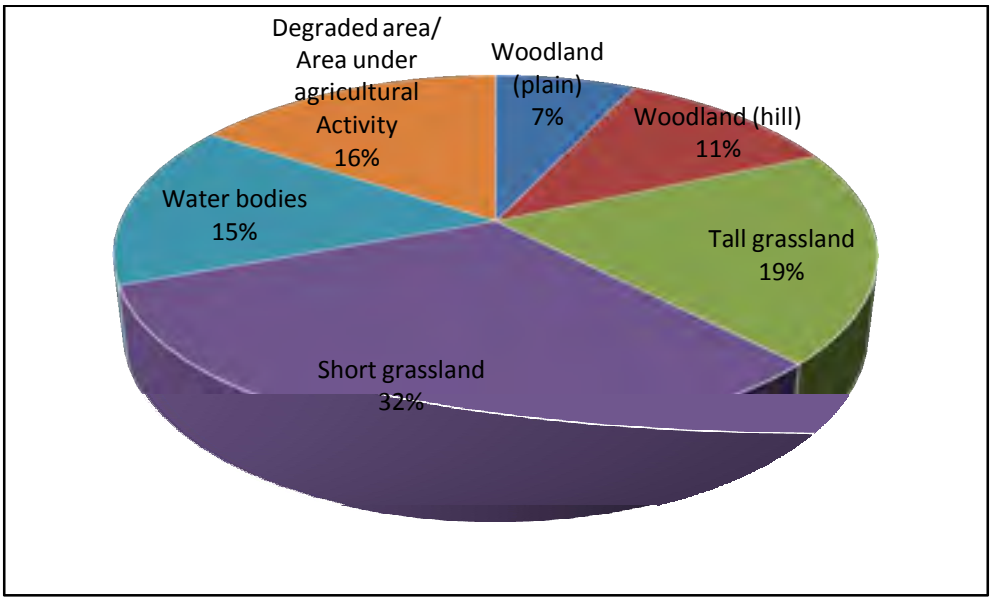


Figure-5.1: Percentage of different landcover type in Pobitora Wildlife Sanctuary

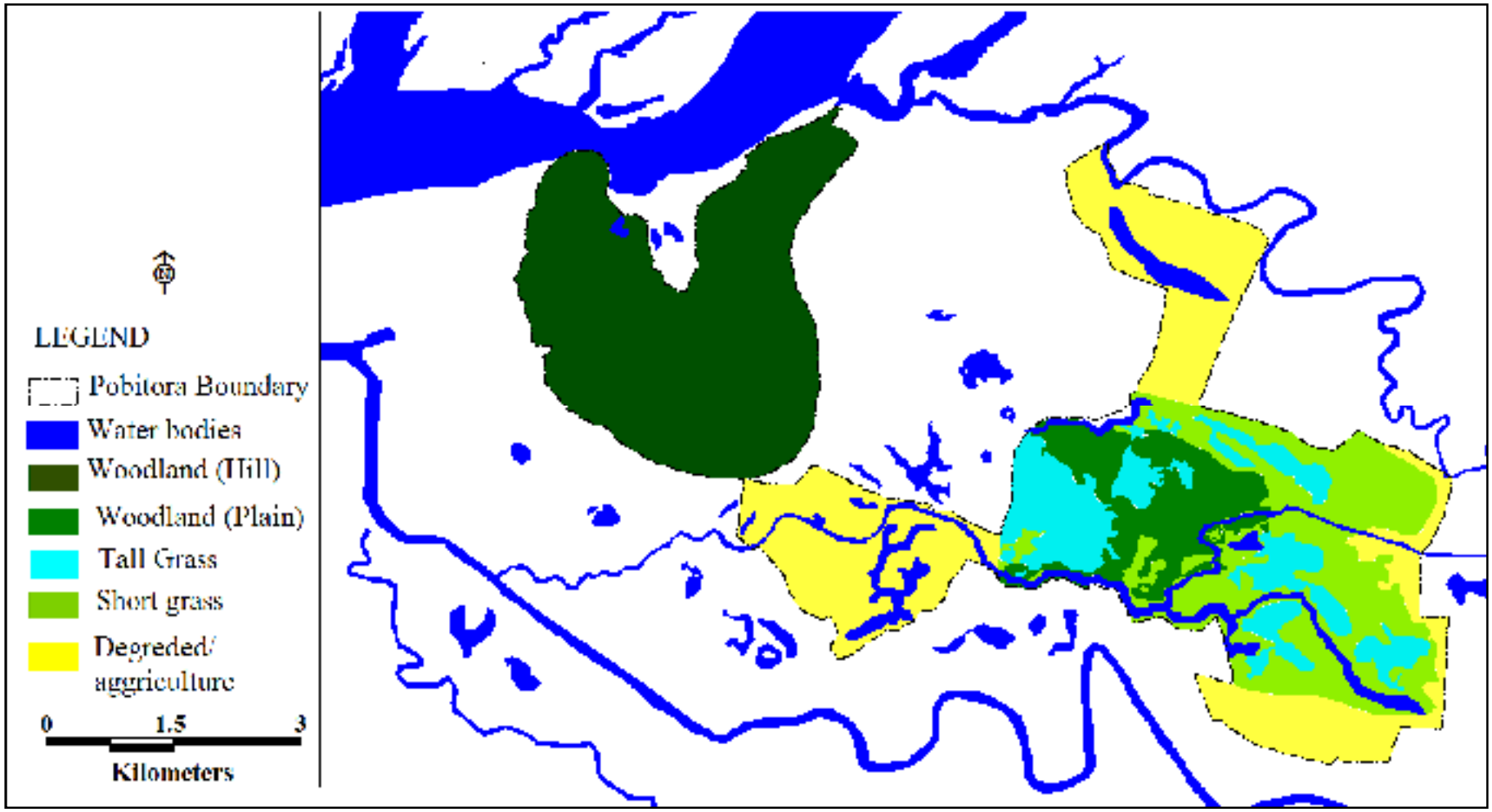


Figure- 5.2: Land-cover Map of Pobitora Wildlife Sanctuary based on visual interpretation of satellite imagery

5.3.2 HABITAT SUITABILITY FOR RHINO

After consideration of the entire positive and negative factor for habitat suitability of Rhinos following habitat suitability map (Table-5.3, Figure -5.3, Plate-5.1) had been generated and found that, only about 8.36% area of the sanctuary was found to be suitable for Indian Rhino. Approximately 12.40% of the area was found to be moderately suitable, about 36.47% area was found less suitable and remaining 42.77% area of the sanctuary was found unsuitable for the species.

Sl. No.	Suitability type	Area (km2)	% of Total Area
1.	Suitable	3.25	8.36
2.	Moderatly suitable	4.81	12.40
3.	Less suyitable	14.15	36.47
4.	Unsuitable	16.60	42.77
Total		38.81	100.00

Table-5.3: Habitat Suitability for Great Indian One-horned Rhinos in Pobitora Wildlife Sanctuary

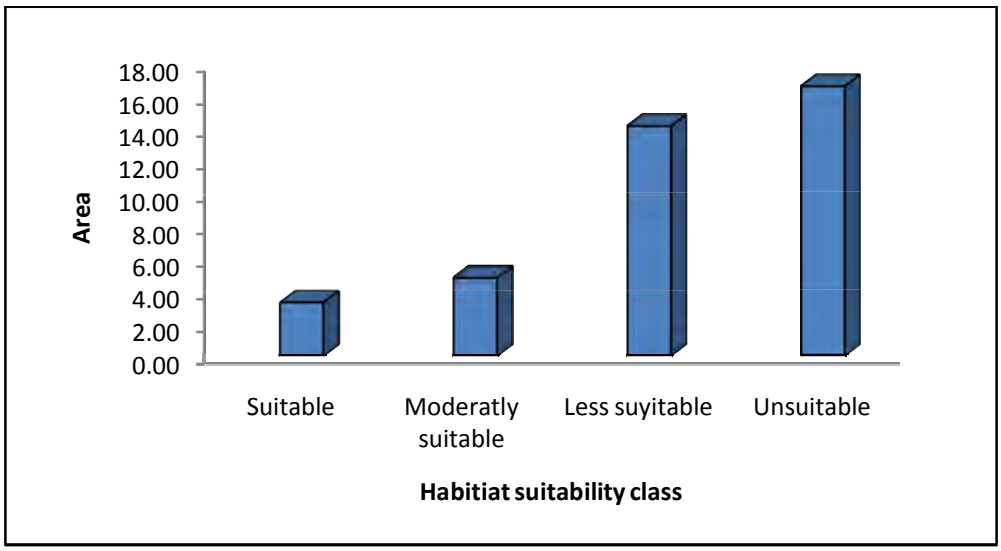


Figure-5.3: Percentage of habitat suitability classes in obitora Wildlife Sanctuary

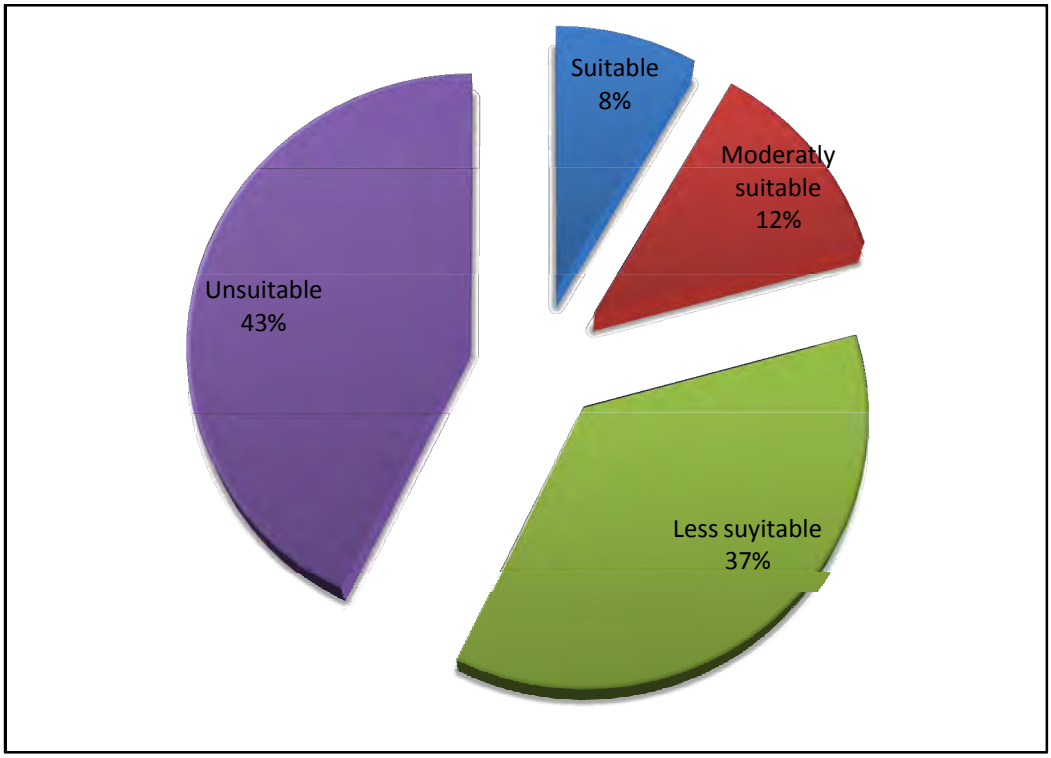


Figure-5.4: Percentage of habitat suitability classes in Pobitora Wildlife Sanctuary

HABITAT SUITABILITY MAP OF POBITORA WILDLIFE SANCTUARY FOR GREAT INDIAN ONE-HORNED RHINOS

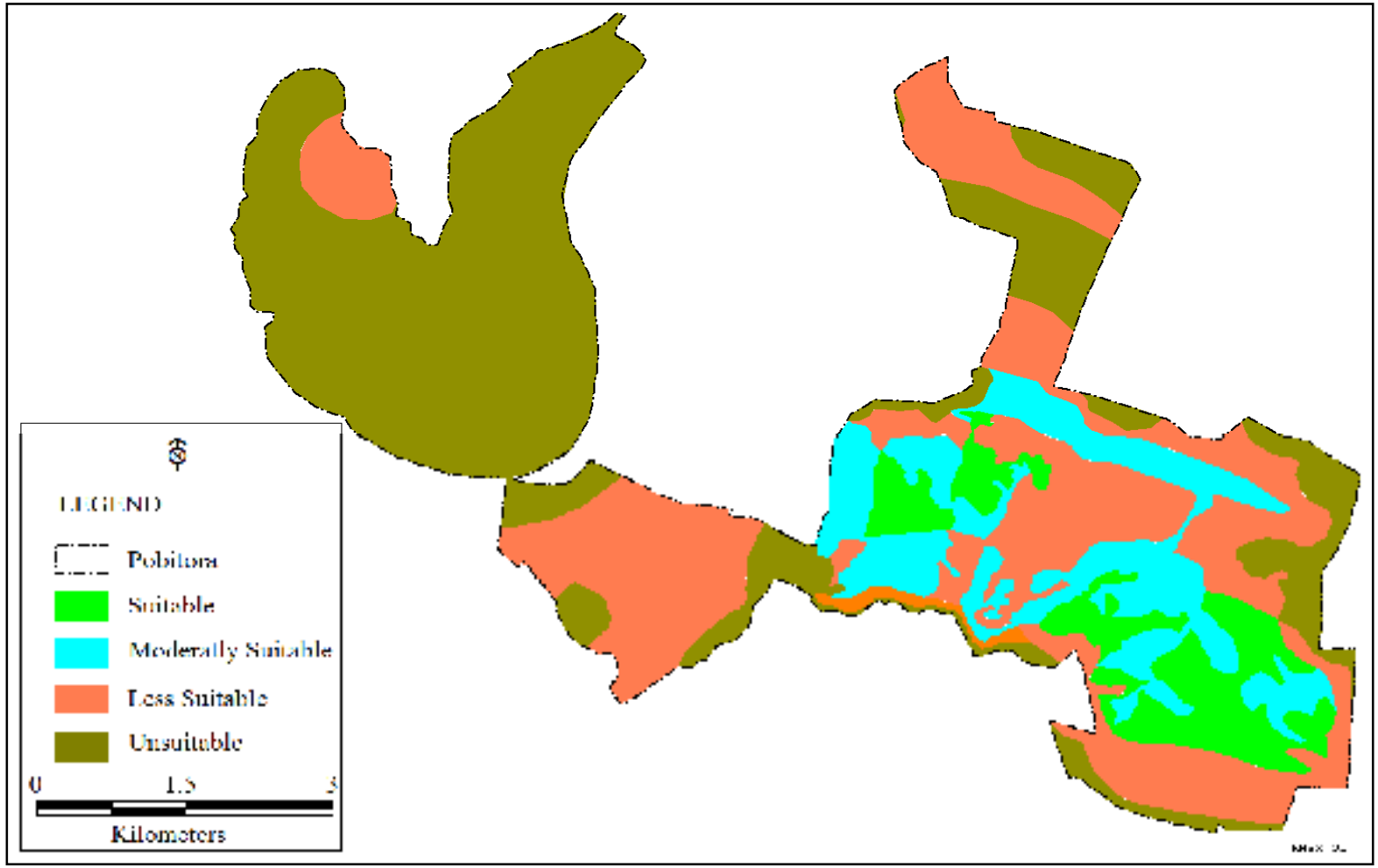
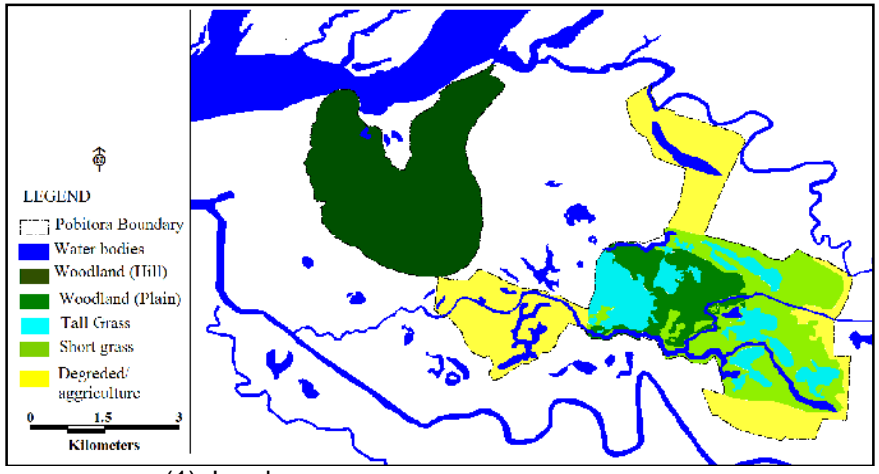
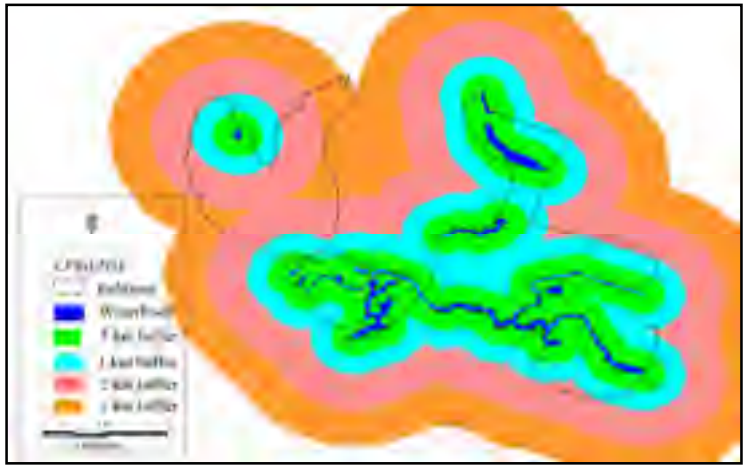


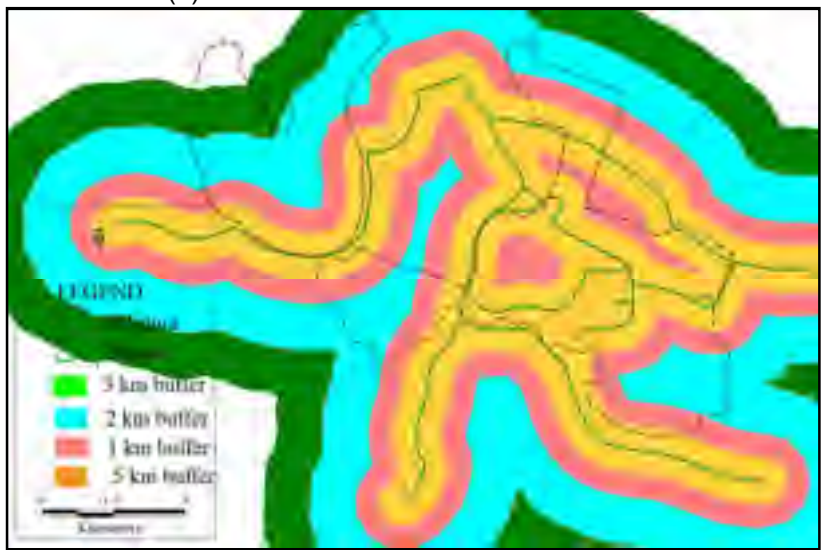
Figure-5.5: Habitat suitability map of pobitora wildlife sanctuary for Great Indian One-Horned Rhino



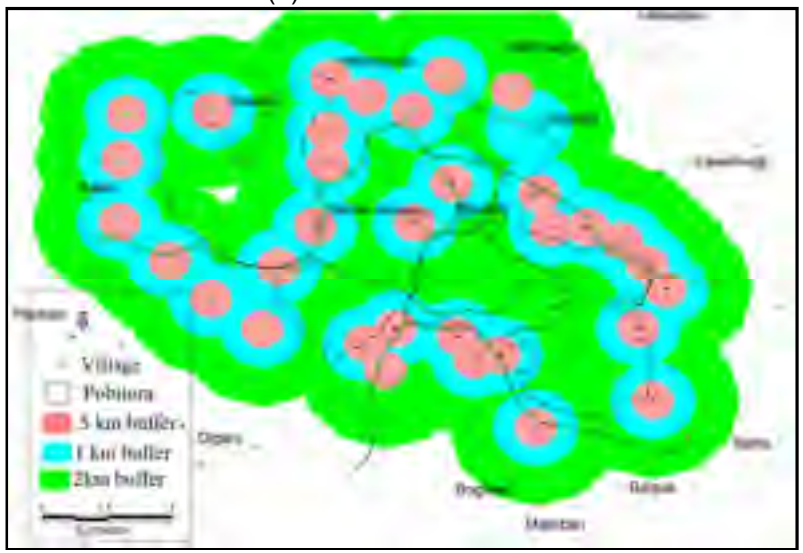
(1) Land cover



(2) Water buffers



(2) Road buffers



(4) Village buffers

Plate-4: Showing Influence of Possitive and Negative Fectors in the Sanctuary

5.3.3 FOOD AVAILABILITY OF INDIAN RHINOS

All total 163 species of different types of plants from 50 numbers of different families were recorded to be consumed by Indian Rhino in Pobitora Wildlife sanctuary during the study. Out of which 24 species of tree, 42 species of grass, 15 species of sharbs, 74 species of herbs and 3 species of fern were found to be consumed during the study by the Indian Rhino in Pobitora Wildlife Sanctuary (Table-5.4 & 5.5).

Sl. No.	Plant Type	Number of Species Recorded
1.	Tree	24
2.	Grass	42
3.	Sharb	15
4.	Climber	5
5.	Herb	74
6.	Fern	3
Total:		163

Table-5.4: Number of different plant species recorded during the study.

Table- 5.5: List of plant species found to be consumed by Indian Rhino during the study in Pobitora Wildlife Sanctuary.

Family	Species	Local Name	Plant Types *	Observation on different Parts Eaten**
Ranunculaceae	*Ranunculus scleratus* Linn.	Bon dhoxia	H	L
Dilleniaceae	*Dillenia indica* Linn.	Ou tenga	T	T,F, L
Dilleniaceae	*Dillenia pentagyna* Roxb.	Bajiou,oxi	T	T,F, L
Caryophyllaceae	*Drymaria diandra* Bl.	Laijabori	H	L
Caryophyllaceae	*Stellaria wallichiana* Benth.	?	H	T
Portulacacae	*Portulaca oleracea* Linn.	Malbhog sak	H	C
Malvaceae	*Abelmoschus moschatus* Medik.	Bon Bhendi	H	C
Bombacacae	*Bombax ceiba* Linn.	Simolu	T	F,T
Tiliaceae	*Grewia multiflora* Juss.	?	S	L
Rutaceae	*Aegle marmelos* Linn.	Bel	T	L,S
Rutaceae	*Glycosmis pentaphyla* Retz.	Matibel/ Sauldhua	S	L,S

Rutaceae	*Murraya koenigii* Linn.	Narasingha	T	L,S
Meliaceae	*Azadirachta indica* Juss.	Neem	T	L,S
Meliaceae	*Melia azedarach* Linn.	Ghora Neem	T	L
Meliaceae	*Toona ciliata* Roem.	Poma	T	L
Rhamnaceae	*Zizyphus mauritiana* Lamk.	Bogori	S	L,S,F
Anacardiaceae	*Mangifera india* Linn.	Aam	T	L,S
Papilionaceae	*Alysicarpus glumaceous* (Vahl) DC.	?	H	L
Papilionaceae	*Alysicarpus Vaginalis* (Linn.) DC.	?	H	L
Papilionaceae	*Atylosia goenisis* Dalz.	?	C	L,T
Papilionaceae	*Atylosia scarabaeoides* Linn.	?	H	L
Papilionaceae	*Canavalia ensiformis* (Linn.) DC.	Bonurahi	T	T
Papilionaceae	*Flemingia liniata* Linn.	?	S	L
Papilionaceae	*Flemingia strobilifera* (Linn.)	Makhiati	S	L
Mimosaceae	*Acacia rugata* Lamk.	Kuchiakata	S	C
Mimosaceae	*Mimosa pudica* Linn.	Lajuki bon	S	T
Combretaceae	*Terminalia bellirica* (Gaertn.)	Bhumora	T	L,F
Myrtaceae	*Psidium guajava* Linn.	Madhuri aam	T	L, T
Myrtaceae	*Syzygium cumini* Linn.	Jamun	T	L,T
Lecythidaceae	*Barringtonia acutangula* Linn.	Hijal	T	L,T
Lecythidaceae	*Careya arborea* Roxb.	Kum	T	L,T
Lythraceae	*Lagerstroemia reginae* Roxb.	Ajar	T	L,T,F
Lythraceae	*Rotala rotundifolia* Buch-Ham.	?	H	L,T
Cucurbitaceae	*Momordica charanita* Linn.	Tita Kerela	C	C
Cucurbitaceae	*Momordica dioica* Roxb.	Bhat Kerela	C	C
Apiaeae	*Centella asiatica* Linn.	BorManimuni	H	C
Rubiaceae	*Anthocephalus chinensis* (Lamk.)	Kadam	T	L,T,F
Rubiaceae	*Catunaregam uliginosa* (Retz.)	Bon bengana	S	C
Rubiaceae	*Paderia foetida* Linn.	Bhebeli lota	H	C
Asteraceae	*Eupatorium odoratum* Lin.	?	H	L,T
Menyanthaceae	*Nymphoides hydrophyllum* Lour.	?	H	C
Hydrophyllaceae	*Hydrolea zeylanica* Linn.	?	H	T
Boraginaceae	*Heliotropium indicum* Linn.	Hatisuria bon	H	C
Convolvulaceae	*Ipomoea aquatica* Forsk.	Kalmo	H	C
Convolvulaceae	*Ipomoea obescura* Linn.	?	C	T,S
Convolvulaceae	Ipomoea quamoclit Linn.	?	C	C
Solanaceae	*Solanum torvum* Sw.	Borbhecuri	H	L
Solanaceae	*Solanum violaceum* Ortega	Bhekuri tita	H	L,T
Lentibulariaceae	*Uticularia auria*	?	H	T,S
Verbenaceae	*Lippia javanica* Burm.	Pahukata	S	T,L
Verbenaceae	*Phyla nodiflora* (Linn.)	?	H	L,T,F
Lamiaceae	*Hyptis suaveolens* Linn.	Tukmah	S	F
Lamiaceae	*Leucas aspera* Willd.	Drun	H	C
Amaranthaceae	*Alternanthera philoxeroides* Mart.	?	H	C

Amaranthaceae	*Alternanthera sessilis* Linn.	Maticaduri	H	C
Amaranthaceae	*Amaranthus spinosus* Linn.	?	H	C
Amaranthaceae	*Amaranthus viridis* Linn.	?	H	C
Chenopodiaceae	*Chenopodium album* Linn.	Bhatua sak, jilmil sak	H	C
Polygonaceae	*Polygonum barbatum* linn.	?	H	C
Polygonaceae	*Polygonum orientale* Linn.	?	H	C
Polygonaceae	*Polygonum pelebeium* R.Br.	?	H	T
Lauracae	*Litsea monopetala* Roxb.	Sowalu	T	C
Lauracae	*Litsea saliifolia* Roxb.	Dighloti	S	L,T,S
Euphorbiaceae	*Antidesma acidum* Retz.	Pani heloh	S	C
Euphorbiaceae	*Bridelia stipularis* Linn.	Sagoli lota	S	C
Euphorbiaceae	*Euphorbia hirta* Linn.	Gakhiroti bon-	H	C
Euphorbiaceae	*Mallotus philopensis* Lamk.	Luchan	T	L
Euphorbiaceae	*Phyllanthus emblia* Linn.	Amlokhi	T	L,S,T, F
Euphorbiaceae	*Phyllanthus virgatus* G.	?	H	C
Euphorbiaceae	*Trewia nudiflora* Linn.	Bhelcor	T	L,T,S
Cannabaceae	*Cannabis sativa* Linn.	Bhang	H	C
Moraceae	*Artocarpus hetrophyllus* Lamk.	Kathal	T	L,F,T
Moraceae	*Ficus hispida* Linn.	Khahata dimaru	S	C
Moraceae	*Ficus semicordata* Buha.	?	T	F,T, S,L
Moraceae	*Streblus asper* Lour.	Shoura	T	L,T,S
Urticaceae	*Ponzolzia zeylanica* Linn.	?	H	L
Hyrocharitaceae	*Hydrilla verticillata* Linn.	?	H	C
Hyrocharitaceae	*Vallisneria spiralis* Linn.	?	H	S
Zingiberaceae	*Alpinia nigra* Gaertn.	Tora	H	L,S
Marantaceae	*Schumannianthus dichotomus* Roxb.	Patidol	S	C
Pontederiaceae	*Eichhornia crassipes* Mart.	Meteka, kashuripena	H	L, F
Pontederiaceae	*Monochoria hastata* Linn	?	H	L
Commelinaceae	*Commelina appendiculata* Clark.	?	H	L
Commelinaceae	*Commelina Benghalensis* Linn.	Kona simolu	H	L
Commelinaceae	*Commelina suffrusticosa* Bl.	?	H	L
Lemnaceae	*Lemna perpusilla* Torr.	Saru puni	H	C
Alismataceae	*Sagittaria suayanensis* H.B.K.	?	H	C
Potamogetonaceae	*Potamogeton crispus* Linn.	?	H	C
Cyperaceae	*Carex spiculata* Linn.	?	H	L
Cyperaceae	*Cyperus compressus* Linn.	?	H	L
Cyperaceae	*Cyperus difformis* Linn.	?	H	L
Cyperaceae	*Cyperus digitatus* Roxb.	?	H	L
Cyperaceae	*Cyperus distans* Linn.	?	H	L,S
Cyperaceae	*Cyperus imbricatus* Retz.	?	H	L,S
Cyperaceae	*Cyperus iria* Linn.	Murfula bon	G	L,S
Cyperaceae	*Cyperus laxus* Lamk.	?	H	L,S
Cyperaceae	*Cyperus nutans* Vahl.	?	H	L,S

Cyperaceae	*Cyperus pilosus* Vahl.	?	H	L,S
Cyperaceae	*Cyperus platystylis* R. Br.	?	H	L,S
Cyperaceae	*Cyperus rotundus* Linn.	?	H	L,S
Cyperaceae	*Fimbristylis aestivalis* Retz.	?	H	L,S
Cyperaceae	*Fimbristylis dicotoma* Linn.	?	H	L,S
Cyperaceae	*Fimbristylis littoralis* Gaud.	?	H	L,S
Cyperaceae	*Fimbristylis quinquangularis* Vahl.	?	H	L,S
Cyperaceae	*Fimbristylis tetragona* R.Br.	?	H	L,S
Cyperaceae	*Kyllinga brevifolia* Rottb.	Keya bon	G	L,S
Cyperaceae	*Lipocarpha chinensis* Obs.	?	H	L,S
Cyperaceae	*Mariscus compactus* Retz.	?	H	L,S
Cyperaceae	*Mariscus sumatrensis* Retz.	?	H	L,S
Cyperaceae	*Schoenoplectus grossus* Linn.	?	H	L,S
Cyperaceae	*Schoenoplectus juncoides* Roxb.	?	H	L
Cyperaceae	*Scleria biflora* Roxb.	?	H	L
Cyperaceae	*Scleria terrestris* Linn.	?	H	L
Poaceae	*Apluda mutica* Linn.	?	G	C
Poaceae	*Arundo donax* Linn.	Dol	G	C
Poaceae	*Axonopus compressus* Sw.	?	H	L
Poaceae	*Bambusa arundinacea* Retz.	Kotoha banh	G	L, S
Poaceae	*Bambusa tulda* Roxb.	Bijuli banh	G	L
Poaceae	*Brachiaria villosa* Lamk.	?	G	C
Poaceae	Coix lacryma-jobi Linn.	Kaurimoni	H	L
Poaceae	*Cynodon dactylon* Linn.	Dubaribon	G	C
Poaceae	*Cyrtococcum accerescens* Trin.	Perenial grass	G	C
Poaceae	*Dactyloctenium aegyptium* Linn.	?	H	L
Poaceae	*Demostahya bipinnata* Linn.	?	H	L
Poaceae	*Digitaria longiflora* Retz.	?	G	C
Poaceae	*Digitaria setigera* Roth ex roem	?	G	C
Poaceae	*Echinochola colonum* Linn.	?	G	C
Poaceae	*Echinochola crusgalli* Linn.	Jaitar ban	G	C
Poaceae	*Eleusine indica* Linn.	Bhubusa bon	G	C
Poaceae	*Eragrostis tenella* Linn.	?	G	C
Poaceae	*Eragrostis unioloides* Retz.	?	G	C
Poaceae	*Hemarthria compressa* Linn.	Lokosa bon	G	C
Poaceae	*Hygroryza aristata* Retz.	Petuli-dal	G	C
Poaceae	*Hymenachne pseudointerrupta* C. Muell.	Dal-ghah	G	C
Poaceae	*Imperata cylindrica* Linn.	Ulu/ San-kher	G	C
Poaceae	*Leersia hexandra* Sw.	Arali bon	G	C
Poaceae	*Leptochloa chinensis* Linn.	?	G	C
Poaceae	*Neyraudia reynaudiana* Kunth.	?	G	C
Poaceae	*Oplismenus burmannii* Retz.	?	G	C
Poaceae	*Oplismenus compositus* Linn.	?	G	C

Poaceae	*Oriza meyeriana* Zoll.	Banaria dhan	G	C
Poaceae	*Oriza rufipogon* Griff.	Banaria dhan	G	C
Poaceae	*Ottochloa nodosa* Kunth	?	G	C
Poaceae	*Panicum auritum* Presl ex nees.	?	G	C
Poaceae	*Panicum repens* Linn.	?	G	C
Poaceae	*Paspalidium flavidum* Retz.	?	G	C
Poaceae	*Paspalidium punctatum* Burm.	?	G	C
Poaceae	*Paspalum scrobiculatum* Linn.	Kodoa dhan	G	C
Poaceae	*Phragmitis karka* Retz.	Nal grass	G	C
Poaceae	*Polytoca digitata* Linn.	?	H	L
Poaceae	Pseudechinolaena polystachya H.B.K.	?	G	C
Poaceae	*Saccharum spontaneum* Linn.	Kahua ban	G	C
Poaceae	Sacciolepis mysuroides R. Br.	?	G	C
Poaceae	*Sclerostachya fusca* Roxb.	Ekora ban	G	C
Poaceae	*Setaria glauca* Linn.	Bisha bon	G	C
Poaceae	*Setaria palmifolia* Koenig.	?	G	C
Poaceae	*Setaria pumila* Poir.	?	G	C
Poaceae	*Sporobolus diander* Retz.	?	G	C
Poaceae	*Thysanolaena maxima* Roxb.	Jharu gach	G	C
Poaceae	*Vetiveria zizanioides* Linn.	Birina	G	C
Lycopodiaceae	*Palhinhaea cernua* Linn.	?	F	L
Lygodiaceae	*Lygodium flexuosum* Linn.	?	F	L
Pteridaceae	*Pteris cretica* Linn.	Dhekia	F	L

*T- Tree, S- Sharb, H- Harbs, G- Grass, C- Climber, F- Furn
**C- Complate, L-Leaf, T-Twig, S- Shoots, F-fruit/ flower

5.4 DISCUSSION

Pobitora wildlife sanctary, one of the important habitats for Indian Rhino in Southeast Asia with a highest ecological density of the species all over the world, was not observed in a right direction interms of conservation of the species (Plate-4). A major portion of the sanctuary (32.05%) was found to be unsuitable for Indian Rhino due to hilly terrain. The suitability of habitat for the species in the plain part of the sanctuary in terms of availability of water, fodder and shalter etc. it was observed that, water fector was still fevourable in all

areas though srinkgng of wetlands due to siltation was observed. Interms of fodder and shelter it was found that the part towards the boundary of the sanctuary degreded heavely due to extensive cattle grazing and other human activities from the nearby villagers, which was also observed extending towards the central part of the sanctuary and was considered unfevaurable for the conservation of the species. More than 8 km^2 area shown as the sanctuary had not seen any characters of the wildlife sanctuary i.e. extensively used by villagers for agriculture. Considering negative fectors like disturabance from roads and human settlements, it was observed that no such space available in the sanctuary that away from more than 2 km from roads or human sattlements (Plat-5.1). Therefore the habitat suitalibility analysis of the sanctuary for Indian Rhino did not considered any area as highly suitable for the species. Whereas in Kaziranga National Park Kushwaha et al., (2000) analysed around 5% area as highly suitable for Indian Rhino. The proportion of the area suitable, moderately suitable, less suitable and unsuitable (i.e. 1.0:1.4:4.5:5.0) for Indian Rhino in the sanctuary was not to be satisfactory for long term conservation of the species in the sanctuary. It was felt that an intensive conservation and management strategy need to be implemented in the sanctuary for conservation of the species; if the situation prevails the population and habitat may be wiped out in near future.

During the Study Indian Rhino was found to be fed on 163 species of plants of 50 families in the sanctuary. A similar type of results found by Laurie (1978) in Chitwan National Park, Nepal, he stated that Indian Rhino fed on 183 species of food plant belonging to 57 Famalies. Ghose (1991) described about

the consumption 82 species belonging to 34 families in Jaldapara Wildlife Sanctuary. Recently Hazarika (2007) and Hazarika & Saikia (2010) found that Indian Rhino confind to 71 plant species. The number of food plants consumed by Rhinos varies in different habitat. The increased diversity of plants recorded to be comsumed by Indian Rhino in the study area may be because of scarcity of fodder and high density of wild animals as well as high intensity of cattle grazing. It had been observed during high flood that, Indian Rhino fed anything green infront of them. This section of study on food plants of Indian Rhino was very brief and qualitative and felt the need of more quantitative study to contribute to formulate habitat management strategy.

Chapter-VI:
RANGING PATTERN AND HABITAT USE

6.1 INTRODUCTION

The size of an animal's home range give an indication of the availability of essential resource, restrictions imposed by the respective conservation areas or/ and other artificial barriers and the degree of disturbance to which the animal is exposed (Hitchins, 1969; Whyte, 1996;). The studies on the home range in various wildlife species suggest that, the sizes of the home ranges are directly related to its body size and weight (Lindstedt et al., 1986; Swihart et al., 1988; Schoener, 1968; Turner et al., 1969). Again, the social structures and behavioral pattern of the animal species have also some effects on the home range size (Gittleman and Harvey, 1982; Lindstedt et al., 1986). Factors like availability of food, forage quality and metabolic requirements also influence the home range sizes in various species (Laurie, 1978-82). Area with plentiful food and water and minimum disturbances will have smaller home ranges (Willums, 2002). Artificial barriers (e.g. dams, cannals, walls, habitat loss due to agricultural settlement) prevent animals for using part of its home range (Jhonsingh et al., 1990). For management point of view especially for animal like Rhino or Elephant it is very important to know the home range and pattern of range utilization. In several cases the ecological boundaries and administrative boundaries don't match (Joshua and Jhonsingh, 1995) and knowledge of the movement of species is critical for preparing management plan in such cases. In addition to the crucial information about the home ranges

it is also important to understand the utilization of resources within the home range (Williums, 2002).

The Indian Rhino in Pobitora Wildlife Sanctuary, Assam seems to be under extreme ecological pressure due to the degradation of habitat and around 40% of the population move out of the sanctuary to the nearby agricultural areas and human habitation (Talukdar et al., 2007). Therefore to ensure long term survival of the species, the study was designed to describe and explain ranging behavior of Rhino in and around Pobitora Wildlife Sanctuary and to analyse habitat utilization pattern by rhino in the sanctuary.

6.2. METHODS

6.2.1. SEASONAL AND ANNUAL HOME RANGE

For home-range and habitat use six individual Rhinos of different age and sex (e.g. 2 numbers Adult male of different age, 2 numbers Adult female with calf of different age, one sub-adult male and sub-adult female; Table-6.1) were individually identified (Section-4.2.1) and fixed locations in different seasons throughout the year using Global Positioning System (GPS) along with related habitat information (Hazarika and saikia, 2007, 2009, 2010, 2011; Hazarika, 2007; Bhattacharyya, 1991-92; Lehner, 1996; Laurie, 1978, 82). The selected animals were located at least for once in every 15 days for minimum 2 months in every season during 2006 to 2009. The data collected were maintained in MS Excel for processing and analysis (Annexure-1& 2). The fixed locations were transferred to GIS platform on the classified imagery using ARC INFO Computer package (Section-5.2). The locations of six selected rhinos

were analyzed by using ARG VIEW extension ANIMAL MOVEMENT ANALIST (Hooge, 1997). Rhino Home range was defined by 100% Minimum Convex Polygon (MCP) methods (Mohr, 1947) for all the locations across the seasons and the year.

Sl. No.	Age And Sex Class	Reference NO. (as mentioned in Section-4.3)
1.	Adult Male (Dominant)	M01
2.	Adult Male	M05
3.	Adult Female With Big Calf	M13
4.	Adult Female With Small Calf	M06
5.	Sub-adult Male	M07
6.	Sub-adult Female	M19

Table- 6.1: Individual ID of Rhinos selected for the study of annual and seasonal Home Range pattern in Pobitora Wildlife Sanctuary.

6.2.2 STRAYING MOVEMENT TO SURROUNDING AREAS

Linear survey following direct and indirect evidences was used to index Rhino used from the sanctuary to the surrounding non protected areas i.e. agricultural field and human habitation (Patridge, 1978; Litvaitis, 1996; Kandel, 2003). Latter part of retreating monsoon (September-October) & early part of pre monsoon (February-March) i. e. September 2007 to August 2009, were selected for surveys as maximum possibility of evidence can be sighted. Historic straying records had been collected and studied prior to field survey. Experienced forest personal and local villagers were accompanied the survey team for better output. Secondary evidences (information from Forest Personal, Villagers etc.) had taken into consideration where route couldn't be traced/ linked due to unavailability of direct evidence for bad soil type. The data for

each route were recorded in a pre-designed field format (Annexure-3) with geo-coordinates using Global Positioning System (Bairagee et al., 2005; Talukdar et al., 2007) and integrate in to the GIS platform using GIS software like “Arc View” to obtain spatial output for each individual straying route (Panwar,1986). After identification of straying route, observer (FD & experienced local villagers) had been deputed for each route for monitoring uses of straying tracts by Rhino (Funston et al., 1994) in a daily basis.

6.2.3 HABITAT UTILIZATION PATTERN

To understand the habitat utilization pattern of Indian Rhino the study area was searched for Rhino in different seasons of the year covering all grids (Section-3.2). All the sighting was recorded along with activities of rhino and the habitat types (Hazarika and Saikia, 2007, 2009, 2010, 2011; Hazarika, 2007; Laurie 1978, with certain modification). The location and time of each rhino sighting had taken with a GPS (Garmin etrex) from the nearest approachable distance, if the animal was in stationary activity, otherwise location was taken in the sight after movement of the animal. All the data was maintained in an MS EXCEL spread sheet for necessary integration in GIS platform (Annexure-2).

Habitat selectivity of Rhino in the area was calculated using following formula-

$$\text{Habitat Selectivity} = \frac{\text{Total no. of rhino sighted in a particular habitat}}{\text{Total no. of sighting record of Rhino in all habitats}} \times 100$$

6.3 RESULTS

6.3.1 ANNUAL AND SEASONAL HOME RANGE

The annual home ranges estimated for Indian Rhino in Pobitora Wildlife Sanctuary during the study were found to be ranges from 9.079 km2 to 27.42 km2 and annual average was calculated 17.15 km2 (Table.- 6.2). The annual home range of adult male of older age was seemed smaller compared to adult male of younger age (Table-6.2; Figure-6.1 to 6.12).The annual home ranges of adult male, Sub adult male and female with larger calf were observed bigger than the annual home range of female with small calf and Sub adult female (Table-6.2; Figure-6.1 to 6.12). There was no significant difference in home range found between the adult male, sub-adult male and the female with bigger calf (3-4year of age).This difference may be due to heavy disturbance (Section-7.1) or/ and scarcity of food in the Sanctuary. More than 60% of the studied individuals were found to be with home range partly outside the conservation area. However home range area changes in corresponding study years were observed for almost all the studied animals, though there were no significant correlations established.

Animal ID	Number of Locations	Observation Time (In Months)	Home range (100%MCP) (km2)
2007-2008			
M01	133	12	13.5
M05	160	12	17.63
M13	158	12	15.67
M06	150	12	12.22
M07	150	12	22.4

M19	174	12	9.079
2008-2009			
M01	164	12	16.07
M05	146	12	24.15
M13	131	12	27.42
M06	131	12	12.26
M07	164	12	22.121
M19	152	12	13.33
Average Annual Home range:			17.15

Table-6.2: Annual Home Ranges (in Km2) calculated using Minimum Convex polygon Method (MCP) in Pobitora Wildlife Sanctuary (2007-2009)

Year/ Animal ID	Seasons							
	Winter		Pre-monsoon		Monsoon		Retreating-monsoon	
	Number of location	MCP	Number of location	MCP	Number of location	MCP	Number of location	MCP
2007-2008								
M01	36	6.86	33	4.101	35	2.929	29	5.992
M05	47	6.495	30	7.087	38	3.815	45	4.912
M13	41	7.327	40	7.715	41	4.662	36	5.673
M06	38	4.833	36	5.110	45	4.037	31	6.431
M07	29	7.038	44	5.256	38	3.841	39	5.407
M19	45	5.747	38	6.097	51	3.101	40	3.579
2008-2009								
M01	43	4.099	35	3.498	35	2.854	51	4.2772
M05	47	7.646	33	7.075	35	4.904	31	9.660
M13	39	11.64	29	8.273	32	3.794	31	7.170
M06	28	7.448	37	5.325	37	5.207	29	6.611
M07	55	11.8	41	3.801	32	2.813	36	3.772
M19	34	6.693	38	4.654	32	3.247	48	3.294

Table-6.3: Seasonal Home Ranges (Km2) calculated by Minimum Convex polygon Method (MCP) in various seasons in Pobitora Wildlife Sanctuary (2007-2009)

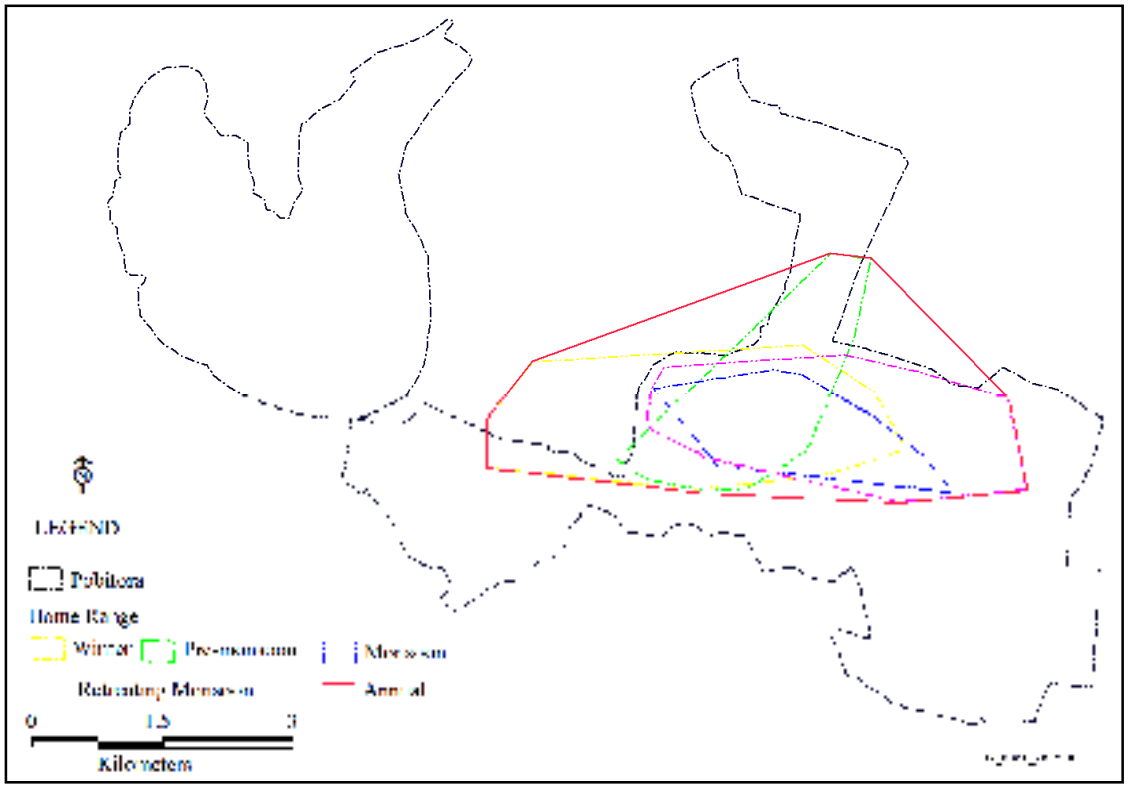


Figure-6.1: Seasonal range use pattern of M001(Dominant Male) during 2007-08

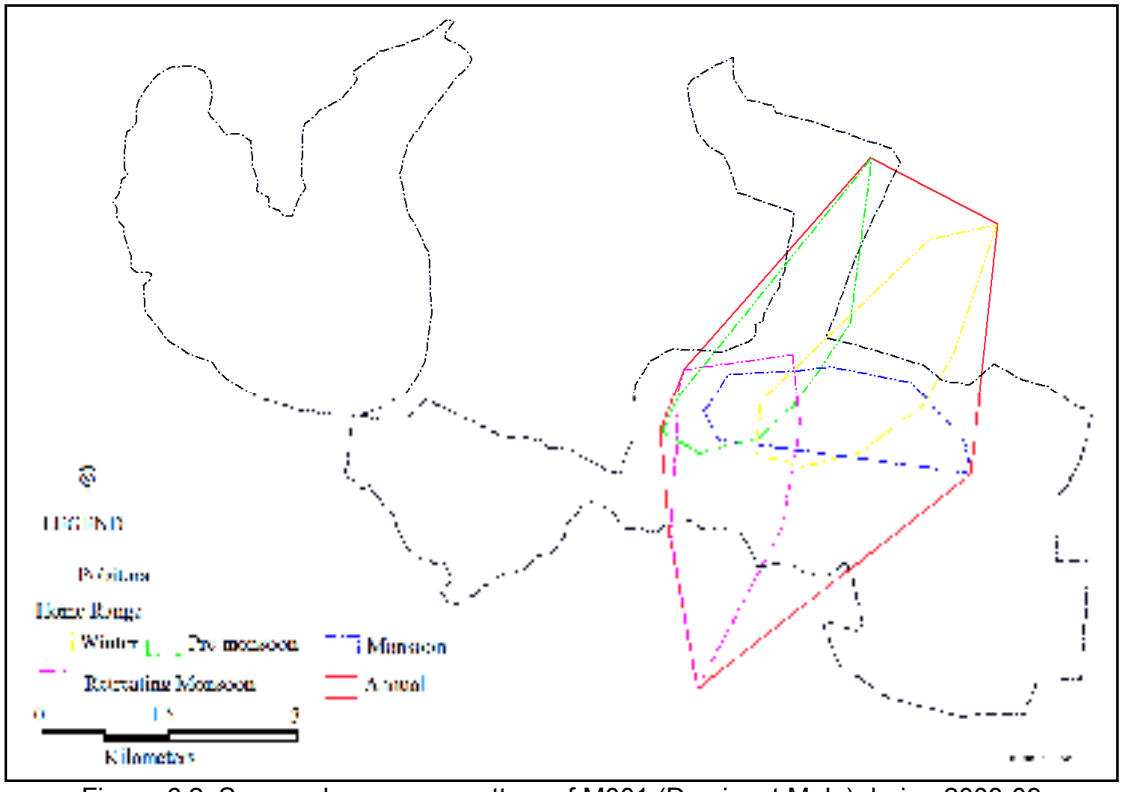


Figure-6.2: Seasonal range use pattern of M001 (Dominant Male) during 2008-09

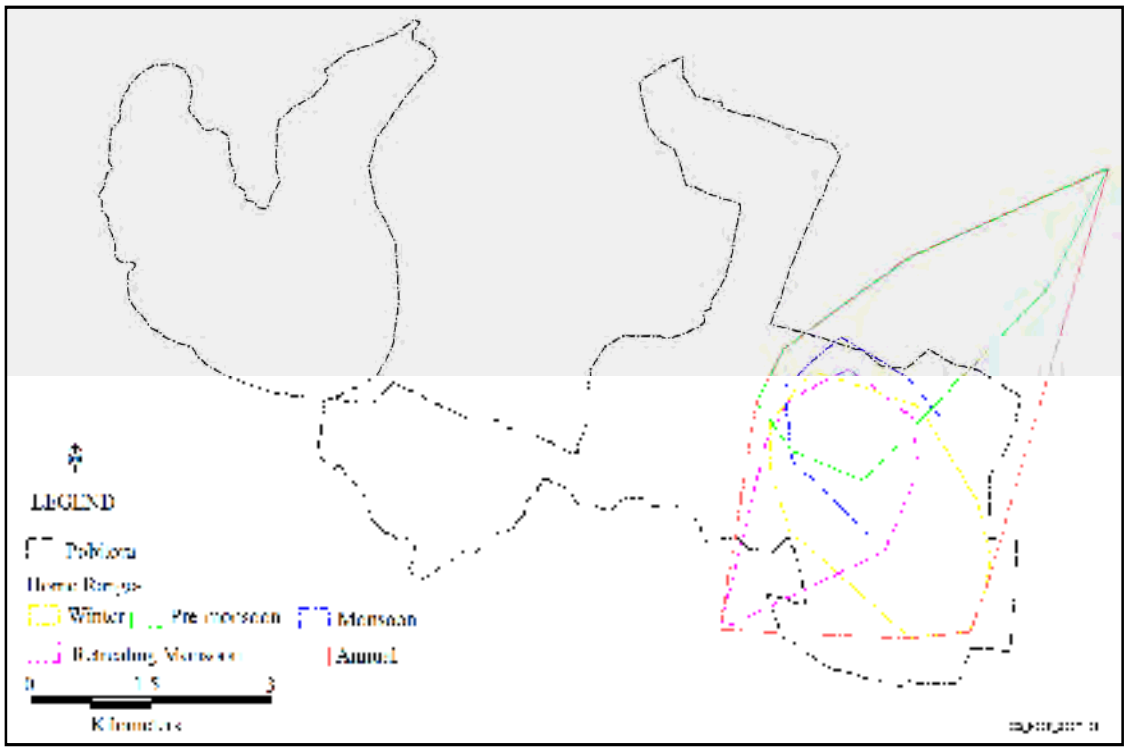


Figure-6.3: Seasonal range use pattern of M005 (Adult-male) during 2007-08

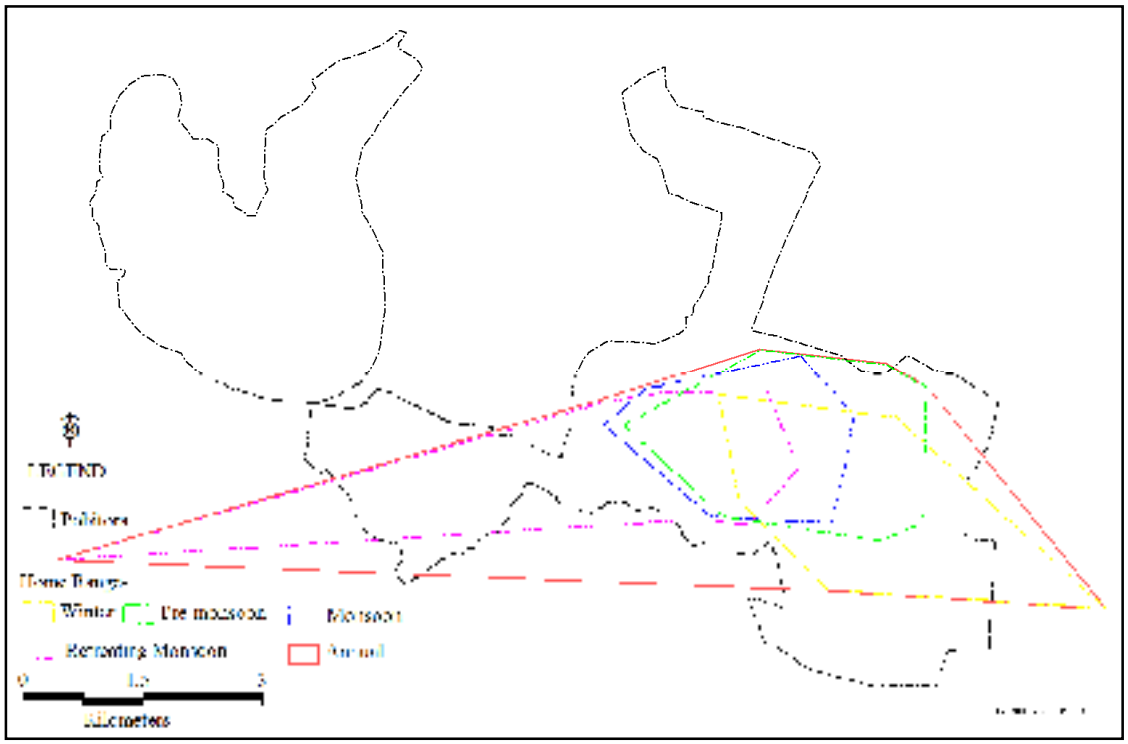


Figure-6.4: Seasonal range used pattern of M005 (Adult-male) during 2008-09

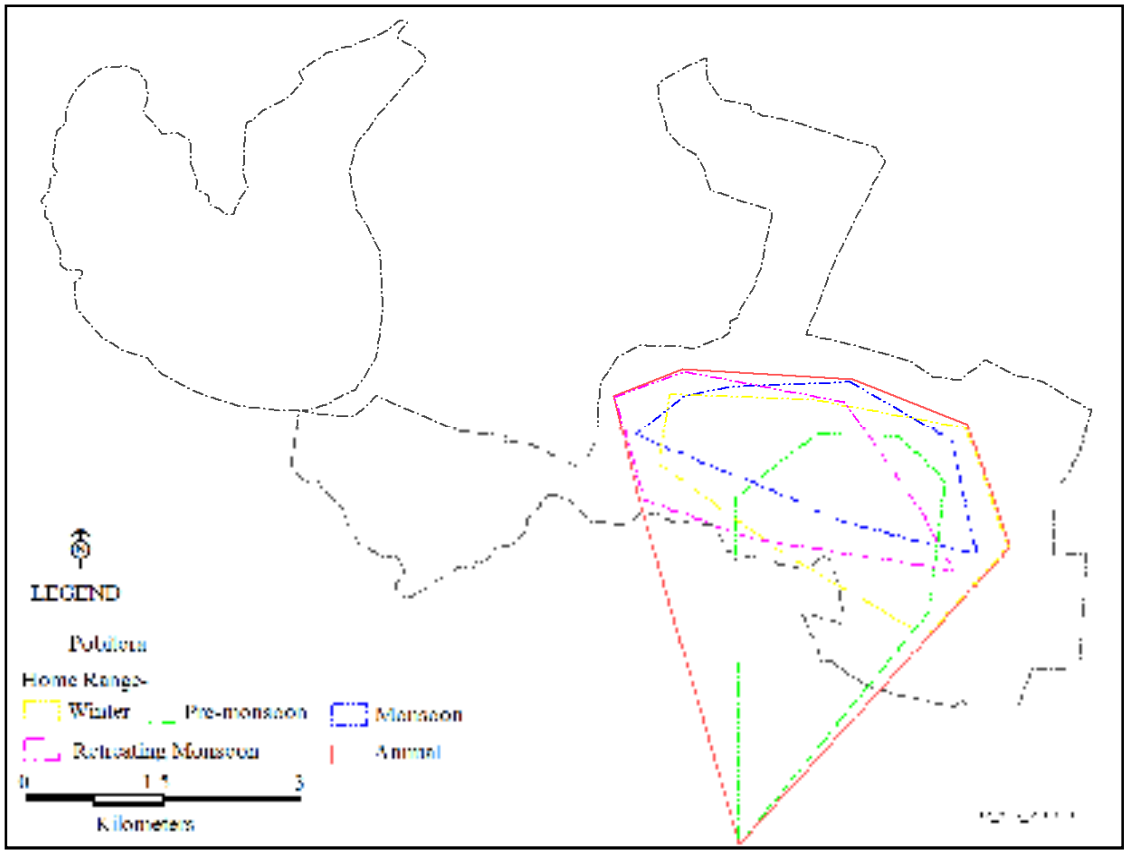


Figure- 6.5: Seasonal range used pattern of M013 (Adult female with big calf) during 2007-08

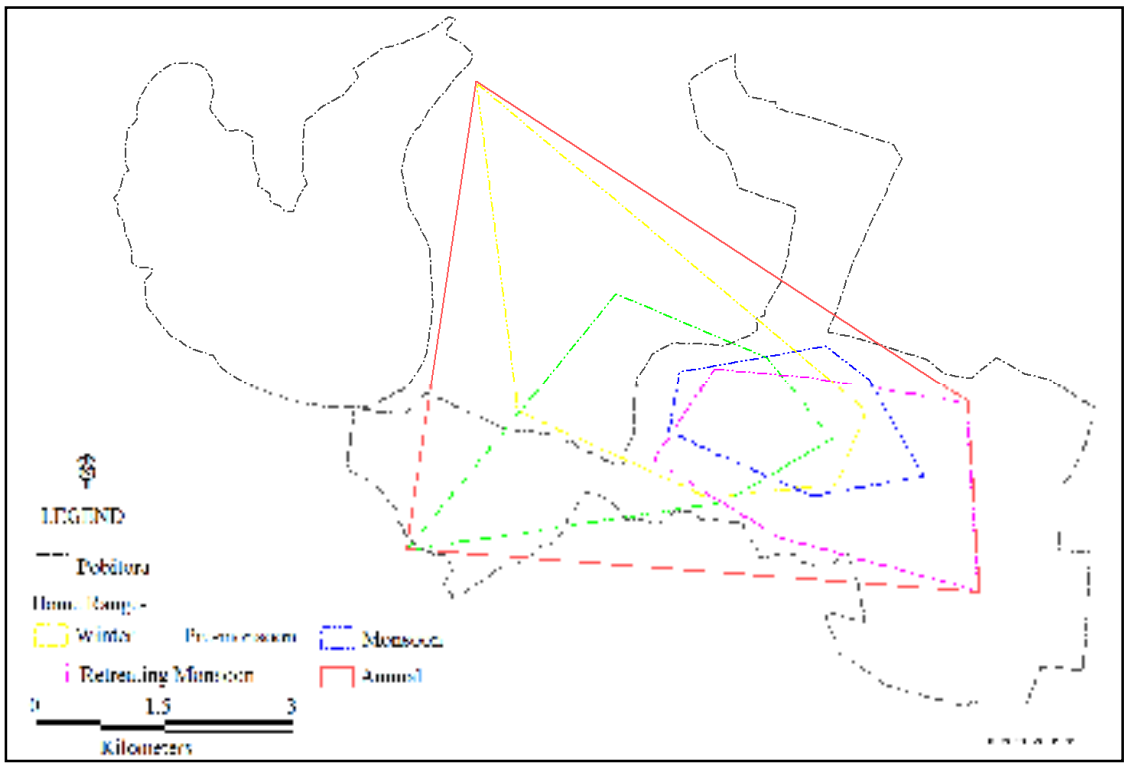


Figure-6.6: Seasonal range used pattern of M013 (Adult female with big calf) during 2008-09

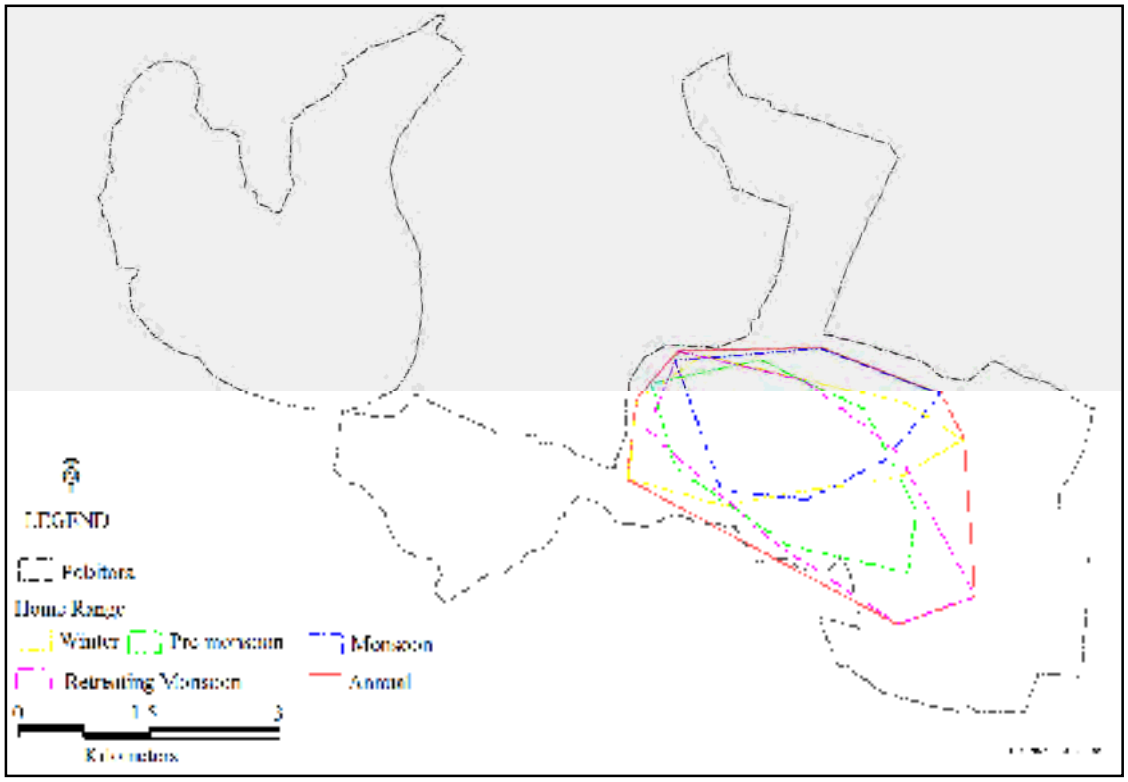


Figure-6.7 Seasonal range used pattern of M006 (Adult-female with small calf) during 2007-08

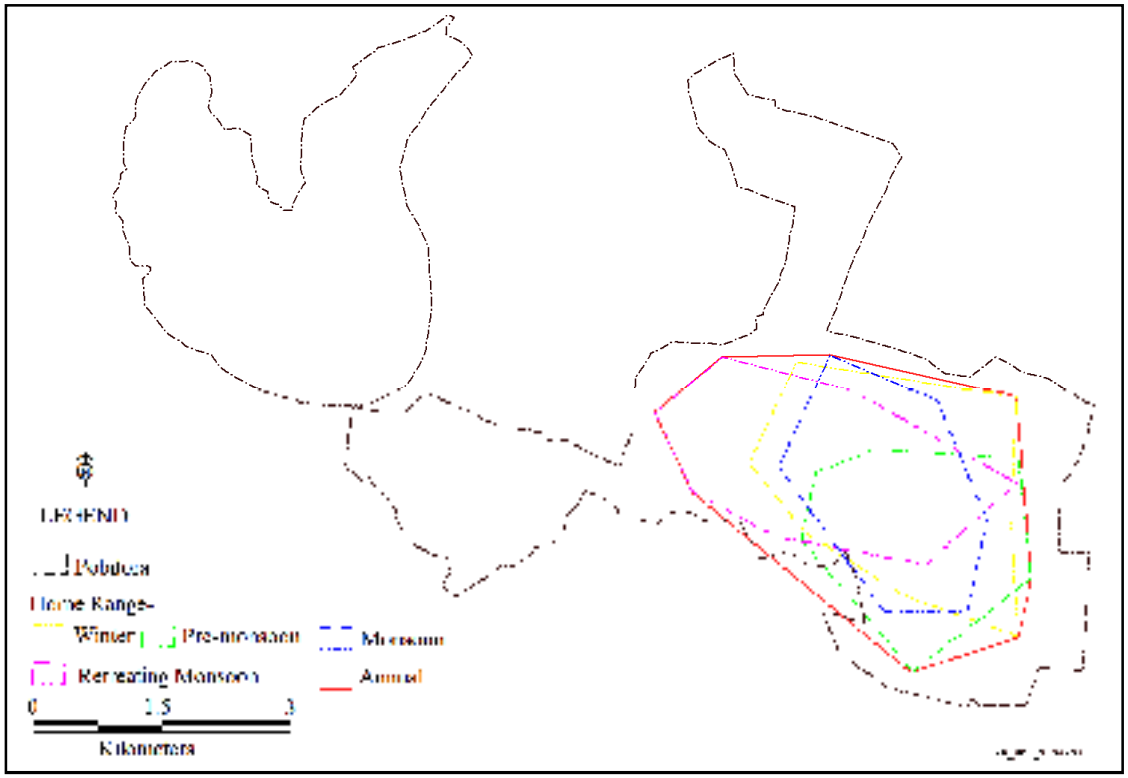


Figure-6.8 Seasonal range used pattern of M006 (Adult-female with small calf) during 2008-09

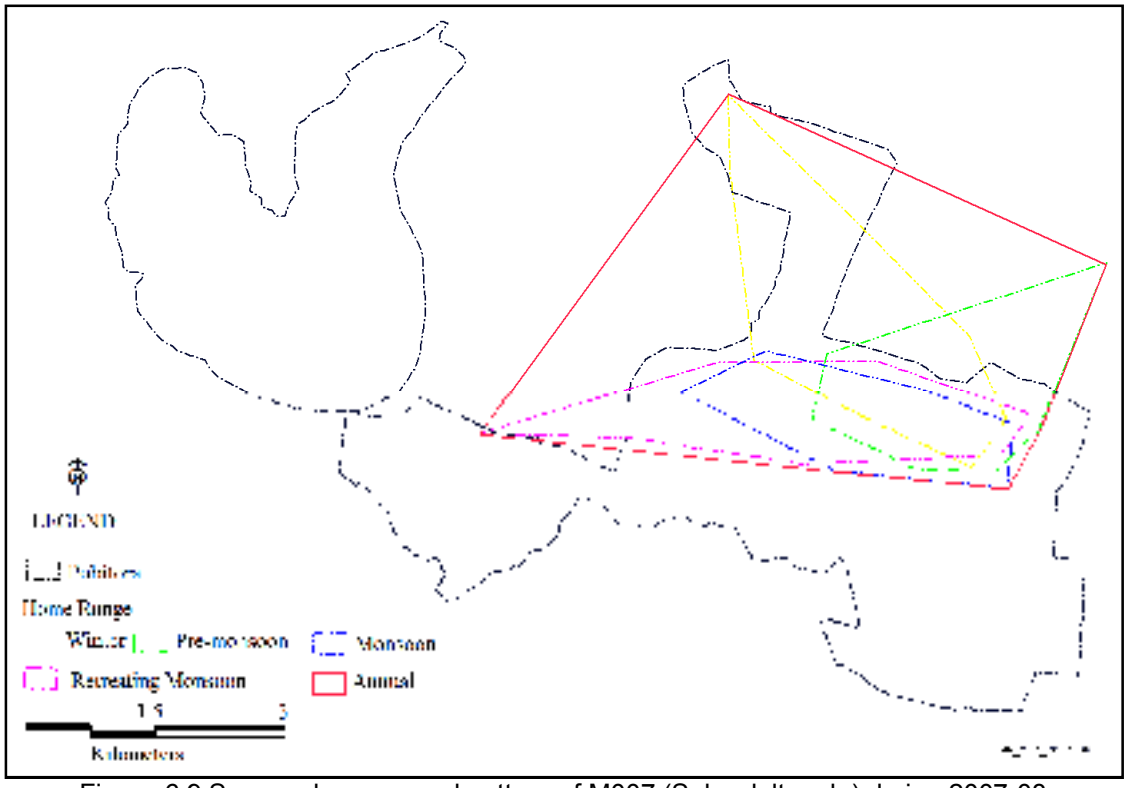


Figure-6.9 Seasonal range used pattern of M007 (Sub-adult male) during 2007-08

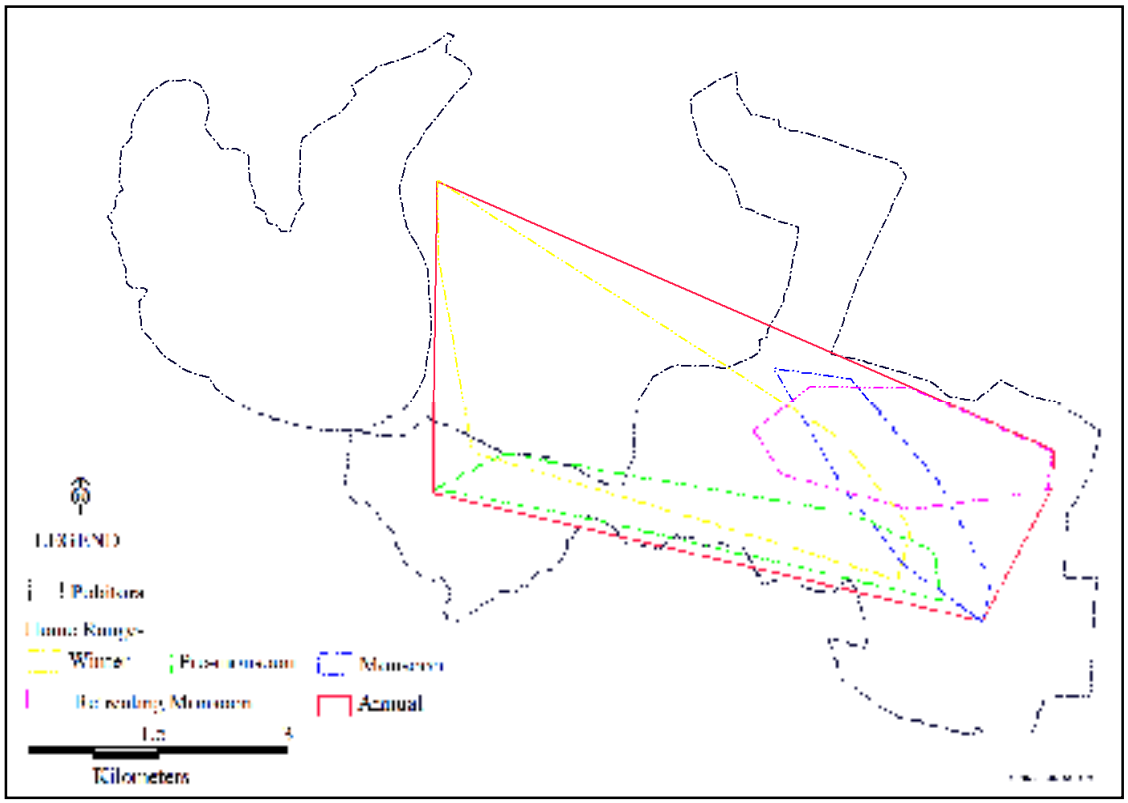


Figure-6.10 Seasonal range used pattern of M007 (Sub-adult male) during 2008-09

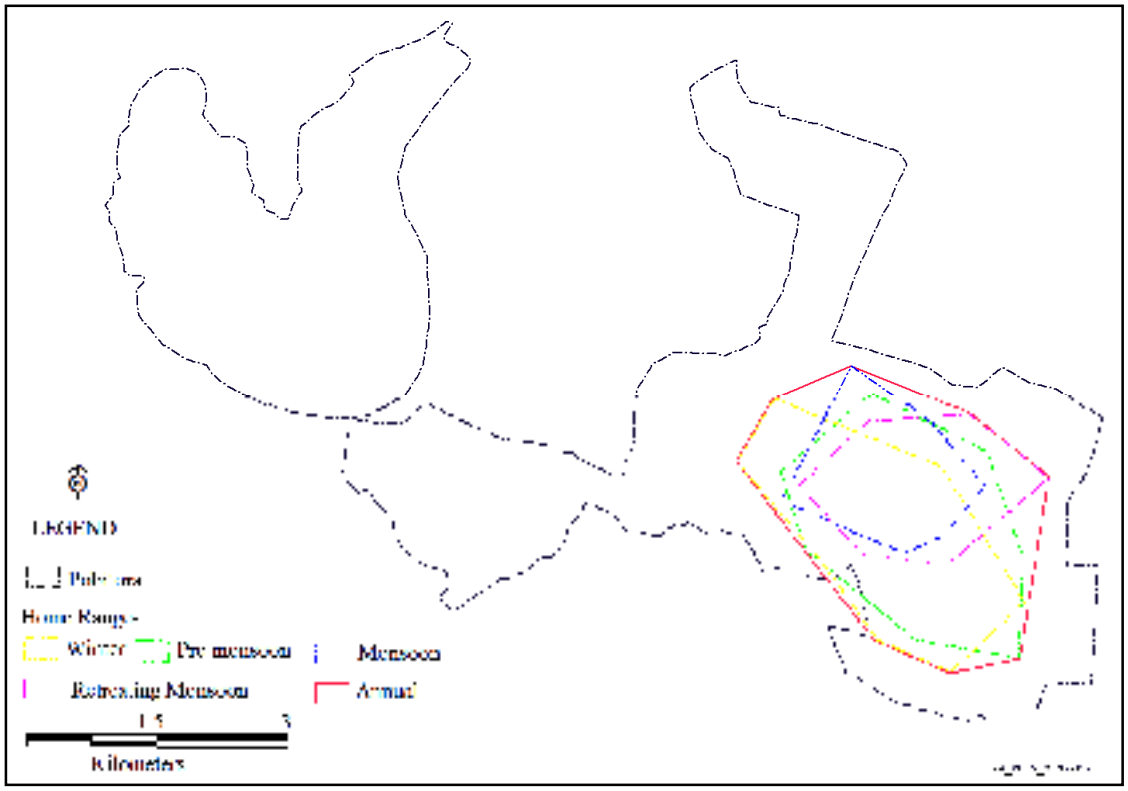


Figure-6.11 Seasonal range used pattern of M019 (Sub-adult female) during 2007-08

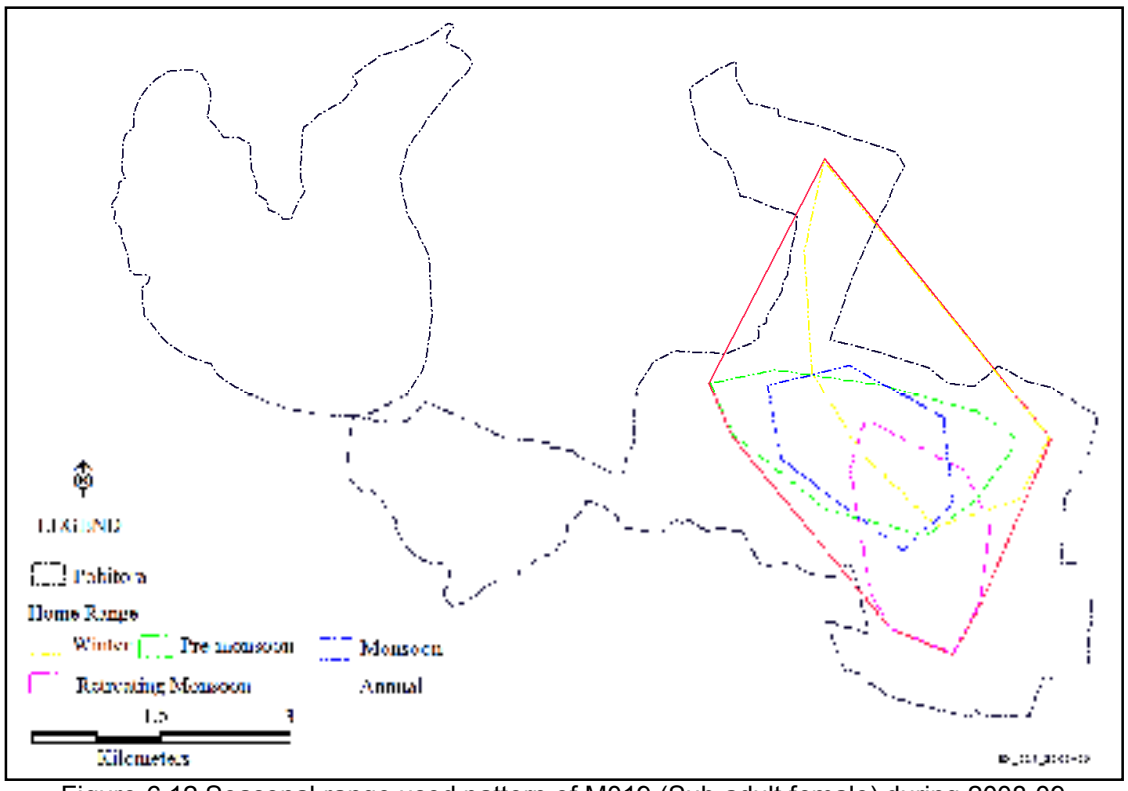


Figure-6.12 Seasonal range used pattern of M019 (Sub-adult female) during 2008-09

The average home range size of studied individuals in different seasons were found highest in winter season (7.302 km^2), followed by Pre-monsoon season (5.666 km^2), retreating monsoon season (5.56 km^2) and lowest in Monsoon season (3.767 km^2) respectively. Significant correlation between the home range size in winter and monsoon; winter and re-treating monsoon; Pre monsoon and retreating monsoon were observed respectively form the Spearman Rank Correlation analysis. Whether, no significant correlation had been observed between winter and Pre-monsoon; monsoon and retreating monsoon.

6.3.2 STRAYING MOVEMENT OUTSIDE THE SANCTUARY BOUNDARY

6.3.2.1 STRAYING ZONES

The analysis of straying incidences of Indian Rhinos in the study area during 2007-2008 and 2008-2009 revealed that, the Rhinos had utilized a total space of around 270 km^2 at 90% probability level (Figgure-6.13), which was found 7 times greater than the total area covered by the Sanctuary.

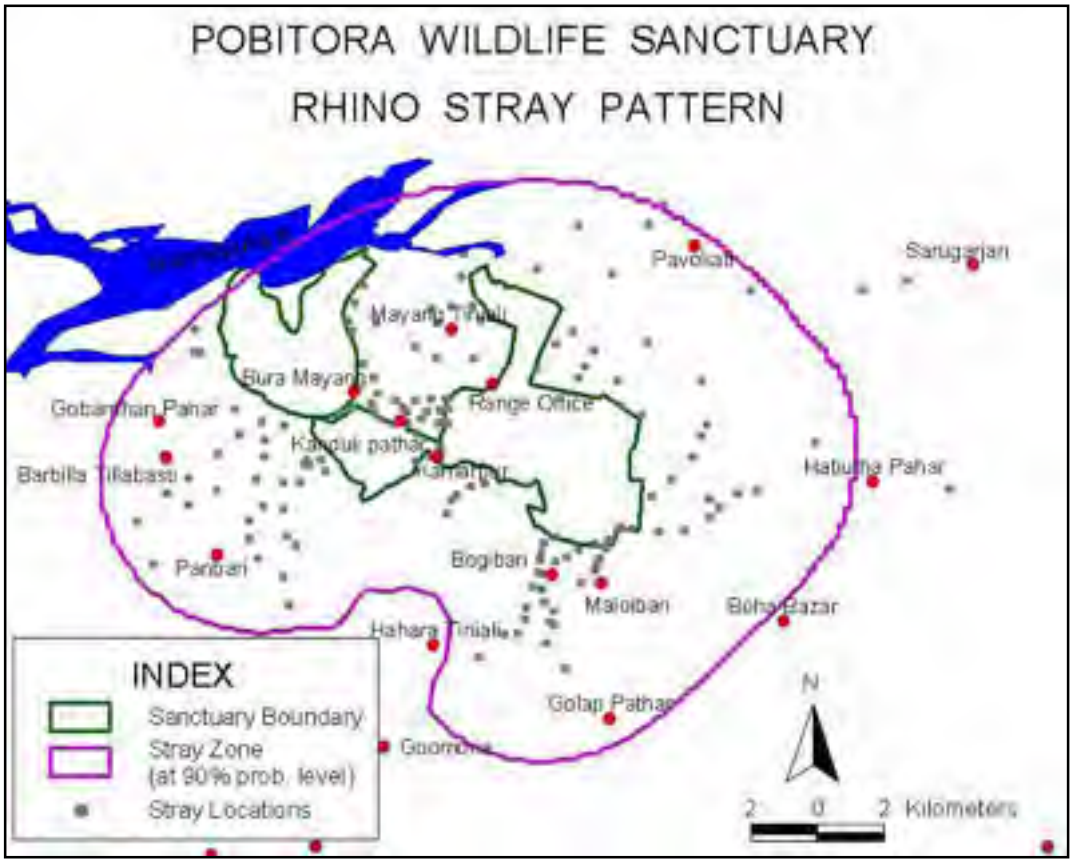


Figure-6.13: Pobitora Wildlife Sanctuary Showing Rhino stray zone (Area at 90% probability level is about 270sq.kms.)

6.3.2.2 STRAYING TRACK

Altogether 27 major straying tracks of Indian Rhino had been identified and Mapped during the study period. Out of these 27 tracks, 7 numbers of the tracks were used to move from one part of the Sanctuary to the other i.e. from the core rhino bearing area (former pobitora RF) to new additions viz., Dubaritali area, Kandulipathar area and foot hills of Rajamayang hill (former Rajamayang RF). The rest 20 numbers of tracts were the straying tracks to the nearby villages and agricultural field up to the river Brahmaputra and very occasionally to Rajib Gandhi Orang National Park, crossing the river Brahmaputra. The spatial distribution pattern of straying tracks towards different directions from the sanctuary was highest 26% in South-West Direction, 15% in North-West, 15%

in North-East, 11% in North, 11% in West, 7% in South-East and minimum 4% in East Direction (figgure-6.14). It had been observed that rhinos commonly strayed long distance towards the North-Eastern (NE) and South-Western (SW) side of the sanctuary i.e. in NE- direction from Nekerahabi, Kukari, Kholabhuyan side to Lehpati, Beradia, Garmari, (bank of river Brahmaputra) & Manaha area and in SW- direction from Kamarpur, Kanduli pathr to Barbilla, Kolong par and up to Dimoria area. Occasionally rhinos had moved to long distances towards the southern side i.e. from Kamarpur, Thengbhanga area up to Hahara near Khetri. The said movement towards the North and North Eastern side was observed mainly because of availability of different crops and low-lying areas on the fertile bank of river Brahmaputra. It was also observed that rhinos also strayed to those areas during mating chase, might be to avoid other male in the core area or might be due to their tendency to run long distance in mating display chase. The movement towards the NW- side to Barbilla area was because of very good rhino habitat with low-lying grassland with sufficient water source and less human disturbance in the said area adjacent to another Wildlife Sanctuary i.e. Aamseng Wildlife sanctuary.

Figure-6.14: Pobitora Wildlife Sanctuary Showing Rhino movement pattern outside PWLS

Table-6.4: Straying tracks of rhino around Pobitora Wildlife Sanctuary

Track code	*Track name*	*Length of the track (km)*	*Direction from the Sanctuary*
1	*Govali –Kajali Track*	5-6	NW
2	*Barchapara beel - Gobardhan - Barbilla Track Towards Songbeel)*	10-12	SW
3	*Barchapara beel - Barbilla Track (Towards Kalbari)*	12- 15	SW
4	*Borchapara - Kolong- Digaru Track*	15-20	SW
5	*Dhepuji - Kolongpar Pathar Track (Towards Dimoria)*	15-20	SW
6	*Dhepuji – Borchapara Track*	3-4	SW
7	*Kardia - Barchapara beel1 Track*	3-4	SW
8	*Kardia - Barchapara beel2 Track*	3-4	SW
9	*Kamarpur - Kamarpur Track*	0.5-1	W
10	*Thengbhanga- Garangamandir- Natanapathar Track*	1-2	S
11	*Thengbhanga- Bogibari - Amguri- Track (Towards Hahara).*	10-12	S
12	*Moliarpar-Thengbhanga- Bogibari Track*	3-4	S

13	*Diprang-Bogibari-Maloibari-(Towards Khetri.)*	10-12	SE
14	*Dholi-Nekarahabi-bahadalani- Baha Pahar Track*	5-7	SE
15	*Nekera Kukari-Jhargaon-Kwarhagi-Bhurgaon Garmari Track*	10-12	NE
16	*Kukuri - Hatiutha pahar – Manaha Track*	4-5	E
17	*Kholabhuyan-Pokoria – Burgaon Track*	7-9	NE
18	*Kholabhuyan - Kukuri – Dubaritali Track*	1-2	N
19	*Naltali-Sildubi-Bardia-Dubaritali Track*	1-2	N
20	*Amaramul-Rajamayang Track*	.5-1	NW
21	*Dubaritali-Hatibhangi - Pabhakati - Patekibari Track.*	3-4	NE
22	*Rajamayang-Hatimuria- Hatibhangi- Tepuri Track (towards Orang)*	10-12	NE
23	*Amaramul Rajamayang Kalsila- Bordal pathar Track*	2-3	N
24	*Tamlidova- Kandulipathar-Hiloikhunda Track.*	6-7	NW
25	*Haduk bridge – Burhamayang Track*	4-5	NW
26	*Tamulidova - Kandulipathar 1 Track*	1-2	W
27	*Tamulidova - Kandulipathar 2 Track*	1-2	W

N-North, S=South, E-East, W-West, NE-North East, NW- North West, SE-South East- South West.

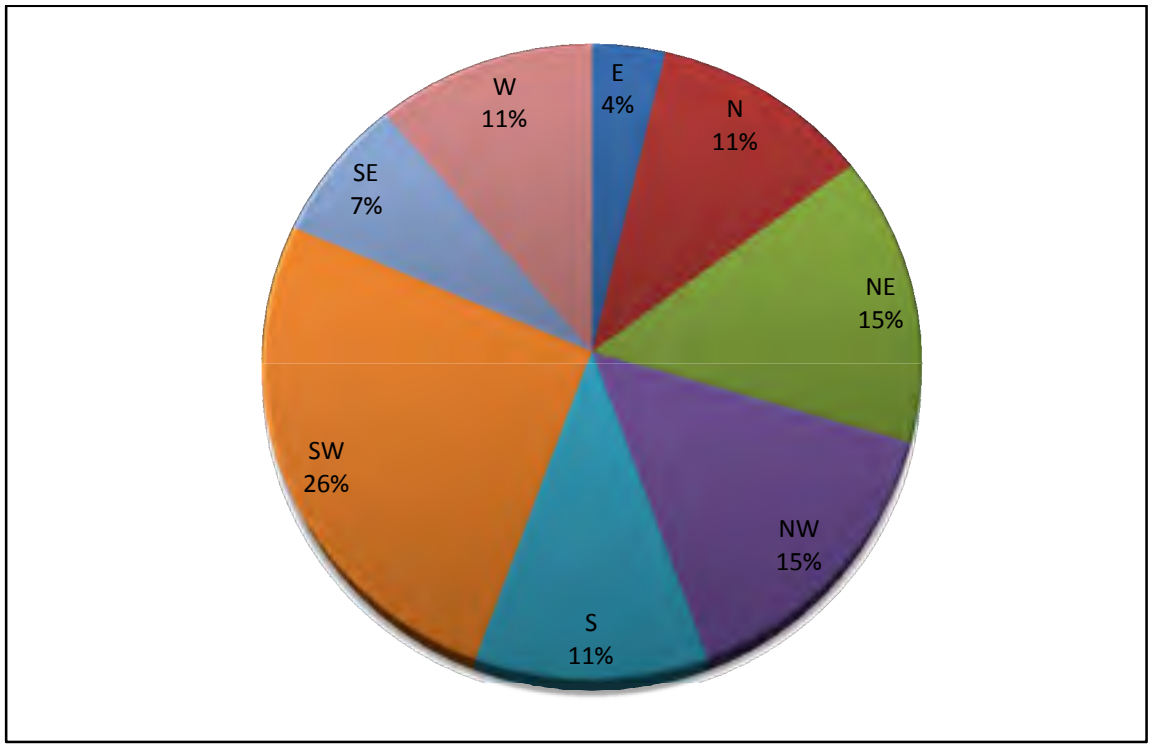


Figure-6.15: Spatial distribution of straying traccks indifferent directions

6.3.2.3 SEASONAL USE OF STRAYING TRACKS

The analysis of daily monitoring of Rhino straying in identified tracks for the year 2007-2008 and 2008-2009 had been found that during 2007-2008 Rhinos used 44% tracks for 01 – 30 days, 4% tracks for 31-50 days, 7% tracks for 51- 80 days, 19% tracks for 81-100 days, 19% tracks for 101-130 days and 7% tracks for 131- 160 days (Figure-6.16 and 6.17) and during 2008-2009 rhinos used 44% tracks for 01 – 30 days, 15% tracks for 31-50 days, 11% tracks for 51- 80 days, 4% tracks for 81-100 days, 26% tracks for 101-130 days(Figure-6.18 and 6.19).

Significant variations in the utilization pattern in different seasons were observed during the study period. In Winter season almost all the tracks were used by rhinos, on the other hand in Pre-Monsoon, Monsoon and Retreating-Monsoon a considerable number (9-10) of tracks were inactive(fig-6.18 & 6.19). It was because during pre-monsoon the nearby agricultural areas were covered by Paddy crops (Bodo rice) cultivation and was strongly guarded by villagers. During monsoon and retreating monsoon, some of the straying tracks were inactive due to the natural barrier i.e. deep water logging. Importantly during the said seasons food availability in the core area were found considerably higher compared to the winter and pre-monsoon seasons, which had reduced the straying tendency in search of food.

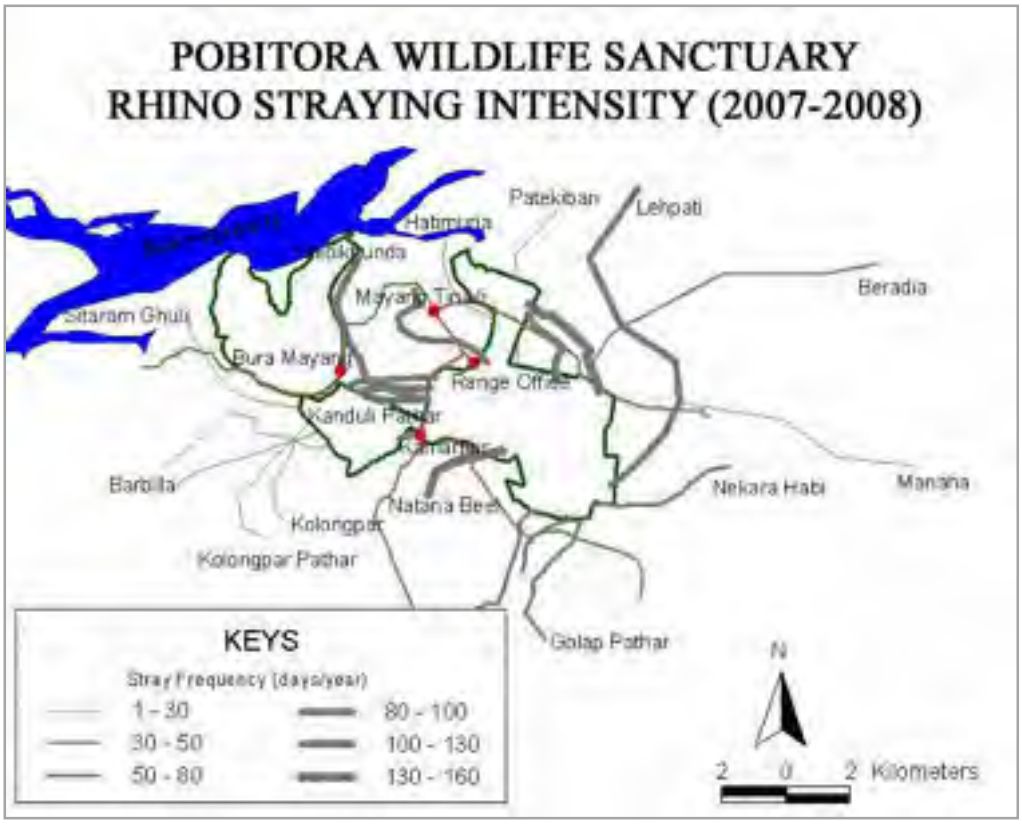


Figure-6.16: Pobitora Wildlife Sanctuary Showing Rhino movement intensity (2007-2008) outside PWLS

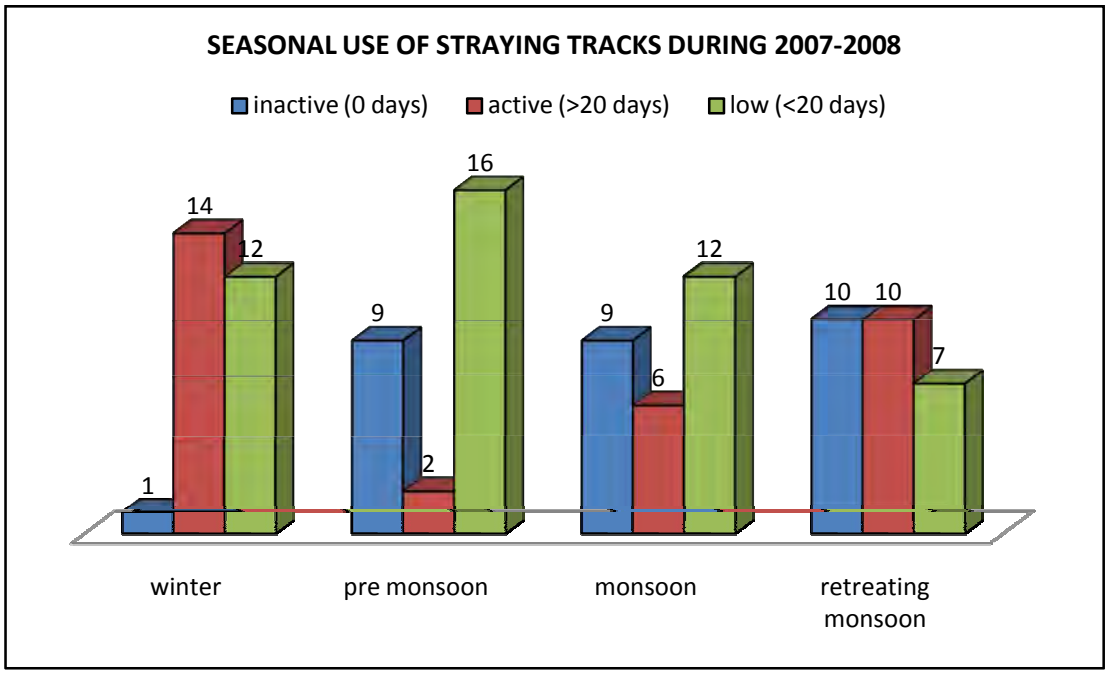


Figure-6.17: Seasonal use of straying tracts by Rhinos around Pobitora Wildlife Sanctuary-2007-2008

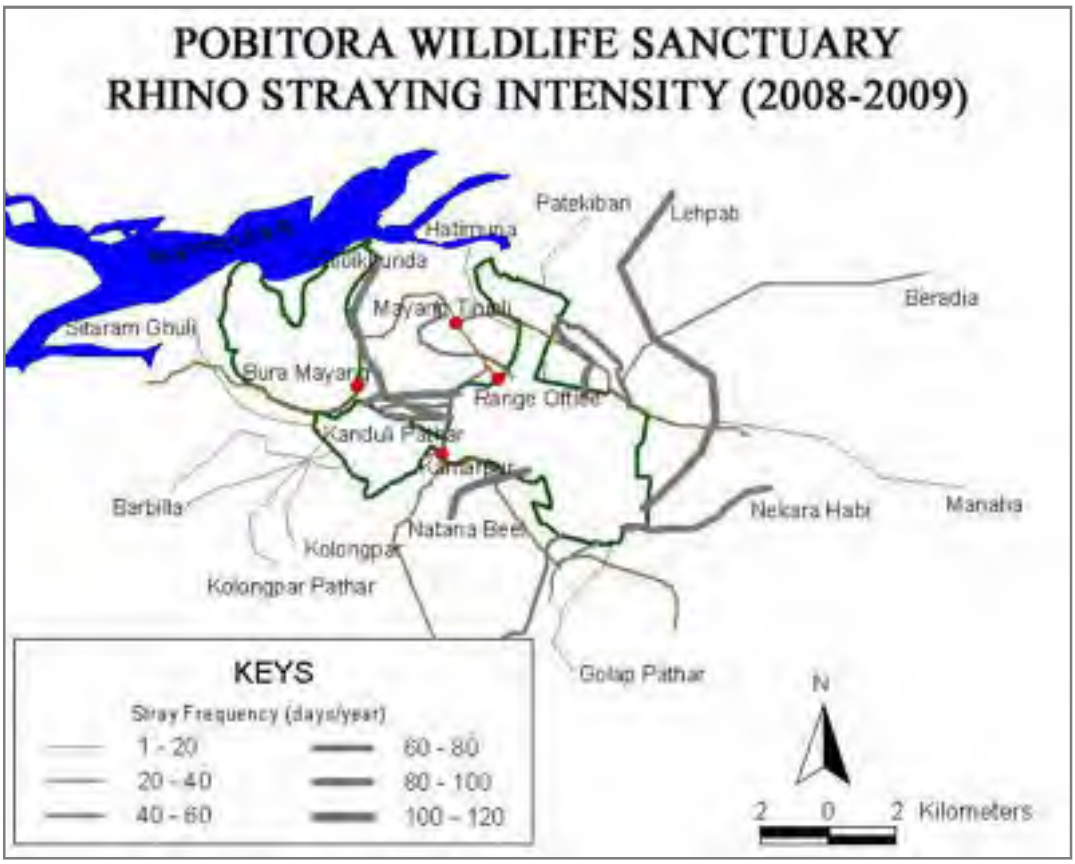


Figure-6.18: Pobitora Wildlife Sanctuary Showing the Rhino movement intensity (2008-2009) outside the Pobitora Wildlife Sanctuary

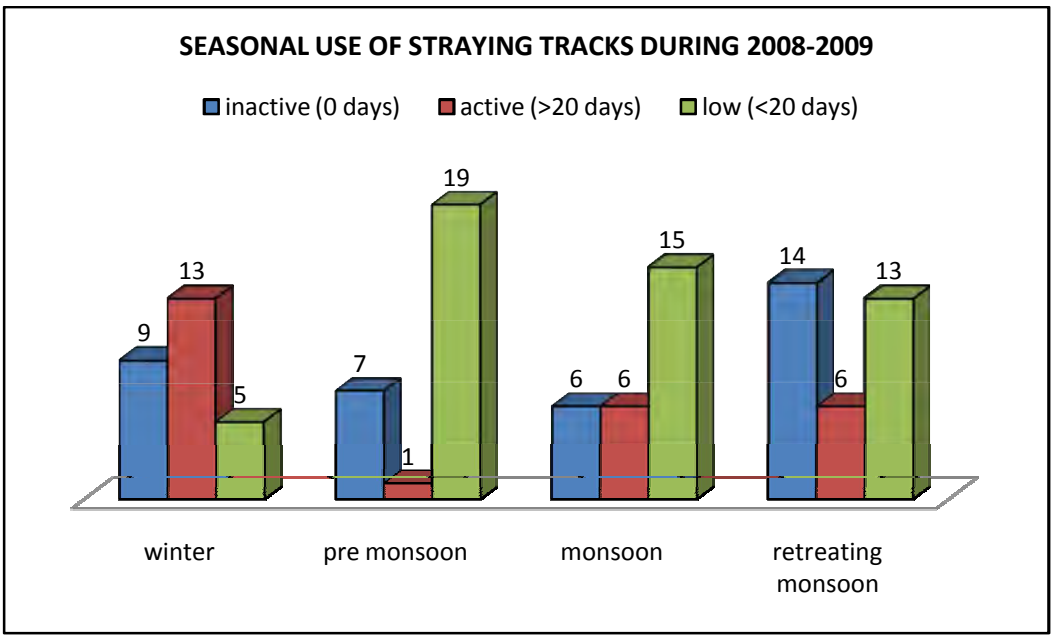


Figure-6.19: Seasonal use of straying Tracts around Pobitora Wildlife Sanctuary during 2008-2009

6.3.3 HABITAT UTILIZATION

The present study had revealed that Indian Rhinos in Pobitora Wildlife Sanctuary utilized a maximum of 28.52% short grassland habitat, followed by 23.05% woodland habitat, 22.61% wetland habitat, 17.72% Tall grassland habitat and 8.10% degraded and other habitat throughout the year (Figure-6.20)

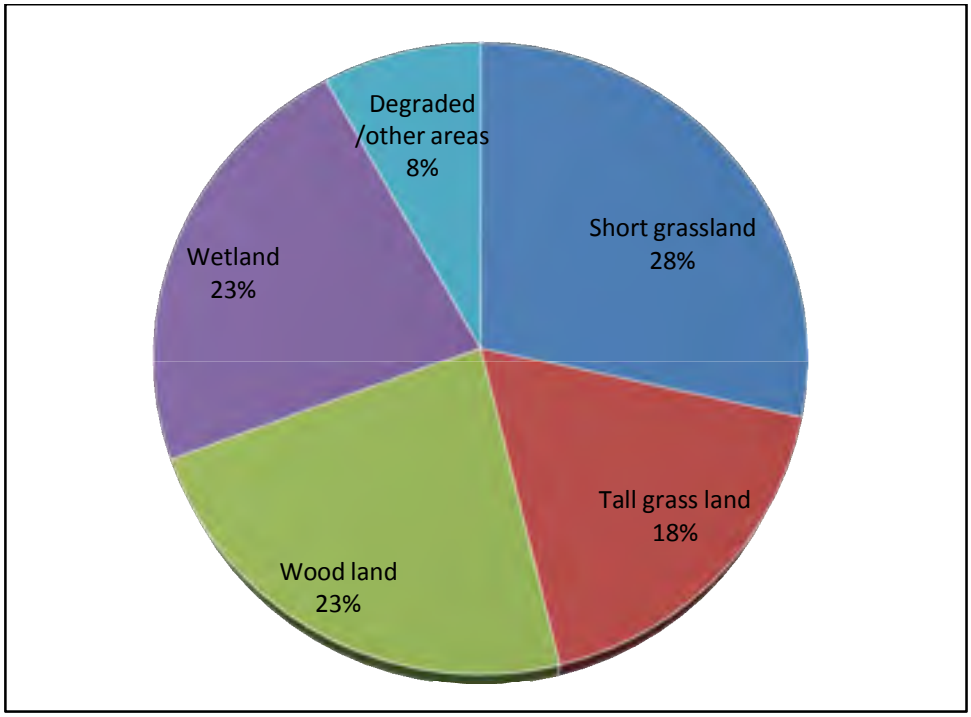


Figure-6.20: Habitat selectivity of Indian Rhinos throughout the year.

6.3.3.1 SEASONAL USE OF HABITAT

a) Winter-

During winter seasons of the study period it was observed that, Indian Rhino used highest 34.02% short grass land followed by 26.97% woodland, 15.91 wetland, 13.97% tall grassland and around 09.13% degraded/ other areas in the sanctuary (Figure-6.21 and Table-6.5)

Table-6.5: Habitat utilization Pattern of Indian Rhinos in different Seasons in Pobitora Wildlife Sanctuary.

Habit type/ seasons	Winter		Pre-monsoon		Monsoon		Retreating Monsoon	
	Number of rhino observed	Habitat Selectivity (%)*	Number of rhino observed	Habitat Selectivity (%)*	Number of rhino observed	Habitat Selectivity (%)*	Number of rhino observed	Habitat Selectivity (%)*
Short grassland	246	34.02	209	30.92	145	20.95	192	27.99
Tall grass land	101	13.97	122	18.05	111	16.04	158	23.03
Wood land	195	26.97	142	21.01	159	22.98	144	20.99
Wetland	115	15.91	128	18.93	228	32.95	157	22.89
Degraded /other areas	066	09.13	075	11.09	049	07.08	035	05.10
Total number of observation	723	100	676	100	692	100	686	100

*Habitat Selectivity = (Total no. of rhino sighted in a particular habitat/ Total no. of sighting record of Rhino in all habitats) × 100

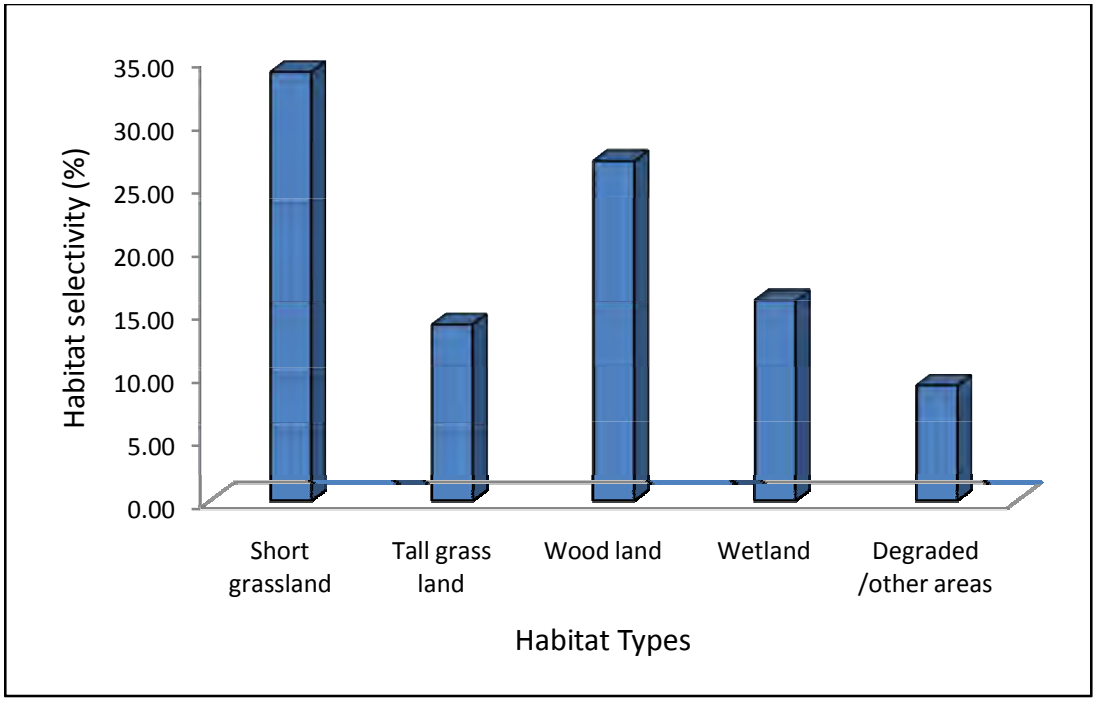


Figure-6.21: Habitat selectivity during Winter Season

b) Pre-monsoon

During Pre-monsoon it was observed that, Indian Rhino used highest 30.92% short grass land followed by 21.09% woodland, 18.93 wetland, 18.05% tall grassland and around 11.09% degraded/ other areas in the sanctuary (Figure-6.22 and Table-6.5)

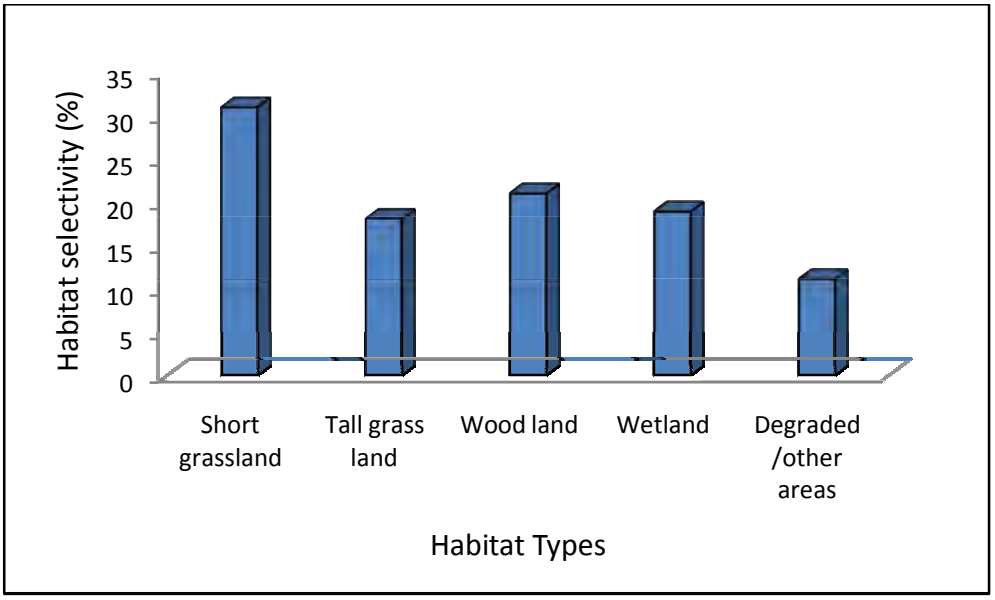


Figure-6.22: Habitat selectivity during Pre-monsoon Season

c) Monsoon

During Monsoon it was observed that, Indian Rhino used highest 35.95% wetland, followed by 22.98% woodland, 20.95% short grass land, 16.04% tall grassland and around 07.08% degraded/ other areas in the sanctuary (Figure-6.23 and Table-6.5)

Figure-6.23: Habitat selectivity during Monsoon Season

d) Re-treating Monsoon

During Re-treating Monsoon it was observed that, Indian Rhino used highest 27.99% short grass land, followed by 23.03% tall grassland, 23.89% wetland, 20.99% woodland, and around 05.10% degraded/ other areas in the sanctuary (Figure-6.24 and Table-6.5)

Figure-6.24: Habitat selectivity during Re-treating monsoon Season

6.4 DISCUSSION

In Pobitora Wildlife Sanctuary the size of annual home ranges was observed between 9.079 km2 to 27.42 km2. Earlier Jonwali (1995), Hazarika (2007) and Hazarika & Saikia (2006, 2009, 2010, 2011) had found the annual home range between 25.1-41.8 km2 in Bardia, 2.9-3.3 km2 in Chitwan and 5.51-7.67 km2 in Orang respectively. The variation in the home range size of Indian Rhino in different habitat might be due to variation of habitat qualities. Goddard (1967) and Hutchinns (1969) had described about variation of home range size in different habitat. According to their study the home range in forest habitat was 2.5 km^2, 8.8 km^2 in drying thron scarb habitat, 3 km^2 in thicket and 5 km^2 in Savanna habitat of olduvai and Kenia. A variation of home range size among different age-sex class was found in the study. The annual home range of adult male of older age was seemed smaller (14.785 km^2) compared to adult male of younger age (20.89 km^2). This was observed that young adult males were to cover larger areas due to the conflict with dominant male for territory and for mate resource. These findings were also supported by Hazarika (2007) and Hazarika & Saikia (2010) in Orang National Park. The annual home range of adult female with small calf (<1 year) were observed smaller than the Adult-female with bigger calf (3-4year of age). This was because of the limitation of the calf to move longer distance crossing different barriers, so the mother had to restrict her within the sanctuary. During the study it was clearly observed that home range of all the studied individuals were overlapped within the sanctuary, which indicated about the competition of individuals for different resources. It was also observed that more than 60% of the studied individuals were found to

be with home range partly outside the conservation area. This might be because of scarcity of food, space, high animal density and heavy disturbance inside the Sanctuary area (Section-7.1).

During the study period it was observed that Rhinos of the of Pobitora Wildlife Sanctuary strayed out in most part of the year and utilized around 270 km^2 covering mostly agricultural areas & scattered villages, which was not a healthy situation for conservation of rhino in the sanctuary. Several Rhino poaching incidences were occurred outside the conservation area during stray. This was also stated by Talukdar(1999) in Assam Rhino habitats. The cause of this stray behavior of rhino was mainly due to scarcity of food, drastic changes of grassland of the sanctuary owing to extensive cattle grazing each day within the sanctuary boundary, extensive thatch collection by villagers. Increased numbers of feral water buffalos grazing in the Sanctuary, heavy annual flood and siltation during monsoon were aggravating the habitat degradation. Bairagee et al. during 2002-04 had also described same findings on degradation of habitat in the sanctuary. Cultivation of crops preferred by Rhinos in surrounding areas had found to attract them to move out of the sanctuary. In Nepal Jnawali, (1989) had described the same fact in Bordia and Chitwan NP. Human disturbance inside the sanctuary and high density of rhinos in the core area (territorial conflicts) might compel the rhinos to stray out. The movement of rhino to the foot hill and hillocks that scattered all along the sanctuary boundary i. e. North- Hatimuria, Kasha-sila, Rajamayang; East- Baha, Kukari; West- Panbari and South- Kamarpur, Hahara, Khetri might be due to the presence of high mineral content in the soil and rocks. Affinity of Rhinos towards mineral-

licks had described by Dr. Laurie (1978) in Chitwan National Park, Nepal. Occasionally Rhinos was found to move out of the sanctuary, loosing tracks during matting chase.

The findings of present study (Section-6.3.3) revealed that, Indian Rhino in Pobitora Wildlife Sanctuary mostly prefered short grassland habitat, followed by tall grassland, Woodland, Wetland and degraded/ other areas. During Monsoon season Indian Rhino was mostly found in Wetland habitat, this was because during monsoon most of the Rhino bearing areas submerged due to heavy rain fall. High temperature during monsoon was also compelled Indian Rhino to spend more time in water to regulate the body temperature. It was observed that wallowing in water and mud relieved Indian Rhino from disturbance of annoying flies flourished during monsoon. The same findings were also supported by Hazarika (2007) and Hazarika & Saikia (2006, 2009, 2011) during their studies in Orang National Park. It was observed that, the preference of wood land habitat (plan area) in Pobitora Wildlife Sanctuary by Indian Rhinos was considerably higher than all earlier finding of different studies done in India and Nepal on the species. This was might be because of heavy disturbance in the sanctuary and absence of sufficient hide needed for the population.

Rhino hoof mark at sandbars of Brahmaputra River

A rhino near human Habitation

Crop depredation by Rhino

Rhinos grazing inside the sanctuary

Plate-5: Indian Rhinos in and around Pobitora Wildlife Sanctuary

Chapter-VII:
CONSERVATION AND MANAGEMENT

7.1 INTRODUCTION

All destruction of biodiversity is human-induced, losses of species or habitats due to natural processes such as fires from lightening or hurricanes are not threats to biodiversity (Margoluis and Salafsky, 2001). The survival of many of India's Wildlife species today is threatened by human induced factors like habitat destruction, reduced geographical range, low population and severe fragmentations of populations (Sale, 1986). If this endangered species are to escape extinction, dynamic conservation and management measures required to reverse the process of decline and set their population in an upward trend in a context of restored ecological balance (Sale, 1986).

Overall, the conservation of Indian rhinos (Vulnerable, IUCN, 2010) in Assam and India has been a great success. In 1905, numbers of the species in Assam had declined to a dozen (Foose and Strien, 1997). Through strict protection, this population has recovered to over 2,300 individuals (Talukdar, 2002, Talukdar et al., 2010). Despite the obvious success booked by the Government of Assam and India in protecting Indian rhinos, there are several concerns regarding the long-term survival of the species (Figure-7.1). As the Assam State holds almost the entire world population, protection and the removal of threats and pressures on this species is a special obligation in this particular range of the species (Polet et al., 2006).

This chapter of the study aimed to analyze different threats and pressure on Indian rhino with special reference to Pobitora wildlife sanctuary, to analyze the prevailing conservation and management practices, the conservation-management gaps in the sanctuary and to evaluate the reduction of threats and pressures due to implantation of different conservation and management measures by the authority.

7.2 METHODS

7.2.1 CONSERVATION THREATS & PRESSURE

To analyze the threats and pressure on survival of Indian Rhino was done using direct and indirect methods. In direct method, the entire sanctuary, dividing 1' interval grid (Section-3.2) and periphery was surveyed periodically for different parameters or determinants like wood cutting, weed abundance, lopping, human and animal trail, human presence, direct and indirect livestock signs and direct and indirect human signs (Annexure-6) (Jhala et al., 2008). In indirect methods existing literature on the species and the present habitat was surveyed and comments received from several informal discussions with park Managers, frontline staff, conservationist was working for the species and with local villagers. All the said comments were re verified and considered to summarize the type and intensity of threats and pressure on Indian Rhino in the study area (Talukdar et al., 2007). To understand the park people relationship and perceptions towards conservation of Rhino, a rapid survey was conducted in affected villages around the Sanctuary to know the pattern and intensity of affect. Factors like crop damage, human injury/ human death & personal

harassment etc. were taken in to consideration to measure the intensity i.e. Highly affected, Moderately affected and Lowly affected (Annexure-7)(Jonwali, 1986, 1989; Sharma; 1991).

7.2.2 CONSERVATION MEASURES ADOPTED BY AUTHORITY

A questioner survey was conducted among the park managers, front line staff and individuals working in the sanctuary for conservation of the species to summarize the collective measures taken to conserve the species and prevailing gaps to strengthen the conservation effort (Talukdar et al., 2007).

7.2.3 CALCULATION OF THREAT REDUCTION INDEX

The evaluation of conservation efforts against each threat (Section-7.2.1 and 7.2.2) was calculated using *Threat Reduction Assessment index* (TRA-index) method. In this method all the threats listed were defined and ranked for different criteria like-affected area, intensity and urgency. Then the percentage of threat reduction was calculated using following index formula (Margoluis and Salafsky, 2001)-

(Total Raw Score ÷ Total Ranking) X 100 = TRA Index (%)

List of Threats considered	Definition of 100% threat reduction
1. Extensive cattle grazing	No House hold cattle graze inside the sanctuary for all seasons
2. over extraction of resources by villagers	No extraction of resource from the sanctuary by villagers
3. Weed invasion to grassland	No weed species found within the grass

	patchs
4. Siltation of wetland	No more siltation occur over the wetlands
5. Invasion of woodland to grass land	No more invasion of woodland to grassland
6. Poaching for Horn and other body parts	No poaching of Rhinos for horn
7. Accidental Killing of Rhinos	No Killing of Rhinos in accidental
8. Conflict with people	No incidences of Conflict with people
9. Epidemic outbreak of disease among Rhinos	No epidemic outbreak
10. Inadequate conservation awareness among stakeholders	Adequate awareness on Rhino Conservation among stakeholders

Table-7.1: List of threats and definition of 100% threat reduction for each threat.

7.3 RESULTS

7.3.1 CONSERVATION THREATS TO POBITORA WILDLIFE SANCTUARY

During the study period from all the above mentioned sources (Section-7.2) following threats and pressures had been observed, understood and discussed below (Figure-7.1)

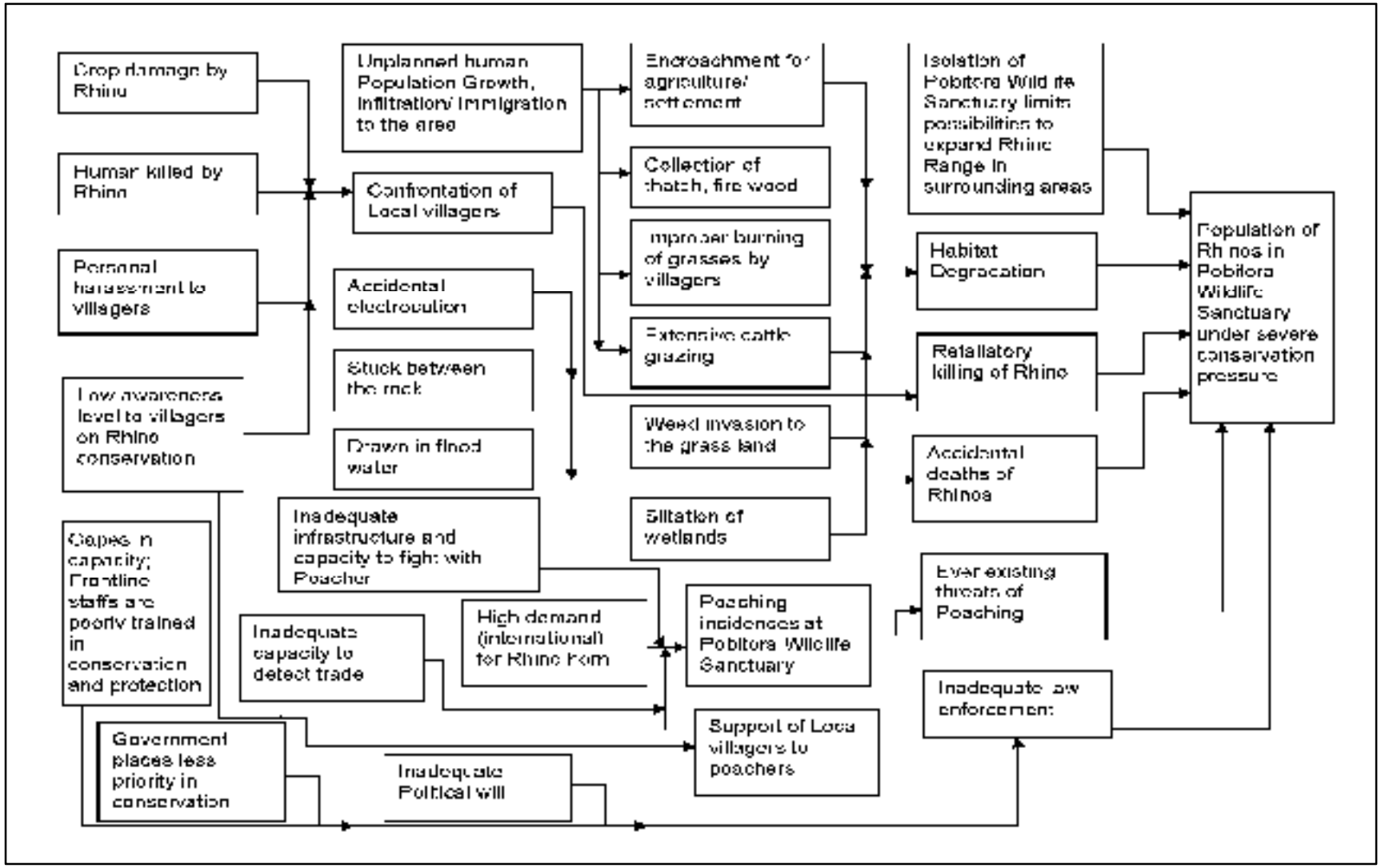


Figure- 7.1: Threats and pressures on the survival of Indian Rhino in Pobitora Wildlife Sanctuary

7.3.1.1 HABITAT DEGRADATION

The habitat of the sanctuary was seems to be degraded due to following pressure-

a. Extensive Cattle Grazing-

The survey conducted during the study for estimation of cattle grazed in the sanctuary had revealed that, around 27±1.35- 109±5.45 numbers of domestic cattle was found to be grazed in every square kilometer area of the sanctuary (Table- 8.2). Extensive cattle grazing inside the Sanctuary led to degradation of grassland and were resulting severe food crisis for wild herbivores including Rhino. This was also increasing chance of contamination and spurt of epidemic disease.

Cattle type	Density of cattle in different season in 95% confidence level (Density/ km^2)			
	Winter	Pre-monsoon	Monsoon	Retreating Monsoon
Domestic Cow	91±4.55	88±4.4	27±1.35	58±2.9
Domestic Buffalo	5±0.25	5±0.25	0.0±0.0	5±0.25
Domestic Goat	13±0.65	9±0.45	0.0±0.0	7±0.35
Total	109±5.45	102±5.1	27±1.35	70±3.5

Table-7.2: Density of domestic Cattle inside the sanctuary gazed in different

b. Collection of Thatch

A major share of the grass had been found to be collected by the local villagers as fodder for cattle and thatch for building house which was also

leading the shortage of food to already crowded population of Rhino and Water buffalo inside the Sanctuary. The villagers also destroyed a major portion grass by burning improperly during collection of thatch.

c. Weed invasion to the grass land

The invasion of weeds was found one of the major threats to the grass land. Species like *Desmodium trifliatumum, Cardiospermum helicacabum, Ipomea cornea Argemone maxicana* were some of the weed species which were found as threats to grassland degrading the quality of the grassland as fodder for Indian Rhino.

d. Encroachment

During the study it was observed that around 10.1 km2 area (Figure-7.2) was found to be used by local villagers for agriculture.

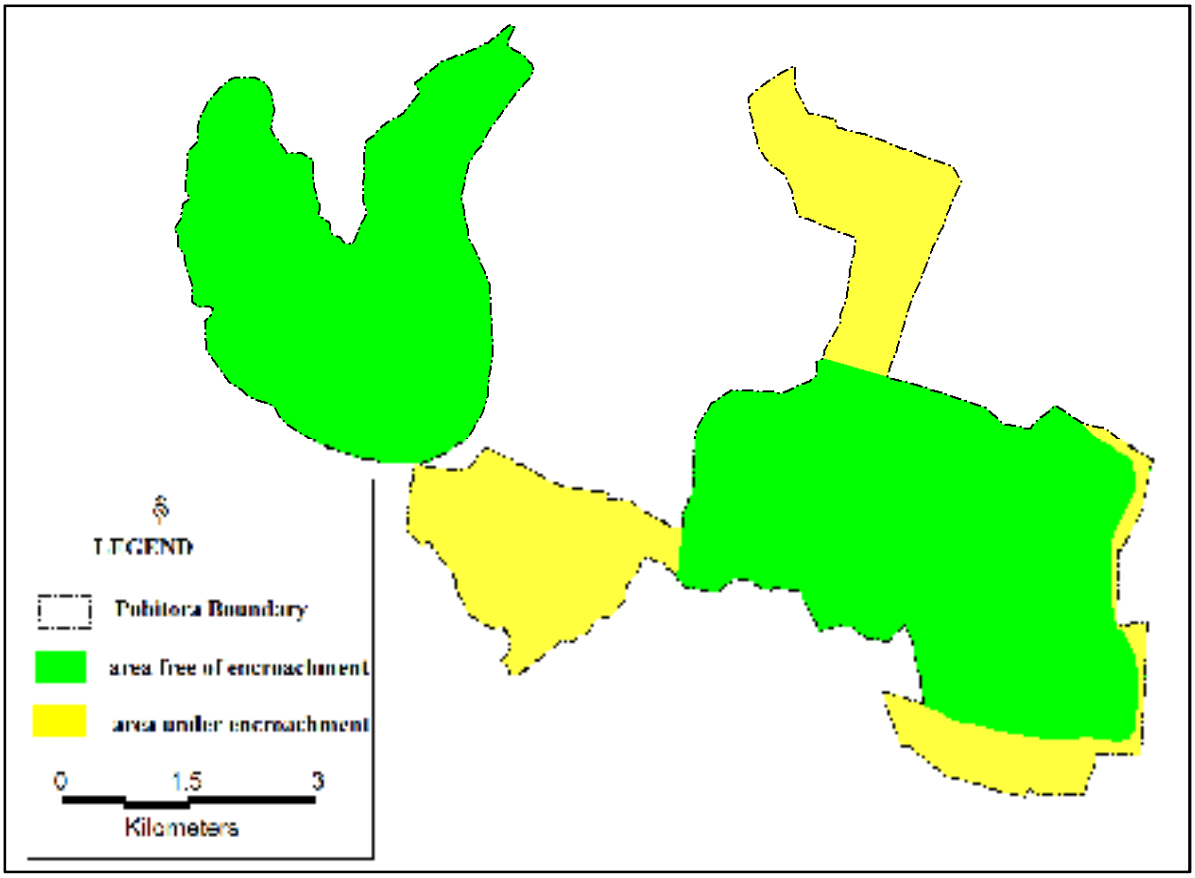


Figure-7.2: Encroachment inside the notified boundary of Pobitora Wildlife Sanctuary.

Sl. No.	Encroachment Site	Type	Area (km2)	Remarks
1.	Dubaritoli area	For Agriculture	3.8	Extension area not under sanctuary management
2.	Kamarpur Kandulibeel ,Burha mayang area	For Agriculture	4.57	Extension area not under sanctuary management
3.	South to Dholi beel	For Agriculture	1.55	Encroach by villagers
4.	Kholabhuyan, North to the Mayang Manaha Road	For Agriculture	0.18	Encroach by villagers
Total			10.01 km^2	

Table-7.3: Areas under encroachment inside the notified boundary of Pobitora Wildlife Sanctuary.

e. Siltation of wetlands

Seasonal inundation of the sanctuary by flood from mighty river Brahmaputra deposited silt in the sanctuary and gradually reduced the depth and area of wet lands. The process of siltation of wetlands was found to be quicker after construction and development of PWD roads without sufficient water channels. Construction of embankment on the out flow channels of wetland by sanctuary authority to retain more water in the sanctuary also contributed the siltation process by hampering the natural clearance mechanism of silt.

f. Invasion of woodland to grassland

Expansion of woodland towards grassland habitat was found common in the sanctuary. If this would allow to continuing a major portion of grassland would alter to wood land. The amount of invasion couldn't measure during the study because of strategic falling of trees to arrest the invasion of woodland to grassland.

7.3.1.2 POACHING FOR BODY PARTS

Poaching of Rhino for horn was common in the Sanctuary. All total, 52 Rhinos had been poached during 1987- 2010. The main way of poaching was recorded as Electrocution (20), Bullet Injury (30) and Poisoning (2). Poachers had taken the advantage of crossing high tension (11KV) electric transmission line through the Sanctuary.

Table-7.4: Rhino poaching incidences in Pobitora Wildlife sanctuary during 1987-2010

Year	Poaching				Type of Poaching		
	Male	Female	Unidentified	Total	Electrocution	Bullet	Poisoning
1987	0	2	0	2	-	-	2^{i}
1988	2	1	0	3	-	$1^{i}+2^{o}$	-
1989	2	2	0	4	$1^{i}+1^{o}$	2^{o}	-
1990	2	0	0	2	-	$1^{i}+1^{i}$	-
1991	1	0	0	1	-	1^{o}	-
1992	3	0	0	3	2^{o}	1^{o}	-
1993	1	3	0	4	-	$1^{i}+3^{o}$	-
1994	3	1	0	4	$1^{i}+3^{o}$	-	-
1995	1	1	0	2	-	2^{i}	-
1996	2	3	0	5	$2^{i}+2^{o}$	1^{i}	-
1997	0	3	0	3	-	$2^{i}+1^{o}$	-
1998	3	1	0	4	1^{i}	$1^{i}+2^{o}$	-
1999	3	2	1	6	3^{o}	3^{i}	-
2000	1	1	0	2	-	2^{i}	-
2001	0	0	0	0	-	-	-
2002	1	0	0	1	1^{o}	-	-
2003	0	2	0	2	2^{i}	-	-
2004	0	1	0	1	1^{o}	-	-
2005	0	2	0	2	-	2^{i}	-
2006	0	1	0	1	-	1^{i}	-
2007	0	0	0	0	-	-	-
2008	0	0	0	0	-	-	-
2009	0	0	0	0	-	-	-
2010	0	0	0	0	-	-	-
Total:	25	26	1	52	20	30	2

^{i}=inside the sanctuary, ^{o}= outside the sanctuary

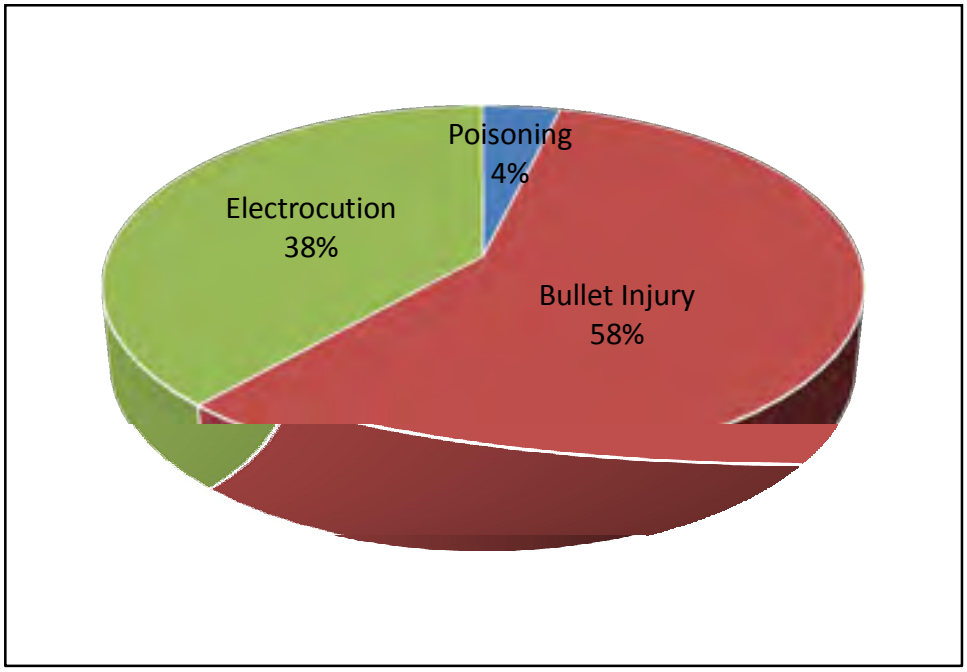


Figure-7.3: Methods of Rhino poaching incidences in Pobitora Wildlife Sanctuary during 1987 to 2010

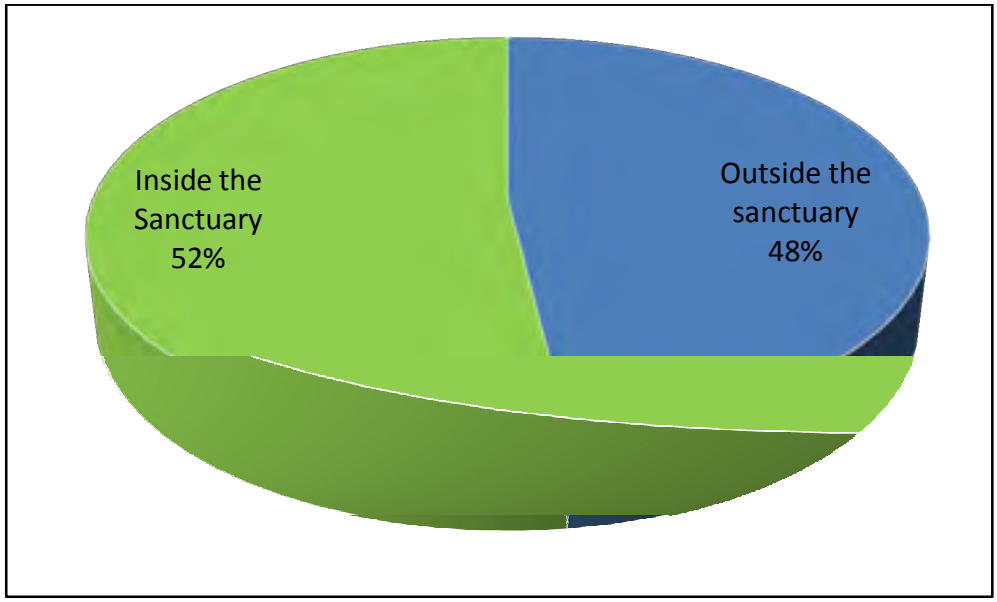


Figure-7.4: Rhino poaching incidences inside and out side the Sanctuary boundary (1987-2010)

7.3.1.3 ACCIDENTAL KILLINGS

There were all total 23 numbers of Rhino deaths due to different accidental deaths recorded during 1987 to 2010 viz. dawning in flood water (7), stuck between rocks (3), premature birth (2), refused by mother, infighting (5), attack of mature rhino(2) (Table-7.5).

Sl. No.	Type of Accidental deaths	Number
1.	Drawn in flood water	7
2.	Stuck between the rock	3
3.	Accidental electrocution	1
4.	Food poisoning	1
5.	Infighting	5
6.	Premature birth	2
7.	Refused by mother	2
8.	Attack of mature Rhino	2
Total:		23

Table-7.5 Accidental death incidences of Rhinos during 1987-2010

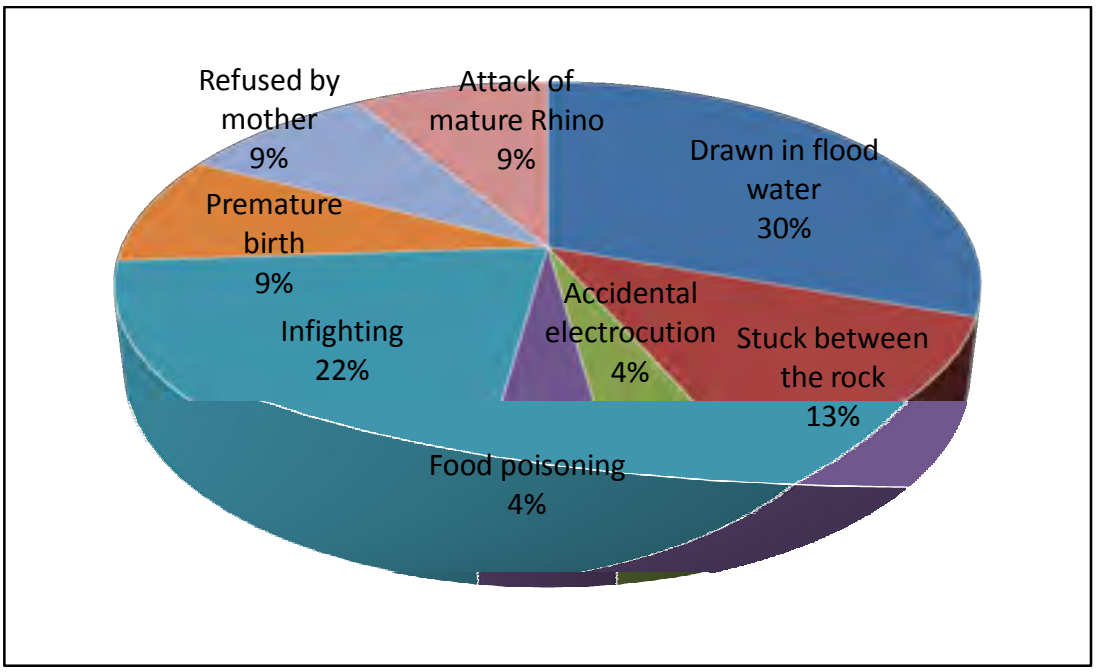


Figure-7.5: Different types accidental Rhino death incidences during 1987-2010

7.3.1.4 CONFLICT WITH PEOPLE

Result of the rapid surveys was revealed that, all total 75 villages around Pobitora Wildlife Sanctuary affected due to the movement of Rhino. Out of which 17 villages were observed as highly affected, 25 villages moderately affected and 33 villages as less affected (Table- 7.6 and Figure- 7.5).

Sl. No.	Intensity of affect	Number of Villages
1.	Highly affected	17
2.	Moderately affected	25
3.	Less affected	33
Total affected Villages		75

Table-7.6: Conflict intensity in different affected villages around the sanctuary

During the year 2000 to 2010, all total 5 human were died due to Rhino attack and 9 Rhinos were poached.

Year	Human killed by Rhino	Rhino Poaching
2000	0	2
2001	0	0
2002	0	1
2003	0	2
2004	2	1
2005	1	2
2006	2	1
2007	0	0
2008	0	0
2009	0	0
2010	0	0
Total:	5	9

Table-7.7: Human died in Rhino attack and poaching of Rhinos

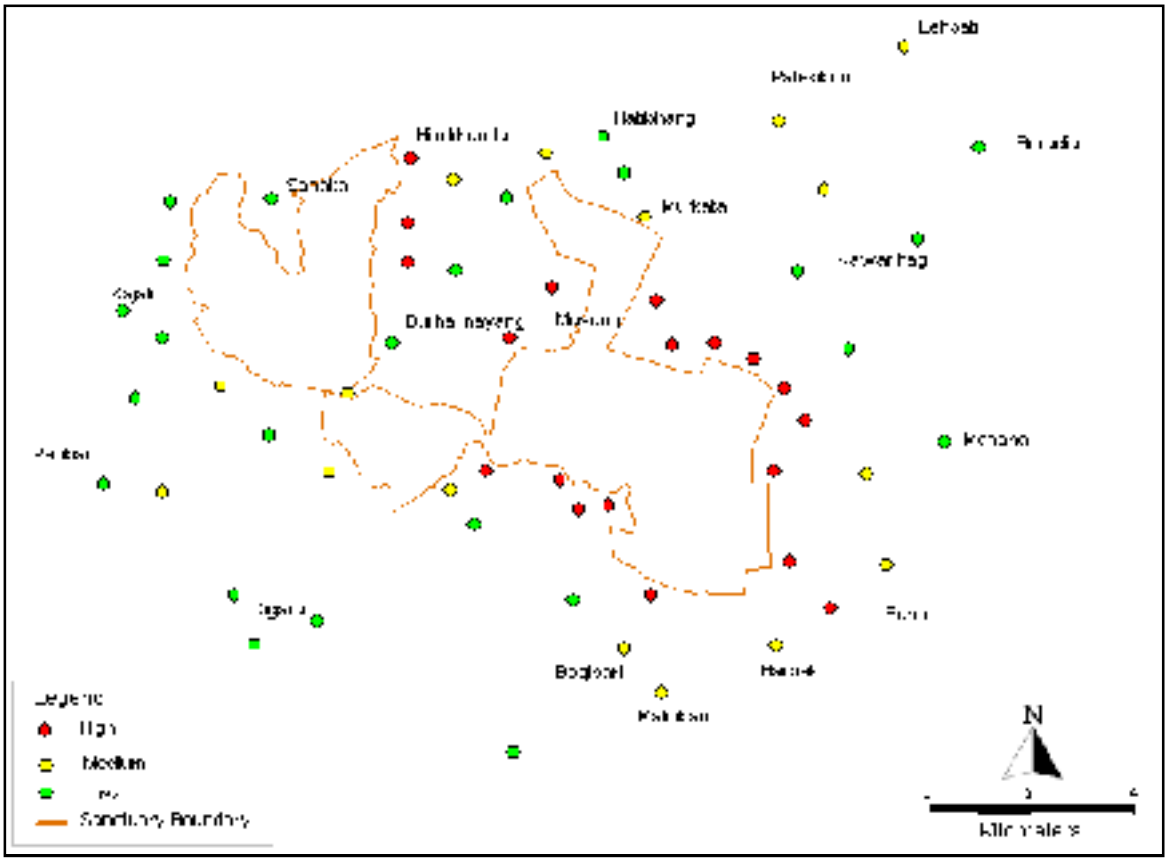


Figure-7.6: Distribution of Rhino affected villages around Pobitora Wildlife Sanctuary

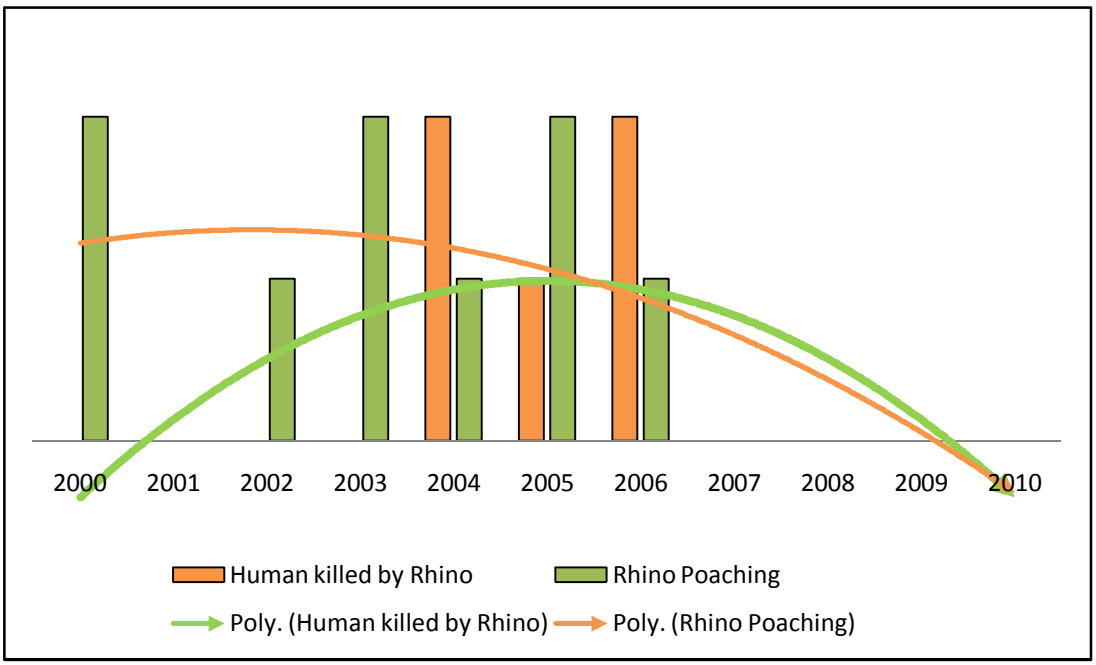


Figure-7.7: Rhino poaching & human deaths trend around Pobitora Wildlife Sanctuary

Table 7.8: VILLAGES ALONG THE BOUNDARY OF POBITORA WILDLIFE SANCTUARY

Sl. No.	Name of the Village	Location			No of House hold	Dominant Community	RHC			
		Lat	Long	Alt			CD	HD	RD	PH
1	Sanaka	26.25876	92.02117	44	105	Assmese, Bihari	L	N	N	N
2	Mikir Pam	26.25739	91.99335	53	45	ST, (Mikir)	L	N	N	N
3	hatibagra	26.24766	92.00182	51	75	Assamese	L	N	N	N
4	Khgatobasti	26.24000	92.00856	50	53	St	L	N	N	N
5	Dhekiabari	26.23725	92.02033	51	80	Asssamese	M	N	N	Y
6	Gobhali	26.23033	92.03840	47	157	SC (Hindu Bengali)	M	N	N	Y
7	Dhepujijan Pam	26.22070	92.03550	46	55	SC (Hindu Bengali)	L	N	N	N
8	kardia	26.22102	92.04782	53	45	SC (Hindu Bengali)	M	N	N	N
9	Santipur	26.21827	92.06704	51	38	Assamese, SC,	M	N	N	Y
10	Kamarpur	26.21830	92.08149	48	142	Assamese	H	N	N	N
11	Hatigarh Nepali gaon	26.21733	92.09623	47	65	Nepali	H	N	N	Y
12	Gorubandha	26.20951	92.09550	50	41	Assamese, SC, Nepali	H	N	N	Y
13	Thengbhanga	26.20290	92.11132	48	102	SC (hindu Bengali)	H	N	N	Y
14	Diprang	26.20030	92.12701	53	87	SC (hindu Bengali)	H	N	N	Y
15	Bohadalani	26.21012	92.13108	47	150	Assamese	H	N	Y	N
16	Nekera	26.21920	92.13000	48	100	Bangla Muslim	H	N	N	Y
17	Nekerahabi	26.22802	92.13054	47	35	Bangla Muslim	H	N	N	N
18	Kukari	26.23097	92.12187	46	36	Bengla Muslim	H	N	N	Y
19	Buraburi	26.24127	92.14216	47	224	Muslim	M	N	N	N
20	Kholabhuyan No1	26.23835	92.12683	51	215	Bengla Muslim	H	N	N	Y
21	Kholabhuyan No2	26.24638	92.12549	50	238	Bengla Muslim	H	N	N	N

22	Hatigar Kusuany	26.24415	92.11095	50	42	Assamese	H	N	N	Y
23	Murisutipam(kusuani)	26.24632	92.12021	48	100	Bengla Muslim	H	N	N	Y
24	Sildubi	26.25086	92.10731	48	44	Assamese	H	N	N	Y
25	Bordia	26.25346	92.09644	47	75	Assamese	H	N	N	Y
26	Murkata No.2	26.25481	92.08846	48	113	SC (Hindu Bengali)	M	N	Y	Y
27	Rajamayang	26.25018	92.07909	50	309	Asssamese	H	N	N	Y
28	Murkata No.1	26.26791	92.08989	48	62	SC (Hindu Bengali)	H	N	N	Y
29	Teteliguri	26.27619	92.09111	48	60	SC (Hindu Bengali)	L	N	N	N
30	Kathaguri	26.28199	92.08522	48	120	Muslim	L	N	N	N
31	Kasosila	26.27618	92.07512	49	157	SC(Hindu Bengali) Muslim	M	N	N	N
32	Hatimuria	26.26528	92.07141	48	81	Assamese, SC	M	N	N	Y
33	Loonmati	26.25814	92.05793	47	69	Assamese	M	N	N	Y
34	Ouguri	26.24912	92.05174	49	91	Assamese	L	N	N	N
35	Hiloikhunda	26.26946	92.04894	51	70	Assamese	L	N	N	Y
36	Jhargaon	26.25657	92.04680	50	115	SC(Hindu Bengali) Muslim	L	N	N	N
37	Satibheti	26.24874	92.05744	52	101	Assamese	M	N	N	Y
38	Burhamayang	26.24422	92.04671	49	98	ST, SC	M	N	N	N

CD- Crope Damage; H-High; M-Medium; L-Low
HD- Human Death; Y-Occur; N-Not occur
RD-Rhino Death; Y-Occur; N-Not occur
PH- Personal Harassment Y-Observed; N-Not Observed

Table- 7.9: Other affected villages that Rhino use to stray Pobitora Wildlife Sanctuary

Sl. No.	Name of the Village	Location			No of House hold	Dominant Community	RHC			
		Lat	Long	Alt			CD	HD	RD	PH
1	Kajalichaki	26.24845	91.98108	52	NA	Assamese	L	N	N	N
2	Gobardhan	26.23222	91.99221	50	NA	SC(Hindu Bengali) Muslim	L	N	N	N
3	Nizpanbarigaon	26.20210	91.96050	51	NA	ST	L	N	N	N
4	Barbilla (Tilabasti)	26.22113	91.96798	49	NA	Nepali	M	N	N	Y
5	Ghagua	26.19726	91.93829	59	NA	Assamese	L	N	N	N
6	Digaru village	26.18226	91.98178	51	NA	Assamese	L	N	N	N
7	Gomoria village	26.16161	92.01146	45	NA	Assamese	L	N	N	N
8	Aahat tali	26.19768	92.03011	47	NA	Assamese	L	N	N	N
9	Dhankhunda	26.20884	92.07218	45	NA	Assamese	L	N	N	N
10	Hahara village	26.16613	92.03118	47	NA	ST	L	N	N	N
11	Mitoni village	26.17325	92.05375	55	NA	Assamese	M	N	N	Y
12	Bogibari	26.19597	92.05469	44	NA	Assamese	M	N	N	Y
13	Maloibari	26.16373	92.08260	46	NA	Assamese	M	N	N	Y
14	Garumara Dalani	26.21130	92.14417	44	NA	SC(Hindu Bengali) Muslim	M	N	N	N
15	Borpak	26.19452	92.13644	58	NA	SC(Hindu Bengali) Muslim	L	N	N	N
16	Boha Pahar	26.19927	92.15464	58	NA	Assamese	L	N	N	Y
17	Borjari	26.20876	92.16159	49	NA	Assamese	L	N	N	N
18	Belguri	26.20810	92.18898	47	NA	Assamese	L	N	N	N
19	Hati utha	26.21968	92.17830	47	NA	ST	L	N	N	N
20	Manaha	26.22643	92.20320	51	NA	Assamese	L	N	N	N

21	Jhargaon	26.23474	92.16044	49	NA	SC(Hindu Bengali) Muslim	L	Y		N
22	Kuranibori	26.23817	92.13572	46	110	SC (hindu Bengali)	M	N	N	N
23	Patekibori	26.25901	92.12606	46	NA	Bengla Muslim	M	N	N	Y
24	Kaurihagi	26.25835	92.14418	48	49	ST (Boro), SC	M	Y	N	Y
25	Pabhokati	26.29794	92.11305	47	NA	Muslim	M	N	N	Y
26	Burgaon	26.28343	92.14795	41	NA	SC(Hindu Bengali) Muslim	M	N	N	Y
27	Sidhaguri	26.27548	92.13176	46	NA	SC(Hindu Bengali) Muslim	M	N	N	Y
28	Hatibhangi	26.28318	92.10449	45	NA	SC(Hindu Bengali) Muslim	M	Y	N	Y
29	Bhalukajari	26.28636	92.12211	43	NA	Bengla Muslim	M	N	N	Y
30	Khatagiri	26.18213	92.08560	44	NA	Bengla Muslim	M	N	N	Y
31	Garubandha	26.29090	92.09676	47	NA	Bengla Muslim	L	N	N	N
32	Lehpati	26.21393	92.09437	46	NA	Bengla Muslim	L	N	N	N
33	Garmari	26.25996	92.22752	46	NA	Bengla Muslim	L	N	N	Y
34	Lecheribari	26.28484	92.16878	52	NA	Bengla Muslim	L	N	N	Y
35	Beradia	26.27263	92.16025	43	386	Bengla Muslim	L	N	N	Y
36	Dandua	NA	NA	NA	NA	Assamese	L	Y	N	Y
37	Chenimari Laharighatr	NA	NA	NA	NA	Assamese	L	N	N	Y

CD- Crope Damage; H-High; M-Medium; L-Low
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7.3.2 MANAGEMENT PRACTISES

The introduction of Forest Management in Pobitora was started practically in the year 1981 to enhance the habitat attributes through scientific grassland management, Rhino protection and population registers. The management structure of Pobitora Wildlife sanctuary was running under the Guwahati Wildlife division as a Wildlife range. One Range officer was in charge of all the ground management under active guidance of Divisional forest officer based at Guwahati, which was earlier under Nagaon Wildlife Division. The observation on Management practices in the sanctuary was described as following modules-

7.3.2.1 RESEARCH AND MONITORING

a. Day to day monitoring

Frontline staff of the sanctuary visited parts of the sanctuary and recorded information relating to habitat, population and security in a day to day basis and maintained in a register in their base camp. The said information was also conveying to the range head quarter through a wireless communication device.

b. Scientific studies

Different scientific studies were conducted in the sanctuary in collaboration with NGO's, Scientific and Educational Institute as per the need of management and proposal from those organisations (see Section-3).

7.3.2.2 PROTECTION

a. Anti poaching Patrol and Anti Poaching Camps

During the study it was observed that, the entire sanctuary was patrolled by armed guards irrespective of day and night. All total 23 numbers of Anti-Poaching Camps (APC) with fooding and lodgeing facilities were observed in different strategic location to cover the entire sanctuary round the clock. 3 to 5 numbers armed guards along with arms, ammunition and other infrastructure as per the need were observed to depute in each camp (Table-7.8). The deputed staff were observed to patrol their jurisdiction round the clock on foot, on elephant back, on boat or using vehicles. During patrolling, information on the habitat, population and any sign of illegal activities (entry of poachers) were recorded. All the anti poaching camps were linked with wireless communication system and a central operator based at range head quarter had recorded all the information from different anti Poaching camps in a day to day basis. A central team of armed guard under guidance of range forest officer had visited entire sanctuary strategically to coordinate between the camps, to evaluate patrol effort of different camps and to organize anti poaching operations.

Sl. No.	Infrastructure and Man Power	Numbers
1	Anti Poaching Camps	23
2	Permanent staff	68
3	Staff under fix Pay	9
4	Casual Staff	16
5	Armed Home Guard	18
6	vehicle (LMV)	4
7	Motor cycle	4

8	Fire Arms	37
9	Ammunition	Annual requirement 300-500 nos
10	Number of elephant	9
11	Wireless main station	4
12	Wireless hand sets	20
13	Number of country boat	20
14	Number of mechanized boat	2

Table-7.10 Protection strength (Manpower and infrastructure)

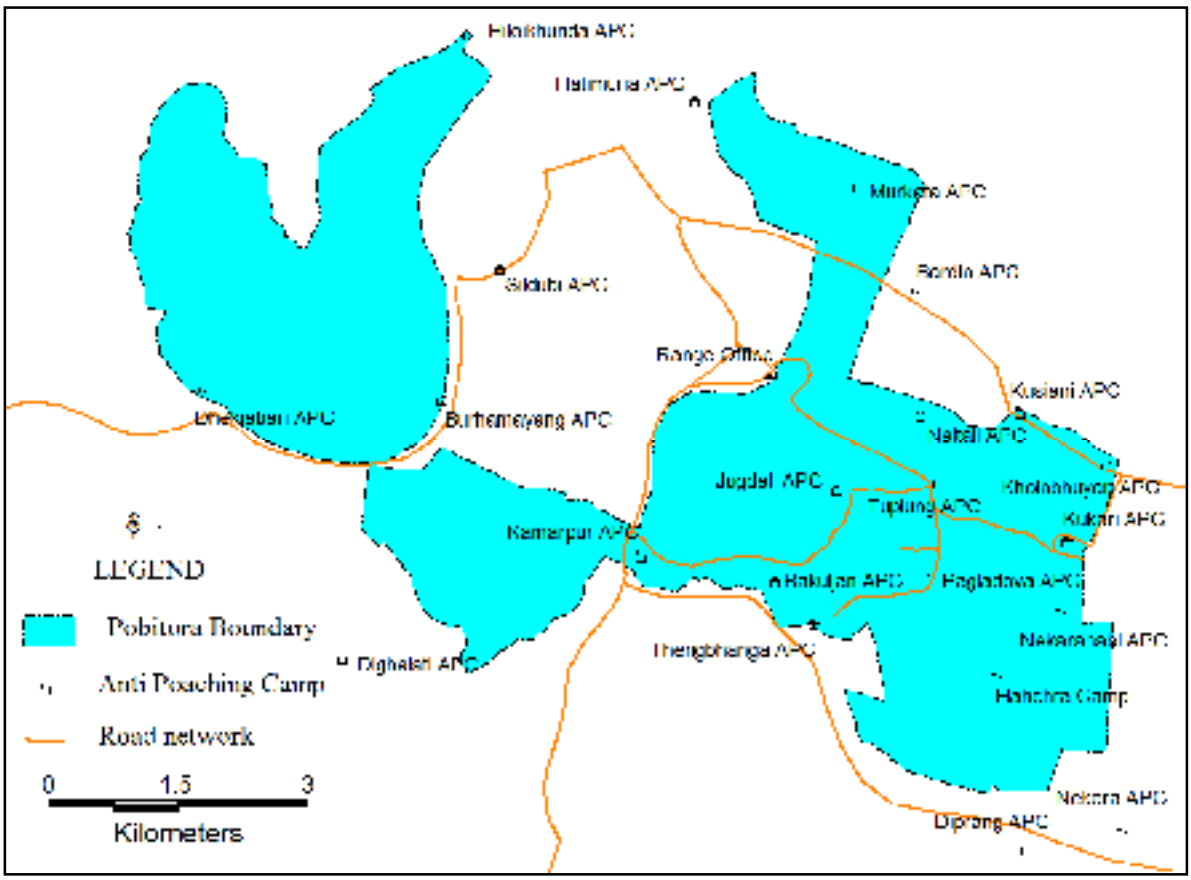

Figure-7.8 Showing anti Poaching Locations and patrol paths

b. Intelligence networking

It was understood that an information network around thepark (i.e. 10 kilometer buffer from the boundary intensively) was developed by the sanctuary authority under leadership of divisional forest officer. Information on entry of

suspected person in to the zone, arrangement of rhino poaching, entry of illegal fire arms to the zone, entry of Rhino horn dealers etc. were communicated to representative of sanctuary management by some highly motivated villagers (called as informer) identified in strategic locations. Informers were rewarded for authentic information. There were incidences of self motivated volunteers/ wildlife lovers who also provided information on illegal activities to the management. On the basis of the information sanctuary authority had planned and executed anti poaching operations.

c. Anti-poaching Operations

Anti-poaching operations were observed of two types- i) Sudden/ quick operation- this type of operations had observed when poacher group already entered in the sanctuary and ii) Planned operation- this type operations were mostly on the basis of intelligence report, more organized and were mostly outside the sanctuary boundary. In this type of operations help from other divisions of Forest department and line departments (i.e. civil administration, police) were taken.

d. Monitoring/ management of stray animals

Effort for protection of strayed individuals to the neighbouring areas by the front line staff of the sanctuary was observed relentlessly during the study. All total 161 times the front line staff had to guard strayed animals for 1-6 days outside the sanctuary and drove back to the sanctuary using elephant.

7.3.2.3 HABITAT MANAGEMENT

a. Annual burning of grassland

It was observed that to arrest the natural process of succession sanctuary authority were exercised block wise burning of grassland during February March of the year. During the study it was hardly observed to follow any protocol for burning of grassland. Even in most of the cases it was observed that villagers illegally entered in to the sanctuary connect fire to the grassland in a very improper way.

b. Driving of cattle

To reduce the pressure of cattle grazing in the sanctuary, cattle were drove out by front line staff. Sometimes elephants were also use to drive the cattle, but this was not found effective because soon after the driving, the cattle were again entered in to the sanctuary.

c. Electric fencing

Electric fence was erected from Amaramul to Kukari (North and East boundary) to restrict the entry of cattle inside the sanctuary and also to stop the outwards movement of rhino towards human habitation and agricultural areas. Due to poor maintenance, part fencing, periodical use and inadecuate cooperation from fringe villager; the said fencing was found to be ineffective to fulfill the objectives.

d. Construction of High land and de-siltation of wetlands

Periodic exercises of de-siltation of silted water bodies were found during the study period. The silt removed were dump for construction of high land and road cum high land which was found to be useful for shelter of animals during high flood. Initially the exercise was done manually and in recent years (2008-2010) the exercise was done mechanically using excavator and dumper.

e. Eradication of Weed Species

Steps for eradication of weed species flourished in the grassland of the sanctuary mainly *Ipomea aquatica* had been taken by the sanctuary authority and was found satisfactory reduction of destruction rates to the grass land. During dry season the weed species were manually/ mechanically removed with root from all dominant patches of grassland and let it dry under sunlight. After drying it was burned properly to restrict the re-growth in next season.

7.3.2.4 POPULATION MANAGEMENT

The population of rhinos in Pobitora Wildlife Sanctuary was seen beyond ideal density levels resulting in animals straying out of the sanctuary creating a negative rhino-human interaction and had felt an urgent need for adoption of strategic conservation plans to maintain suitable Rhino Human Interaction as everyday animals moved out of the park into agricultural areas. In June 2005 Government of Assam through a notification had constituted a task force for Rhino translocation in Assam with chairmanship of Chief Wildlife Warden, Assam with representatives from scientific/ conservation organizations and civil

society. This Task Force has articulated the *'Indian Rhino Vision 2020'*, which envisages increase in the total Rhino population in Assam from about 2,000 to 3,000 distributed over at least 7 Protected Areas to ensure, long term viability of Assam meta-population of Rhinos. Under the programme, during 2009-2011, all total 6 numbers of Rhinos had been translocated from Pobitora Wildlife sanctuary to Manas National Park.

7.3.2.5 AWARENESS DRIVE FOR CONSERVATION

Sanctuary authority was organized a series of awareness programme in collaboration with different Governmental and Nongovernmental organization to aware the local villagers about the importance of conservation of the species and to gain support towards conservation of the species lots of bridge building activities were also organized.

7.3.2.5 CATTLE VACCINATION IN FRINGE VILLAGES

Sanctuary authority was organized a series of cattle vaccination drive in collaboration with different Governmental and Nongovernmental organization to immunize cattle grazed inside the sanctuary for prevention of outbreak of epidemic disease among wild population.

7.3.3 THREAT REDUCTION INDEX

The evaluation of different management practices to manage emerging threats to the species was calculated and overall threat reduction (TRA Index) during the period was found 19.5% (Table-7.9)

Threats	Criteria Ranking			Total Ranking	% of threats reduced	Raw Score
	Area	intensity	urgency			
1. Extensive cattle grazing	8	8	8	24	0	0
2. Over extraction of resources by villagers	6	5	7	18	2	0.36
3. Weed invasion to grassland	4	4	3	11	20	2.2
4. Invasion of woodland to grass land	3	3	4	10	30	3
5. Siltation of wetland	4	3	5	12	20	2.4
6. Poaching for Horn and other body parts	7	7	7	21	60	12.6
7. Accidental Killing of Rhinos	4	4	4	12	10	1.2
8. Conflict with people	6	7	5	18	5	0.9
9. Epidemic outbreak of disease among Rhinos	2	2	2	6	0	0
10. Inadequate conservation awareness among stakeholders	5	5	5	15	40	6
Total	49	48	50	147	187	28.66
TRA INDEX= (Raw score/ Total Rankling)100%	19.50%					

Table-7.11: Calculation of Threat Reduction Index for conservation of Rhinos in Pobitora

7.4 DISCUSSION

The overall observation from the study could be summarized that the habitat for Indian Rhino at Pobitora Wildlife Sanctuary was degraded extensively due to above mentioned threats and pressures (Plate-5 & 6). Rhino population in the sanctuary seemed to be beyond the ideal density. With the increasing number of rhinos in the Sanctuary and their need were found to

compel them move to unprotected areas. Movement of animals to civil areas had developed a negative Rhino human interaction due to crop damage, loss of life, loss of property and personal harassment and increases the poaching pressure. The dependencies of nearby villagers were also compelling them to share the Rhino habitat inside the sanctuary. Therefore the interaction between the Human and Rhino in and around Pobitora Wildlife Sanctuary was very important to be in a positive direction for future conservation and management of Rhino in this region. Moreover, the projected area of 38.81 km^2 of the sanctuary was not under the management controls. Unplanned tourism development was also one of the upcoming causes of disturbance to the animal and may lead increased stray activity.

The overall management practices in the sanctuary were not found to be satisfactory, because it was able to affect less than 20% in reduction of prevailing threats during the study. It was also observed that management control was mainly protection based, less priority ware given to other threats related to habitat, behavior, disease etc.

The present study has concludes with following conservation recommendations for all the stakeholders-

- All the 38.81 sq km. proposed area needs to bring under management control with proper demarcation.
- Necessary steps need to be initiated to add BARBEEL area near newly created AAMSENG wildlife Sanctuary (Govt. Khas-land) with proper

connecting link(Corridor) & protection mechanism to Pobitora Wildlife sanctuary.

- Cattle grazing need to stop inside the sanctuary to save the grassland by construction of fence around the sanctuary or by motivation of local villagers through implementing community development projects.
- Necessary steps need to be taken to reduce the number of feral buffalo grazing inside the sanctuary.
- A proper protocol need to be developed and implemented for the regular management of grassland and wetland.
- Need to implement organized monitoring system for stray rhino and compensation package for affected villagers.
- Need to reduce the number of Rhino from the sanctuary by translocation to other suitable habitat
- Need to implement proper strategy for tourism to reduce the disturbance of wild animal inside sanctuary with a tourism free zone.

Rhino and domestic cattle graze together

cattle grazing intensity in the sanctuary

Villagers cutting trees in the sanctuary

Villagers collecting Thetch from the sanctuary

Large scale death of domestioc cattle in the sanctuary during 2007-2008

A rhino poashed and take out his horn

a villager killed by rhino during stray

Plate-6: Photgraphic evedences of some threts and pressure in the sanctuary

Invesion of Weed (*Ipomea sp.*) in to grassland

Creations of high land for shalter during flood

Destruction of electric fence by villagers

Missuse of Electric fence by villagers

An anti poaching camp in the sanctuary

Night petrolling using elephant

A poacher nabbed with arms and ammunition

a view of translocation operation in 2009

Plate-7: some pressures and conservation measures adopted in the sanctuary

SUMMARY

The Assam state has celebrated hundred years of successful conservation of Great Indian One Horned Rhinoceros from a very small population in the beginning of 20th century. Presently, Assam is the home for more than 75% of total global population distributed in three main ecological pockets namely Kaziranga National Park, Orang National Park, Pobitora Wildlife Sanctuary and Manas National Park. Manas population has recently been translocated from Pobitora Wildlife sanctuary and Kaziranga National Park. However, very less study has been carried out in the state mainly on ecology, behaviour and conservation of the species in different habitat conditions. Therefore, the present study on "Ecology and conservation of Great Indian One horned rhino *(Rhinoceros unicornis)* at Pobitora Wildlife Sanctuary Assam India" has been proposed and carried out at Pobitora Wildlife Sanctuary, a small area encircled by human habitation with a population of more than 80 numbers of rhinos in 38.81 km^2.

The Indian Rhino (*Rhinoceros unicornis*) survives only 2800 individuals in India and Nepal, where, more than 80% global wild population resides within the Indian subcontinent, inside the protected areas of Assam's Kaziranga National Park, Pobitora Wildlife Sanctuary, Orang National Park and Manas National Park. Formerly, Indian Rhino was widely distributed throughout the Indo-Gangetic and Brahmaputra floodplain and was a survivor, the product of at least 35 million years of evolution, but this species had under gone least

morphological changes through the process of evolutionary changes. Pabitora Wildlife Sanctuary holds 84 rhinos and seems to be going beyond the ideal density as every day animals move out of the park into adjacent agricultural areas. The habitat of the sanctuary had been severely degraded as a result of extensive cattle grazing and anthropogenic disturbances from nearby villages leads to human rhino conflict. The protection of Rhino from poachers outside the sanctuary is a challenging task for the wildlife authority. The present study was carried out to know, Rhino demography, habitat suitability, habitat utilizarion pattern and to quantify the extent of various conservation threats.

Rhinoceros unicornis Linn., (1758) was described scientifically in detailed by Person during 1743 in London. Prior to that, the facts and figures about Indian Rhino was mainly based on Religious Literatures. The status and distribution of Indian Rhino in India, Pakistan and Nepal has been studied by various authors. Intensive studies on Ecology and Behaviour of this species have been carried out in India and Nepal by Laurie, Dinerstein, Price, Wemmer, McCracken, Blanford, Ghose, Bhattacharya, Jnawali and Hazarika. Behavioural aspects of Indian Rhinos were studied by Ulrich, Lahan, Brattacharya, Goswami, Brahmchari, Patar, Deka, Mackler, Buchner, Marry and Lang from 1964-2003. Stracey, Ahmed, Choudhury, Kandel, Mishra, Jnawali, Vigne, Menon, Arora Bordoloi, Foose, Van, Aziz, Sinha and Takulkdar have studied and raised the issues relating to conservation of the species in India and Nepal from 1949 to 2007.Kushwaha et al. has studied land area change and Rhino habitat suitability analysis in Kaziranga National Park during 2000.

Pabitora Wildlife Sanctuary is situated in the flood plains of river Brahmaputra and Kalong between the latitude and longitudes 26º12' to 26º15' N and 90º 5' Eand 15 -350 m msl. The notified area of the Sanctuary is 38.81km².. The vegetation of the sanctuary has classified into four distinct forest type's i.e. Eastern alluvial grassland, Low alluvial savannah woodland, Barringtoia swamp forest and Northern moist mixed deciduous forest. The soil of the area is mostly alluvial deposits of river. The entire sanctuary is a basin like structure having woodland (18.44%), grassland (66.91%), wetland (14.91%) & hillock above 15 to 350 msl. Pabitora holds a diverse fauna & flora having highest ecological density of one-horned Rhinos of the world.

Various methods like Scan animal sampling, Focal count, Direct observation, Photographic technique, Geographic Information System and Remote Sensing Technique etc. were followed to collect data on population and selected behaviour of Indian Rhino in the study area. For the study of habitat parameters, suitability of habitat for Indian rhino and habitat utilization pattern of the species in the habitat were studied using Grid based transect survey technique, Linear Survey Technique and Remote Sensing and GIS Technique. Conservation aspects like emerging threats, conservation and management measures and conservation successes were studied using Rapid Survey, Questioner survey and Informal Discussion Technique.

This chapter developed a basic database of each individual rhinos with photographic evidences to make a best estimates of minimum Rhino population

in the sanctuary and formulated of “RHINO REFERENCE CARD” for each individual animal. This could be useful to estimate population and regular monitoring of the population, that the wildlife authority can take informed management decision. Collection of rhino reference cards were suggested that, there were altogether 74 numbers of rhinos in Pobitora Wildlife Sanctuary comprising 59 numbers of independent rhinos and 15 numbers of dependent calves that attached to their mother. The minimum population demography was concluded during the study with 29%-Adult Female(22), 21%-Adult Male(16), 10%-Sub Adult Female(8), 10%- Sub Adult Male(8), 10%-Male Calf (8), 7%-Female Calf(5) and 13%-Calf where Sex is not sure(10).

Conservation threats to the species like- poaching or epidemic outbreak can be minimized by a systemic monitoring system in the level of each and every individual combining the existing park patrol with monitoring that may be called as patrol based monitoring system.

The land cover of the sanctuary as estimated in the study area from the satellite imagery of 2005 was 38.81 km^2. Majority of the park area (54.8%) was occupied by grassland of which, 10.23% was found to tall grassland and 17.44% was short grassland. A large portion of the sanctuary (26.73%) inside the notified sanctuary boundary was found to be degraded due to extensive human activity/ agricultural practice by the surrounding villagers. The woodland cover of the sanctuary was found to be 32.05% in hills and 8.23% in plain area. Wetland was found to be occupied by 4.92% area of the total sanctuary land cover.

Based on positive and negative habitat parameters, habitat suitability map for Rhino had been generated and found only 8.36% area of the sanctuary was suitable for Indian Rhino. About 12.40% area was found to be moderately suitable, 36.47% area was less suitable and remaining 42.77% area of the sanctuary was found to be unsuitable for the species.

Alltogether 163 species of different plants belongs to 50 numbers of families were recorded to consumed by Indian Rhino in Pobitora Wildlife sanctuary during the study.

The annual home ranges were estimated for Indian Rhino in Pobitora Wildlife Sanctuary during the study were ranges from 9.079 km^2 to 27.42 km^2 and mean home range was 17.15 km^2. The annual home range of old adult male was seemed to be smaller, compared to young adult male. The annual home ranges of adult male, Sub adult male and female with larger calf were observed larger than the annual home range of female with small calf and Sub adult female. There was no significant difference of home range was found in adult male, sub-adult male and the female with bigger calf. This differences may be due to heavy disturbance or/ and scarcity of food in the Sanctuary. More than 60% of the studied individuals were found to be with home range partly outside the conservation area. Altogether 27 major straying tracks of Indian Rhino had been identified and mapped during the study period. Significant variations in the utilization pattern in different seasons were observed during study period. In winter season, almost all the tracks were used by rhinos, whereas, during Pre-Monsoon, Monsoon and Retreating-Monsoon, a

considerable number (9-10) of tracks were inactive. This study revealed that, Indian Rhinos in Pobitora Wildlife Sanctuary utilized a maximum of 28.52% short grassland habitat, followed by 23.05% woodland habitat, 22.61% wetland habitat, 17.72% Tall grassland habitat and 8.10% degraded and others throughout the year.

Numbers of threats and pressures have been observed during study were- extensive cattle grazing (27±1.35- 109±5.45/ km^2), extensive collection of thatch, weed invasion to grass land, invasion of woodland to grass land, encroachment , siltation of wetland, poaching for body parts, accidental death and conflict with people. During the study, infrastructures used and management activities (i. e. Research, Protection, habitat & Population management and awareness drive) for conservation of the species were studied and evaluated the effectiveness of the said practices using threat reduction index (TRA Index) method. The overall TRA Index for the species in the sanctuary was calculated as 12.5%.

The overall observation from the study could be summarized that the habitat for Indian Rhino at Pobitora Wildlife Sanctuary was degraded extensively due to above mentioned threats and pressures. Rhino population in the sanctuary seemed to be beyond the ideal density. Movement of animals to civil areas had developed a negative Rhino human interaction due to crop damage, loss of life, loss of property and personal harassment. The present study has concludes with following conservation recommendations for all the stakeholders-

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- Need to implement proper strategy for tourism to reduce the disturbance of wild animal inside sanctuary with a tourism free zone.

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ANNEXURES

Annexure-1- Rhino sighting field format

Reference N0. ……. Date of Observation: ……..…… Location:

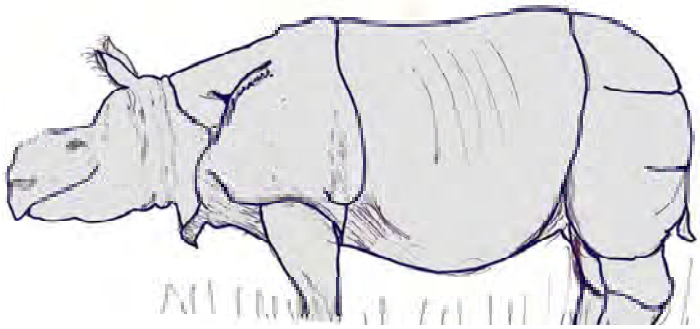
Lat……

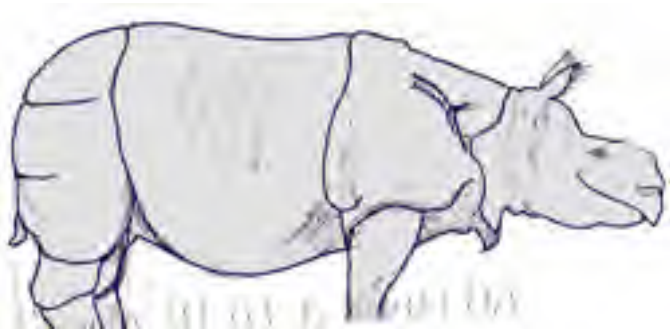
Sex- ……. Age- ……..… Calf Position- …….

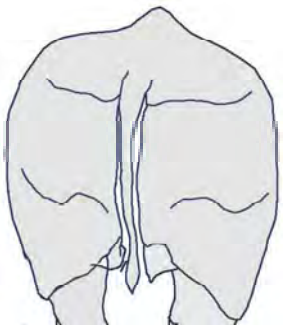
Long……

Remarks-

..……..







Key Identity-

Horn-

Ear-

Skin Folds-

Tail-

Photograph (reference and time)-

Annexure-2: Regular field survey format (Habitat utilization etc.)

Name of the Surveyor: …….. Day of survey: ……/……/…….

Day of Survey	Time	weather	Lat	Long	Alt	Name of the place	Grid No.	Land cover/ Land use	Rhino ID	Clean Rhino Sighted	Activity of Rhino	Sighting of other wildlife	Illegal activity/ sign seen	Photo code	Remarks

Annexure3: Rhino straying tracks survey format.

Name of the Surveyor: …….. Day of survey: ……/……/…….

Location of Rhino mark/ sighting			Time	Land use/ Habitat information	Human activities	Suitability for signs	Width of tract (aprox.)	Major Obstacle	Movement Type	Average No.	Primary evidence	Secondary Evidence	Remarks
Lat.	Long.	Alt.											

Annexure-4: Ground Truthing format

Name of the Surveyor: …….. Day of survey: ……/……/…….

Date	Location			Land cover/ land use	Land cover				Name of the area	Remarks
	Latitude	Longitude	Altitude		NE	SE	SW	NW		

Annexure-5: Rhino feeding Study format

Name of the Surveyor: …….. Day of survey: ……/……/…….

Day of survey	Time	Name of the area	Location			Under which grid	Land use	Species of plant consumed by Rhino	Photograph Code	Herbarium Code	Remarks
			Lat	Long	Alt						

Annexure-6: Disturbance study format

Name of the Surveyor: …….. Day of survey: ……/……/…….

Day of survey	Time	Name of the area	Location			Under which grid	Land Cover/ Land use	Wood cutting	Grass cutting	Weed abundance	Presence of Domestic cattle	Presence of people	Remarks
			Lat	Long	Alt								

Annexure-7: Rhino Human Conflict Around Pabitora WLS (Rapid, presence Absence survey format)

Name of the Surveyor: …….. Day of survey: ……/……/…….

Day of survey	Name of the area	Location			Under which grid	Land use	Conflict present /absent	Conflict pattern						Remarks
		Lat	Long	Alt				Crop damage	Rhino injured	Rhino death	Human injured	Human death	other	