1. INTRODUCTION

1.1 General Background

Eight species of the bears are found in the world (Servheen 1990), of which, one species, Spectacled Bear (*Tremarctos ornatus)* is found only in the Southern hemisphere and all other seven species are found in Northern hemisphere (Cowan 1970). Out of these, three species; Brown Bear (*Ursus arctos*), Asiatic Black Bear (Ursus thibetanus) and Sloth Bear (*Melursus ursinus,* Shaw 1791) are found in Nepal (Shrestha 1997). There are two sub-species of Sloth Bear, sub-species found in Nepal is *Melursus ursinus ursinus* and another sub-species *Melursus ursinus inornatus* is endemic to Sri Lanka (Ratnayeke 2004). Brown Bear and Asiatic Black Bear are found in higher elevation than Sloth Bear which are distributed in the lowland Terai.

The Sloth Bear is endemic to the Indian sub continent: India, Nepal, Bhutan, and Sri Lanka. In Nepal Sloth Bear occur in the lowland Terai and Shiwalik hill ranges (Joshi et al. 1995) and they formally ranged across the full length of Terai, continue with their range in India but recently has been extirpated in some parts of Nepal (Garshelis et al. 1999a). Among the protected areas, the Sloth Bear have been reported in Chitwan National Park, the adjacent Parsa Wild Life Reserve and Bardia National Park, formally it was also reported in Suklaphanta Wild Life Reserve but since 1994 they have been extirpated from the area (Garshelis et al. 1999a). Sloth Bears range has shrunk in recent times and the populations have become fragmented, threatening its overall survival (Bargali et al. 2012).

The Sloth Bear differs from the other species of bear in having specialized morphological adaptations for feeding on insects (Laurie and Seidensticker 1977, Joshi et al. 1995). The first pair of maxillary incisors is absent, bony palate is hollowed and extends further back relative to the last molar tooth (Christiansen 2007). The reduced hair on the muzzle is probably an adaptation to cope with the defensive secretion of some termites. Sloth Bears do not accumulate fats or change their rate of metabolism and hence do not hibernate, but spend their time in day den after nocturnal foraging, which are mostly the crevices between big boulders and the space between terrestrial roots of trees (Akthar et al. 2007).

Understanding food habits and diet composition is important to assess distribution and habitat use of the species (MacHutchon and Wellwood 2003). Food habits and distribution of food resources directly influences the reproductive success, ranging patterns and other behaviour of animals (Yoganand et al. 2005b). Most of the bears are opportunistic omnivores; all species of bears except Polar Bears (*Ursus maritimus*) feed on insects, especially ants (Joshi et al. 1997). However, Sloth Bear is the only ursid having myrmecophagous adaptation to feed on insects, especially termites and ants (Laurie and Seidensticker 1977, Joshi et al. 1997). The Sloth Bears diets vary seasonally and geographically across their range (Laurie and Seidensticker 1977, Gokula et al. 1995, Baskaran et al. 1997, Joshi et al. 1997, Bargali et al. 2004). Sloth Bear is only the species that almost entirely depend on social insect for its protein requirements and thus in respect is unique among bears (Yoganand et al. 2005a). This adaptation enables them to compete with other species of ursids and help them survive in less fruiting seasons as well (Bargali et al. 2012).

Sloth Bear breaks the termite moulds with their front claws, suck in the termites and blow away the debris producing the hovering sound which can be heard 100 meter away (Davidar 1983). Maximum digging activities are recorded during the monsoon season as rain water softens the soil and digging for ants and termites mounds becomes easy for bears (Bargali et al. 2004). Other insects that Sloth Bear feeds include Honey Bee, beetles, crickets (Laurie and Seidensticker 1977, Baskaran et al. 1997, Joshi et al. 1997, Bargali et al. 2004). They occasionally feed on the animal carcasses. The scat analysis reveals presence of hair, bones and animal tissue (Bargali et al. 2004), bird feather (Baskaran et al. 1997, Mewada and Dharaiya 2010) and Sambar Deer hoof (Ramakrishnan et al. 2012) in the scats of Sloth Bear.

The Sloth Bear climb trees to feed on Honey Bee hives and sometimes to feed on fruits. Fruits of *Cassia fistula, Ficus cuni, Ficus glomerata, Grewia schlerophylla, Magnifera indica, Millus velutina, Murraya koenigii, Phonex acaulis, Syziugium jambolana, Zizyphus mauritiana, Bombex ceiba (*flower) are eaten by Sloth bear (Joshi et al. 1997). But *Ehretia laevis, Careya arborea, Solanum indicum, Carica papaya, Rhus semialata, Callicarpa macrophyla, Schleichera trijuga, Dillenia indica, grewia sclerophylla, murraya koeniga* were also recorded by Laurie and Seidensticker (1977) and *Ficus bengalensis, Ficus virens, Ficus religiosa, Ficus racemosa, Briedelia squamosa, Madhuca indica* are reported by Bargali et al. (2004).

Sloth Bear prefers alluvial grassland during dry season because of high density of their principal prey termites and during wet season male move to upland in search of fruits (Laurie and Seidensticker 1977). Sloth Bears play an important role in the dispersal of seeds and influence the regeneration of some plant species (Sreekumar and Balakrishnan 2002). The diet of Sloth Bear follows the pattern of food availability (Joshi et al. 1997). The study on Sloth Bear feeding ecology has shown different results. In Chitwan, insects are the main food component all year round (Laurie and Seidensticker 1977, Joshi et al. 1997) whereas fruit comprises a main portion of the diet during fruiting season (April - May). Similar results were found much of India. Gokula et al. (1995) found 40.5% of termites alone in the scats collected in Mudanthuria plateau, Tamil Nadu. In contrast, Baskaran (1997) indicated that fruits comprise 91% of the Sloth Bears diet during March - August.

Sloth Bear is listed as "vulnerable" and kept under Appendix I of CITIES (Garshelis et al. 2008). Habitat degradation due to increased human population, diminished food resources, trade in body parts and increased conflict with human is posing serious threat to the declining Sloth Bear populations (Bargali et al. 2012). Sloth Bears gall bladders are used as medicine to cure liver, stomach, reproductive and intestinal problems (Santiapillai and Santiapillai 1990). Sloth Bears cubs were earlier poached extensively across all states in India mainly for live cubs for using as dancing bear (Satyanarayan et al. 2012). Sloth Bears rarely enter village compounds, damage property or raid the crops (Joshi et al. 1997), conflicts predominately involve attacks on people in forests when they are engaged in forest activities (Pragash et al. 2012). The only natural threats to Sloth Bear are Tigers (*Panthera tigris*) and possibly Leopards (*Panthera paradus*).

Developing effective conservation measures for the Sloth Bear requires detailed information regarding their status and distribution (Garshelies et al. 1999a). So, this study was carried out to collect the information on feeding ecology of Sloth Bears in Chitwan National Park which can help to develop the effective management plans, and to know if any variations have occurred in Sloth Bears diet composition after previous study in same area.

1.2 Objectives

The main objective of this study is to understand the foraging ecology of the Sloth Bear in the Chitwan National Park (CNP). The specific objectives were to:

- determine the diet composition of Sloth Bears in CNP.
- assess the seasonal variation in the diet composition of Sloth Bear in CNP.
- identify the factors affecting the feeding activity of Sloth Bears in CNP.

1.3 Rationale

Some appreciable works have been done on the feeding ecology of the Sloth Bear in Chitwan National Park (Laurie and Seidensticker 1977, Shrestha 1993, Joshi et al. 1997). But since then, not much attention have been given in the study of feeding pattern of Sloth Bear. Information on the current food habits of Sloth Bear is most essential to know the factors affecting the selection of the diet and also to evaluate the success of wildlife management plan. Diet selection is affected by many factors such as availability of food resources (Bargali et al. 2004) and many anthropogenic factors (Bargali 2012). This study assessed the food habits of Sloth Bears in relation to spatial and temporal variables. Thus, the finding of this study seems to be highly useful and time worthy for concerned authorities to make conservation action for this species and can be a basis for the future species level of the studies.

1.4 Limitations of the Study

The study was based only on the indirect observation (scat analysis) due to the bear's aggressive behaviour and nocturnal habit. Scats were not collected in monsoon season due to dense vegetation, flooding problems and also heavy rainfall washed away the scats, due to which results of the study could not be extrapolated for whole the year. Difficult terraces within the grids could not be walked as well as some areas with high risk of other animal especially wild elephants and tigers were not sampled. Genus level of insects could not be identified due to the lack of required equipments. Only the head parts were the undigested portion of the insects in the scats which were not enough for their proper identification.

2. LITERATURE REVIEW

Many researchers have done research on the various aspects of ecology and behavior of Sloth Bear. In CNP, the first attempt on behavioural ecology of Sloth Bears was done by Laurie and Seidensticker (1977). Similarly, Shakya (1993) assessed activity pattern, habitat utilization, movements and home range of Sloth Bear, Joshi et al. (1995) studied home range range of Sloth Bear and sociobiology of mymercophagus Sloth Bear was studied by and Joshi et al. (1999) in the same area. In India, Desai et al. (1997) studied the behavioural ecology of Sloth Bear in Mudumalai Wildlife Sanctuary and National Park, Yoganand et al. (2005a) evaluated Panna National Park with reference to ecology of Sloth Bear and recently, activity pattern of Sloth Bear in Mudumalai Tiger Reserve, Western Ghats, India was studied by Tharmalingam et al. (2013).

Similarly, studies have also been made on the feeding ecology of Sloth Bears. Food abundance in an area and the consequent nutritional status of bears directly influences their reproductive success (Coman 1970). Food habits and distribution of food resources further influences habitat use (Gondaliya et al. 2012) ranging pattern, home range and behaviour of bears (Yoganand et al. 2005b).Understanding the diet composition and foods assess in distribution and habitat use of bears (Machautchon and Wellwood 2003). Most of the bears are opportunistic omnivores (Baskaran et al. 1997, Joshi et al. 1997, Bargali et al. 2004), Sloth Bear is only the Ursid having myrmecophagous adaptation (Laurie and seidensticker 1977, Joshi et al. 1997). This adaptation enables them to compete with other Ursids and help them survive in less fruiting season as well (Bargali et al. 2004). Despite their adaptation for myrmecophagy, result of past studies indicate that diets of Sloth Bear may vary seasonally and geographically across their range from Nepal, South through India to Sri Lanka, depending on the availability of fruits and hardness of mounds that harbor colonies of termites (Laurie and Seidensticker 1977, Gokula et al. 1995, Baskaran et al. 1997, Joshi et al. 1997). Plant abundance, dispersion, fruit length, fruit bite size, fruit presentation and ripe fruit tastes are the plant traits and colony size and colony biomass are the insects traits selected by bears (Yoganand et al. 2005b).

Information on composition and seasonal variation in bear diet can be collected either through direct observations or indirectly through scat analysis (Desai et al. 1997).

Previous studies of food habits of Sloth Bears, based mainly on scat analysis, showed great variation across the geographic range of this species, from Nepal, South through India and Sri Lanka. Laurie and Seidensticker (1997) reported that in Chitwan National Park, Nepal, insects (mostly termites and ants) and fruits (from 17 species) were nearly equally represented in the Sloth Bear diet, insects (52%) and fruits (47%). Termites were considered the most important food item because they occurred throughout the year, whereas fruit consumption was concentrated during April-July. But Joshi et al. (1997) in the same study reported that their diet was dominated by insects especially termites for much of the year. Insects were found in ≥98% of the scats collected during non fruiting (Sept-April) season and 80% of those collected in fruiting season (May- August). Conversely fruit's seeds (from 12 species) were found in 69% of scats collected during the fruiting season but only 9% during non-fruiting season. This dietary shift in Chitwan National Park was considered to be related with changes in habitat condition associated with the relocation of the people out of the park. Similarly, Shrestha's study in Chitwan in 1993 also showed considerable variation in the diet, insect matters constituting 74.5% of the total diet and remaining 24.5% was plant matter.

Studies in India have shown the similar results, Gokula et al. (1995) from Mundanthuria Plateau, Tamil Nadu reported the collected scats comprise 74.55% of animal matter (ants, termites and beetle) and 25.55% of plant matter (from 4 species). The higher proportion of animal matter in the diet was considered due to non-availability of fleshy fruits during the study period (December - March). In Central India, Bargali et al. (2004) revealed that insects were most frequently encountered food items in scat during winter (81.8%) and monsoon (87%) whereas plant matter were more frequent (90.6%) during monsoon season. They related the presence of the ground nuts and maize in diet during monsoon to crop damage by bears. A study in dry deciduous forests of Darrah Wildlife Sanctuary by Sultana et al. (2012) showed 100% scats constituted insect matter, 55% scats plant matter and 11% of the scats constituted insect matter (hair). The most revealing thing was the presence of human garbage (paper and polythene) in the scats. He related their presence to the anthropogenic pressure altering feeding of Sloth Bears. Sukhadiya et al. (2012) in Jassore Wildlife Sanctuary revealed high consumption of termites and ants (79.3%) during monsoon and winter while on fruits (from five species) in summer.

In contrast, some studies have shown the fruits as the more important diets than the insects and animal matter. Baskaran et al. (1997) in Mudummalai Wildlife Sanctuary,

Tamil Nadu, Southern India, found that fruits remains of various plants (from 20 species) dominated the overall diet of Sloth Bear forming the 87.9% of the dry weight but animal matter (insects and bird feather) formed only a small portion of total diet. Here, ants were found more important than termites. Similarly in Panna National Park Yoganand et al. (2005a) reported 56% fruits, 29% ants and 10% termites contributed to annual diet in terms of ingested biomass. Single *Ficus* species contributed more than animal matter in summer and monsoon and *Cassia fistula* in winter as reported by Mewada and Dharaiya (2010) in Vijaynagar, North Gujarat, India. Scats examined by Sajeer (2012) collected from the Parambikulam Tiger Reserve also contained more fruits (from 7 plant species) and only small proportion of insects, termites and ants. Darshan et al. (2012) in Jassore Wildlife Sanctuary revealed, Sloth Bears in the area chiefly consume fruits mainly from five plant species followed by termites, ants and bees. Singh et al. (2012) showed 24 food items are consumed by bears in Karnataka, India, 17 were plant species and eight belong to animal species. Rama Krishnan and Deepalakshmi (2012), in the upper Nilgiri plateau, Western Ghats, Tamil Nadu, India found bears were feeding mostly on *Lantana camara* as their major diet during Nov-March. Although much work has not been done in the composition of Sloth Bear diet in Sri Lanka, termites and various fruits have been noted as principal diet (Ratnayake 2004).

Laurie and Seidensticker (1977), Joshi et al. (1997), Sukhadiya et al. (2012), indicated *Zizyphus* species as the important winter fruit where as the *Ficus* species were found to be more dominating by Bargali et al. (2004), Yoganand et al. (2005a), Gokula et al. (1994) and Mewada and Dharaiya (2010) as they provide constant supply of food throughout the year. *Lantana camera* fruits were considered important only by Ramakrishnan and Deepalakshmi (2012). Unlike others, Baskaran et al. (1997) considered ants more important insects than the termites. Hairs, bones were reported by Bargali et al. (2004), Mewada and Dharaiya (2010), Sultana et al. (2012), Ramakrishnan and Deepalakshmi (2012) but bird feathers were only present in the scats studied by Baskaran et al. (1997) and Mewada and Dharaiya (2010).

The movements of Sloth Bears into the hills in summer is associated with the fruiting of *Ficus* species (Laurie and Seidensticker 1977), however, Joshi et al. (1997) related the seasonal movement between lowland and upland in Chitwan with termite availability. Hard soils during summer deter bears from digging for termites and ants. With the onset of monsoon, rain water softens the soils and bear extensively dig for the termites and ants

(Joshi et al. 1997, Bargali et al. 2004, Mewada and Dharaiya 2010). Relative importance of plants found in the the bear scats during summer is due to seasonal flowering of some plants (Joshi et al. 1997, Bargali et al. 2004) which in turn increases the importance of Honey Bees (Ramakrishnan and Deepalakshmi 2012). There is no relationship between relative productivity of various fruit species and their contribution to annual diet (Yoganand et al. 2005a).

These data suggest that the amount of fruits in the Sloth Bear vary seasonally and geographically with availability, like other bears but unlike other mymercophagous mammals, Sloth Bears can readily adopt its diet to changing food conditions.

3. MATERIALS AND METHODS

3.1Study Area

3.1.1 Location and Physical Features

This study was carried out in Chitwan National Park (CNP) (Fig. 1), situated in the South central Nepal between 27^0 34' to $27^0$68' North latitude and $83^0$87' to $83^0$74' East longitude (DNPWC 2001). As the first National Park of Nepal, CNP was established in 1973, for its unique diversity of flora and fauna and outstanding natural features. In recognition of its unique biological resources, UNESCO designated CNP as a World Heritage Site in November 1984. Initially the area was 544 km^2 which was extended to 932 km^2 in 1997. However, the GPS survey of the park boundary and GIS digitization based on 1992 topographic maps show a total park area of 1182 km^2. In 1996, an area of 750 km^2 surrounding the park was declared a Buffer zone (BZ), consisting of forests and private lands and extending from 27^0 28' to $27^0$70' North latitude and $80^0$83' to $84^0$77' East longitude. The park boundaries extend from Dauney Hill on the West bank of Narayani River to Hasta and Dohoram khola in the East, bordering the Parsa Wildlife Reserve. The park is bordered to Rapti river to the the North and Narayani rivers and it shares the boundary with the Balmiki Tiger Reserve in India in the South.

The park has two Siwalik (hill) ranges, namely Churia and the Someswore ranging from 150 m to over 800 m. GIS maps indicate that 44% of the park area falls below 250 m elevation and only 12% area fall above 500m (DNPWC 2001). The Churia shows a distinctive fault pattern that has produced steep cliffs on the south facing slopes where vegetation is poorer than the northern slopes. Major river system of CNP consists of Rapti, Reu and Narayani and numerous permanent and seasonal streams. The Rapti and Reu flow through the park and ultimately join the Narayani. In between there are several depressions forming lakes and marshes with perennial water sources.

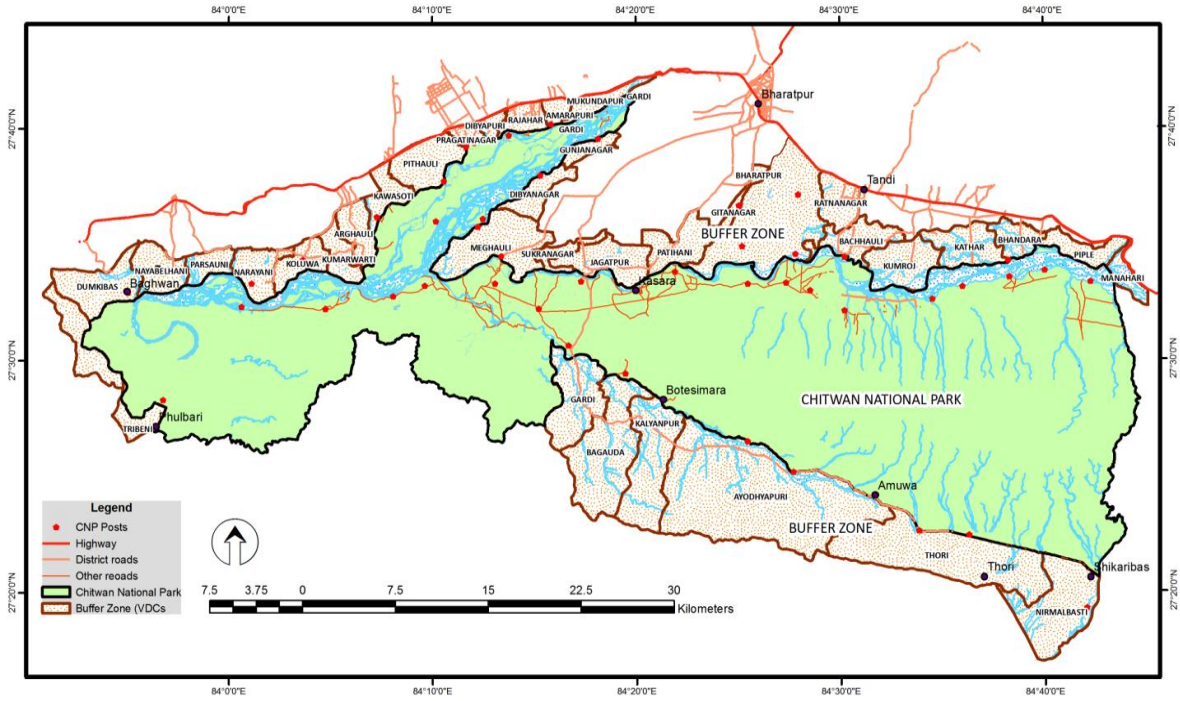


Fig. 1: Map of Chitwan National Park and Buffer Zone.

3.1.2 Climate

In Chitwan, conditions are subtropical with a summer monsoon from mid-June to late-September, and relatively dry winter. The mean annual rainfall of the year between 2001-2010 was 1520 mm with about 90% of the total rainfall occurring from May to September (Figure 2). Monsoon rains cause dramatic floods and changes in the character and courses of rivers.

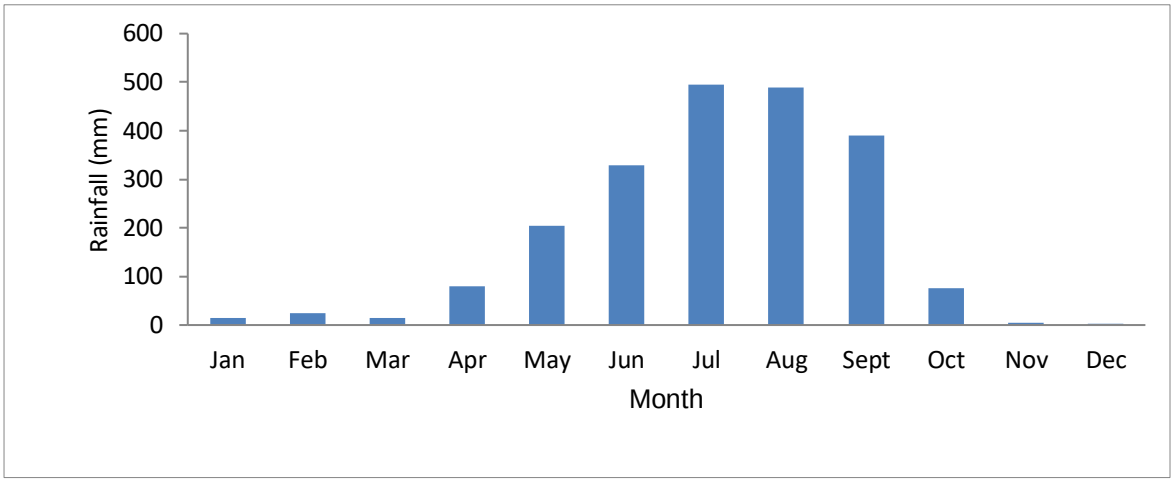


Figure 2: Average monthly Rainfall (mm) (2001 to 2010) recorded at Bharatpur Meteorological Station (Source: Nepal Government, Department of Hydrology and Meteorology).

The annual average minimum temperature of periods between 2001 and 2010 was recorded to be 17.6º C; likewise the maximum temperature was 31.1º C (Figure 3). Winter temperature falls almost to freezing point, when dry northerly winds from the Himalaya and Tibetan Plateau are prevalent, whereas from March to June temperature can reach as high as 43º C.

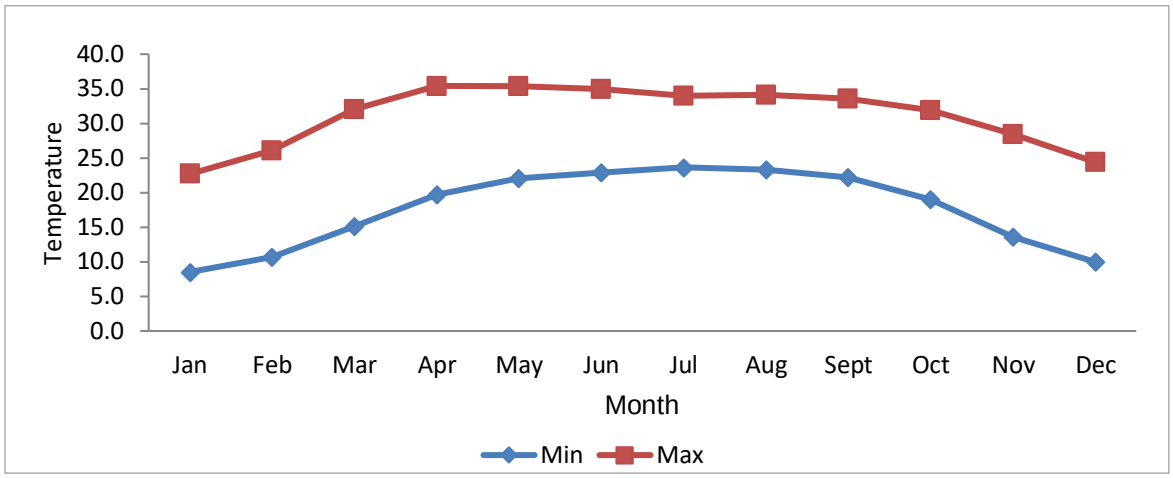


Figure 3: Average monthly Temperature (ºC) (2001 to 2010) recorded at Meteorological Station at Bharatpur, Chitwan. (Source: Nepal Government, Department of Hydrology and Meteorology).

The relative humidity was recorded maximum 96.9% in the month of January and minimum 67.2% in the month of March between 2001- 2010 (Figure 4).

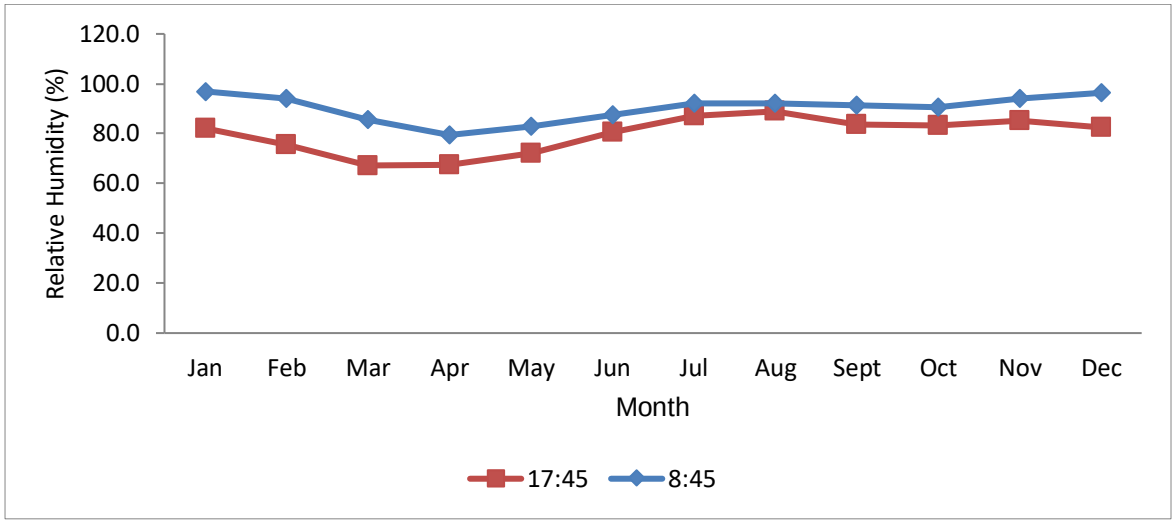


Figure 4: Average monthly Relative Humidity (%) (2001 to 2010) recorded at Meteorological Station at Bharatpur, Chitwan. (Source: Nepal Government, Department of Hydrology and Meteorology).

3.1.3 Biodiversity

The biological richness of the park encompasses eight eco-system types that include seven forest types, six grassland types, five wetlands and three main river system habitats (DNPWC 2001).

3.1.3.1 Flora

CNP consists of tropical and subtropical forest with mostly Sal (*Shorea robusta*). The climax vegetation of the inner Terai is Sal forest. However, floods, fires and riverine erosion combine to make a continually changing mosaic of grasslands and riverine forests in various stages of succession (UNEP 2009). GIS analysis showed that Sal forest, grassland, riverine forest, exposed surface and water body in CNP covered 72.90%, 11.53%, 7.54%, 5.12% and 2.8% respectively (Thapa 2011). The floral diversity of the park consists of more than 600 plant species which includes 3 gymnosperm, 13 pteridophytes, 415 dicotyledones, 137 monocots and 16 species of orchids (DNPWC 2001). Sal is intermingled with the Chir Pine (*Pinus roxburghii*) along the Southern face of the Churia hills. In other areas it is found mixed with the species such as *Terminalia alata, Terminalia belerica, Semicarpus anacardium and Dillenia pentagyna.* Riverine forest is confined to the area close to rivers, lakes and springs. This type of forest is mainly dominated by *Acacia catechu, Delbergio sisso, Trewia nudiflora, Bombax ceiba, Ficus benzamina, Ficus cunia* etc. Grasslands consists more than 68 different types of grasses, including Elephant Grass (*Saccharum* species) which grows to a height of 8 m. Other important grass species are *Saccharum* species, *Imperata* species, *Themada* species etc. The park harbors endangered plant species like *Cyathea spinosa, Cycas pectinata, Padanus furcatus and* several other orchids.

3.1.3.2 Fauna

The park harbors an exceptionally diverse wildlife population, it is the home to more than 68 species of mammals, 546 species of birds, 4 species turtle, 156 species of butterflies, 55 species of reptiles and amphibians and more than 120 species of fish (CNP 2012b).

The park holds second largest population of the one horned rhinoceros in the world and more than 6% of the World bird species (DNPWC 2001). Thirteen species of mammals, six species of birds, and three species of reptiles in the park are considered endangered

and protected under NPWC Act 1973 (ICIMOD 2007). There are 503 one horned rhinoceros, 125 tigers, 312 gaurs, 40-50 wild elephants, 200- 205 Sloth Bears (CNP 2012a). The extensive riverine forest and flood plains form excellent habitats for ungulates. Besides providing habitat to residential fauna, the park also serves habitat for several migratory species. The endangered fauna found in the park includes one horned Rhinoceros (*Rhinoceros unicornis*), Asiatic Elephant (*Elephus maximus*), Gaur Bison (*Bos guarus),* Royal Bengal Tiger (*Panthera tigris*), Four Horned Antelope (*Tetracerus quadricornis*), Pangolin (*Manis pentadactyla*), Bengal Florican (*Houbaropsis bengalensis*), Lesser Florican (*Sypheotides indica*), Giant Hornbill (*Buceros bicornis*), Black Stork (*Ciconia nigra*), and White Stork (*Ciconia ciconia*), Golden Monitor Lizard (*Varanus flavescens*), Asiatic Rock Python (*Phyton molurus*),. Maskey Frog (*Tomopter*na *maskeyi*) is the endemic species of the park.

3.1.3.3 Culture and Ethnic Groups

Tharus, Bote - Majhi and Mushahar are pioneer inhabits of this area. These indigenous groups are dominated by hills migrants following malaria eradication in 1950_s. Migration to Chitwan valley was spurred by government's resettlement programme, fertile agricultural land and the new economic opportunities. Thus, the area has become a meeting point of different caste, ethnic groups having different cultural backgrounds. Brahmin, Chhetri, Bishwokarma, Sarki, Tharu, Mahato, Bote, Majhi, Mushahar, etc. are the common ethnic groups in the area at present. In the buffer zone Brahmin, Chhetri, Thakuri claim 48.3% household and Tharu come in second with 26% (DNPWC 2001). There are two Hindu religious sites, Bikram Baba at Kasara and Balmiki Ashram at Triveni, which are very significant to both local people living around the park and visitors from India.

3.2 Data collection

3.2.1 Sampling Design

The entire study area was divided into grids, each measuring with 4×4 Km^2 (Fig. 5). A total of 70 grids were generated in ARC GIS 9.2 and out of the total grids, only 32 grids (45%) were randomly selected for field survey. The grids with most part lie outside the park was excluded for scat sampling purpose.

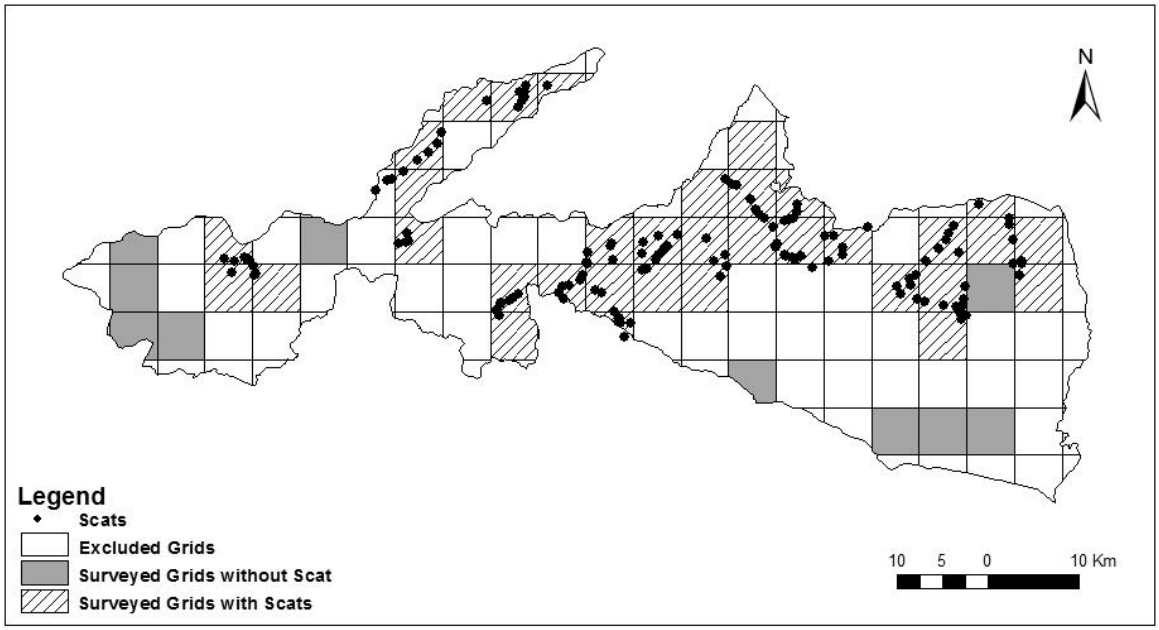


Fig. 5: Map showing surveyed, scat collected and excluded grids in CNP.

3.2.2 Reconnaissance Survey

Prior to field research, a preliminary reconnaissance survey was carried out during March, 2012 to gather preliminary information on distribution of Sloth Bear and to be acquainted with field situation. During reconnaissance survey intensive discussions and interactions were made with Park staffs, local naturalists and experts. Preliminary survey also included collection of Sloth Bear scats by walking through jungle roads and trails, in the

area between Sauraha and Kasara. The secondary information about site and Sloth Bear ecology were collected from literatures.

3.2.3 Diet Analysis

Sloth Bear's diet was determined by identifying undigested food remains in the scats as it is a non invasive technique (Desai et al. 1997). As well, the species forage primarily at night, so it was difficult to collect the data based on direct observation. Similar methods were also used by other researchers for dietary study of Sloth Bears (Laurie and Seidensticker 1977, Shrestha 1993, Joshi et al. 1997, Bargali et al. 2004).

3.2.3.1 Scat Collection

Sloth Bears scat samples were collected walking from the selected grids in the CNP and BZ during April-May 2012 and February 2013 as well along the trail and dirt roads. Elephants were also used to collect the scat when necessary, along the difficult trails and between tall grasses. The samples were identified and confirmed by comparing with colored photographs. Dark black colour, round shape, larger size and easily observed head parts of termites, ants and other insects were the criteria used for scat identification. The Sloth Bear's scat was easily differentiated with those of Pangolin (*Manis crassicaudata*), the only mymercophagus competitor of the species in the park. Scats whenever encountered were dried in the sun if necessary and stored in polythene bags with proper labeling. The location, date, approximate age, associated marking signs and geographic coordinates was recorded for each scat using Global Positioning System receiver (Garmin, Etrex). These scats were then taken to the laboratory of the Central Department of Zoology (CDZ), Tribhuvan University for analysis and identification.

3.2.3.2 Identification of Food Items

The scat analysis was carried out adopting the method used Gokula et al. (1995), Baskaran et al. (1997), Joshi et al. (1997), Bargali et al. (2004). In the lab, all the scat samples were soaked in water for about15 hours, and then washed in running water to

remove mud and other matters using sieves of 0.7 and 0.4 mm mesh size. Remaining portion of each scat was oven dried at 60º C for about 20 hours. These materials were weighed separately and only 4 gms of each scat was taken for analysis. The dried material was sprinkled in a thin layer of non overlapping particles on a paper marked with 16 square boxes of 4 cm length and materials of 2 boxes were selected randomly. Scat samples were separated manually by separating components such as ants, termites and fruits. A dissecting microscope (40X) was used to identify food items when needed. All inseparable, unidentified crushed matters including parts of insects and fruits was considered as waste and excluded from analysis. Fruits were identified by comparing the seeds of fruits collected during field visit. Head parts of the insects were used for their identification. Seeds and insect parts thus collected were weighted separately for analyzing the dry weight composition of food items.

Remains of mammalian hairs and wax were considered as sources of indication of feeding carrion and honey. Food items were broadly grouped into three categories.

(i) Insects = Termites, ants, beetle, Honey Bee and wax

(ii) Plants = Seeds and fruits of various plant species

(iii) Mammalian hair = Hairs

Total number of food items in each scat was recorded to estimate the adequacy of the scat in each season.

3.3 Factors Affecting the Diet Selection of Sloth Bear

Important factors those potentially affect diet selection of the Sloth Bear in CNP were identified through interaction, field survey and literature review (Laurie and Seidensticker 1977, Bargali et al. 2004). Interactions were done with park staffs, NTNC technicians, local people and army personnel. During the field survey various factors such as forest fire, level of human disturbances, distribution of insect moulds, etc. as well as other factors which affected the diet selection of the species were carefully observed.

3.4 Data Analysis

Diet composition was estimated and presented in terms of percent occurrence and percent dry weight (Gokula et al. 1995, Baskaran et al. 1997, Bargali et al. 2004)

$$\text{Percent occurence} = \frac{\text{Number of scats in which a specific food item occured}}{\text{Total number of scats}}$$

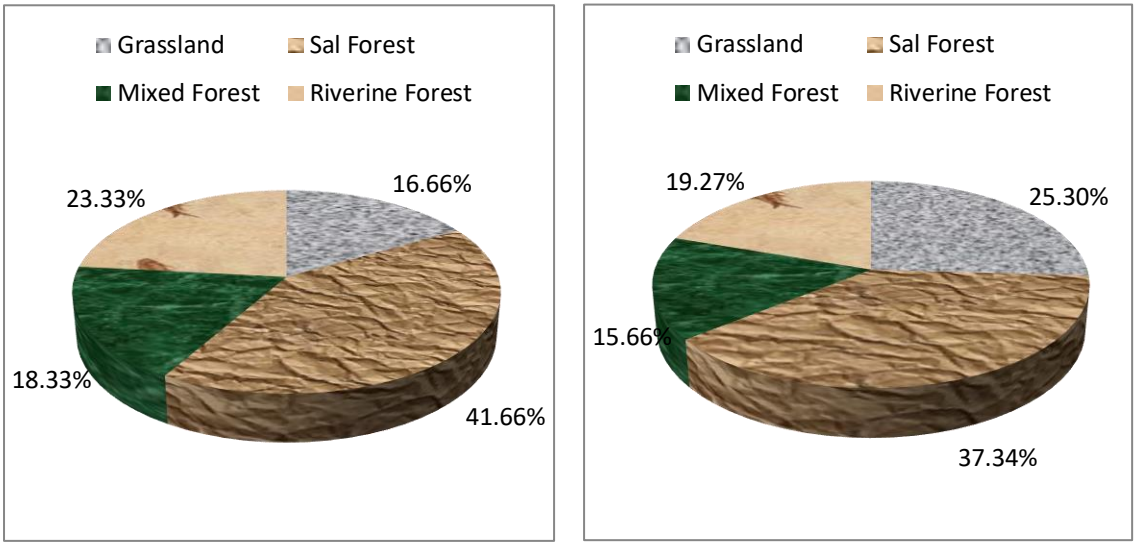
$$\text{Percent dry weight} = \frac{\text{Dry weight of individual food item}}{\text{Total dry weight}}$$

Similar method was used by Landers et al. (1979), Maehr and Brady (1984) and Koji et al. (2012) for scats analysis of Black Bears.

Kruskal-Wallis Rank Sum Test was used to test the significant difference in diet composition of Sloth bear between seasons using program R (R Console version 2.15.2). It is a non parametric test used as an alternative to ANOVA. Since the data was not found normal, hence this test was performed.

4. RESULTS

Altogether, 32 days (17 in summer and 15 in winter season) were spent and approximately 283 km length was surveyed in the field for scat sample collection. In each grid 1.5 km -8.5 km was walked for the survey. A total of 143 scats; 60 from summer and 83 from winter season were collected. During summer, 10 scats were collected from grassland, 25 from sal forests, 11 from mixed forest and 14 from riverine forest (Fig. 6a). Similarly, during winter 23, 31, 13 and 16 scats were collected from the grassland, sal forest, mixed forest and riverine forest respectively (Fig. 6b). Of these 121 were collected along the selected grids.



(a) (b)

Fig.6: Proportions of scats collected during summer (a) and winter (b) seasons from different habitat types in Chitwan.

Most of the scat samples collected from the grasslands and sal forest were from the fire line, human trails and around machans. Majority of the collected scats were dry (without moisture), 48 from dry season and 62 from winter season and remaining fresh (with moisture).

4.1 Diet Composition

4.1.1 Overall Diet Composition

Altogether 13 different food items including six taxa of plants, five taxa of insects as well as wax and mammalian hair were identified from the scat samples. Insects dominated the composition, occurring in 100% of the scats followed by the plants (39.16%) and mammalian hair (3.49%). Termites were most heavily utilized among all the food items occurring in 92.30% of total samples followed by Black Ants (59.44%) and Red Ants (47.55%). Likewise, *Aegle marmelos* (14.68%) occurred more frequently among the plant specimens followed by *Ziziphus spp.* (9.79%) and *Ficus semicaudatum* (9.79%) and other plants identified were *Bridelia retusa* (4.19%), *Cassia fistula* (4.19%) *and Ficus benghalensis* (1.39%) (Table 1).

Table 1: Frequency of occurrence of food items in scat samples of Sloth Bears in Chitwan National Park (n = 143).

Food Categories	Food Items	Frequency of Occurrence	Percentage Occurrence (%)
Insects	Termites	132	92.3
	Black Ants	85	59.44
	Red Ants	68	47.55
	Beetle	17	11.88
	Honey Bee	19	13.28
	Wax	2	1.39
Mammalian Hair	Hair	5	3.49
Plants	*Aegle marmelos*	21	14.68
	Ziziphus spp.	14	9.79
	Bridelia retusa	6	4.19
	Ficus semicaudatum	14	9.79
	Cassia fistula	6	4.19
	Ficus benghalensis	2	1.39

Among the total scat samples, 51.74% comprised insects only. Similarly, 16.08% comprised termites and and 2.08% ants only. Other insects identified were beetles (11.88%), and Honey Bee (13.28%). Mammalian hair (3.49%) also occurred in the Sloth Bear scats.

4.1.2 Summer Season Food Item Occurrence

During summer season, the Sloth Bear heavily depend on the insect. Five different insect taxa occurred in 100% of the scat samples. Among the insect termites occurred most frequently (90%) followed by Red Ants (65%) and Black Ants (61.66%) (Fig.7). Other insects, such as Honey Bees and Beetles as well as wax also occurred in the diet but less frequently. Insect being the important food item, 28.33% of total scat sample comprised insects only. Among the insects, over 6% of samples composed single food item, termites in 6 % and ants in 1.66% of the samples.

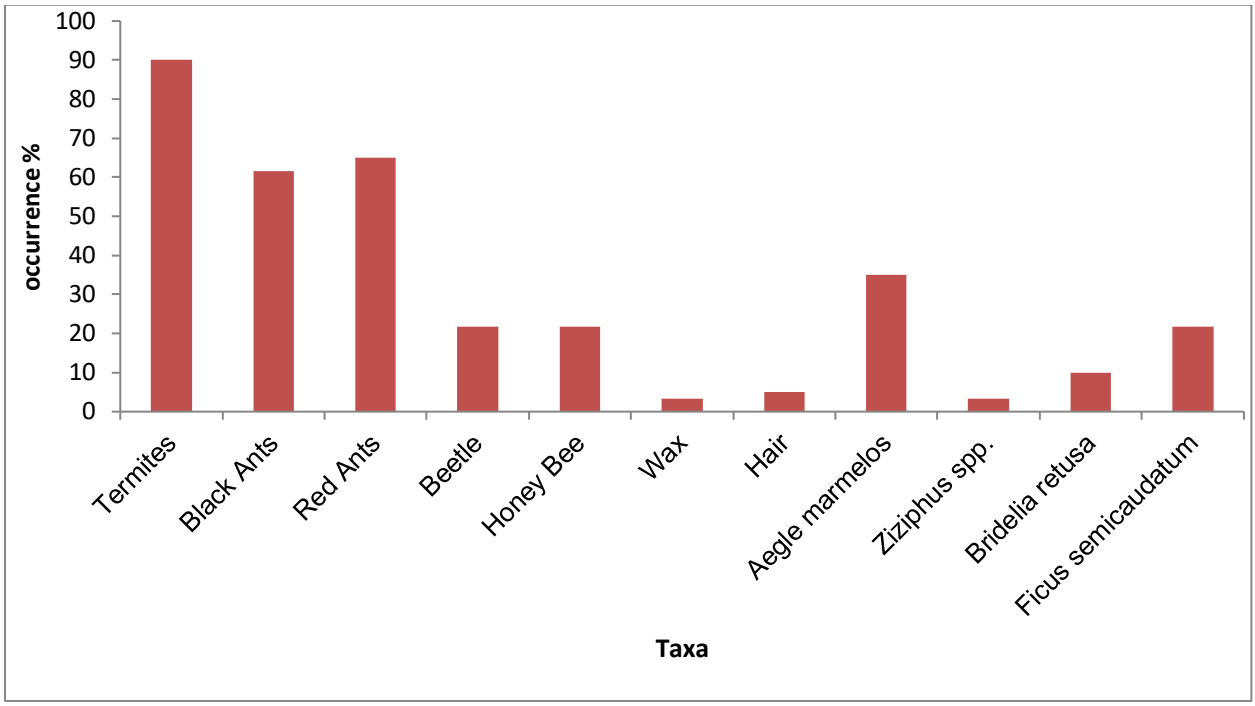


Fig. 7: Frequency of occurrence of food items in scats of Sloth Bears during summer season (n=60)

Plant matter occurred in 63.33% of scats in the summer season. Four different plant taxa were identified, among which *Aegle marmelos* (35%) occurred more frequently, followed

by *Ficus semicaudatum* (21.67%). Other plant taxa *Ziziphus spp.* and *Bridelia retusa* also occurred in the scats but in less than 10% of the total sample.

Mammalian hair was recorded in less than 5% of the scat samples during summer season.

4.1.3 Winter Season Food Item Occurrence

During winter season, the Sloth Bear heavily utilized the insect as food, occurring in 100% of the scat samples. Five different insect taxa were identified in the scat samples. The termites occurred in 93.97% of samples followed by Black Ants (57.83%) and Red Ants (34.93%) (Fig.7), but beetle and Honey Bee occurred in less frequently (Fig. 8). Among the total scats, 68.67% comprised insects only. Similarly, entirely termites (24.09%) and ants (2.4%) were also recorded.

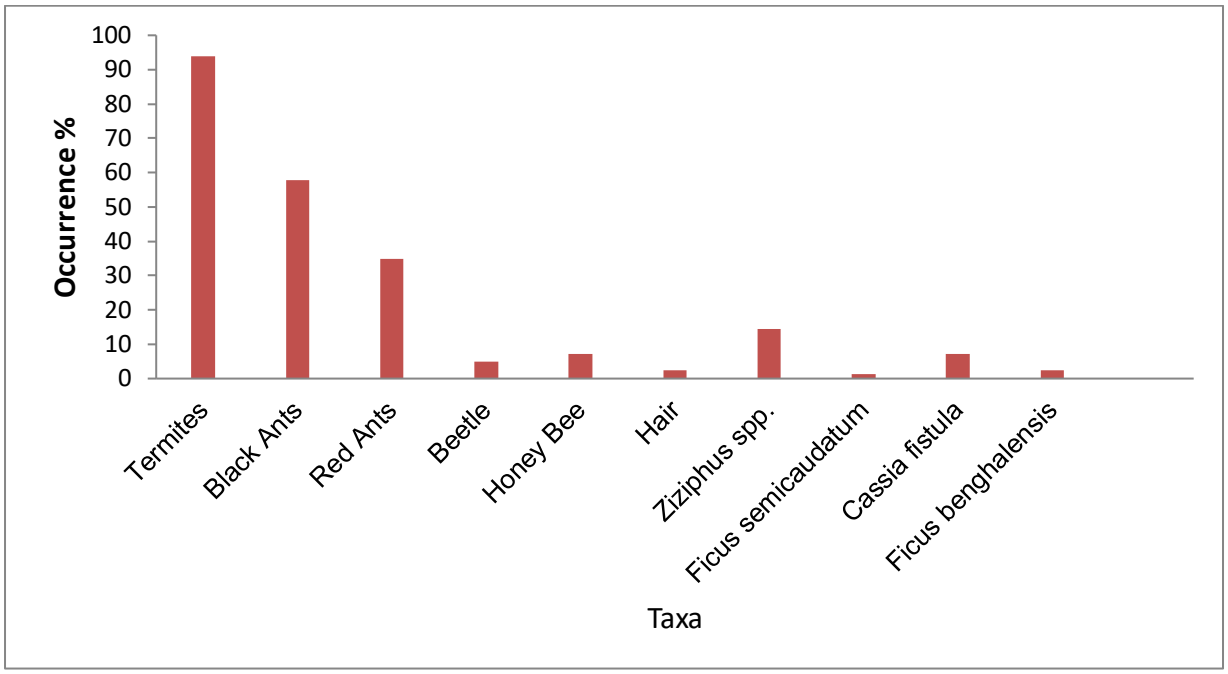


Fig. 8: Frequency of occurrence of food items in scats of Sloth Bears during winter season.

Plants occurred in 21.68% of the scat samples during winter season. Four different taxa of plant were identified. *Ziziphus* spp. (14.45%) was most frequent among the plants followed by the *Cassia fistula* (7.22%). Other plant taxa *Ficus semicaudatum, Ficus bengalensis* also occurred in less than 5% of the scat samples.

Mammalian hair was recorded in winter season also, which occurred only in 2.4% of scats.

4.1.4 Overall Percent Dry Weight Composition

Five different insect taxa (78.98%) were found dominating the overall dry weight composition of Sloth Bear diet (Table 2). Among the insects, the termites (62.70%) have contributed highest proportion followed by Black Ants (8.95%) and Red Ants (4.53%). Similarly, the beetles (1.27%) and Honey Bees (1.07%) and wax (0.39 %) represented in lower proportion. Likewise, plant composition on the dry weight basis was found to be 20.99%, within which *Ziziphus spp.* contributed 10.10% and other were found as *Aegle marmelos* (4.13%), *Ficus semicaudatum* (2.48%), *Bridella retusa* (2.80%), *Ficus bengalensis* (2.47%) and *Cassia fistula* (0.38%). Mammalian hair contribution was least, having only 0.04% of dry weight composition.

Table 2: Percent dry weight composition of food items in the scats of Sloth Bears in Chitwan National Park.

Food Categories	Food Items	Dry weight	Total dry weight %
Insects	Termites	19.242	62.7
	Black Ants	2.749	8.95
	Red Ants	1.393	4.53
	Beetle	0.392	1.27
	Honey Bee	0.33	1.07
	Wax	0.121	0.39
Mammalian Hair	Hair	0.013	0.04
Plants	*Aegle marmelos*	1.27	4.13
	Ziziphus spp.	3.101	10.1
	Bridelia retusa	0.692	2.25
	Ficus semicaudatum	0.5	1.62
	Cassia fistula	0.118	0.38
	Ficus benghalensis	0.76	2.47

4.1.5 Dry Weight Composition in Summer Season

Like percentage occurrence, insect (74.98%) dominated on the dry weight basis also. Within insects group, termites (55.52%) being the most frequent followed by Red Ants (7.47%) and Black Ants (6.07%) (Fig. 9). Similarly, other insects' beetles and Honey Bees as well as wax have ≥ 2% contribution.

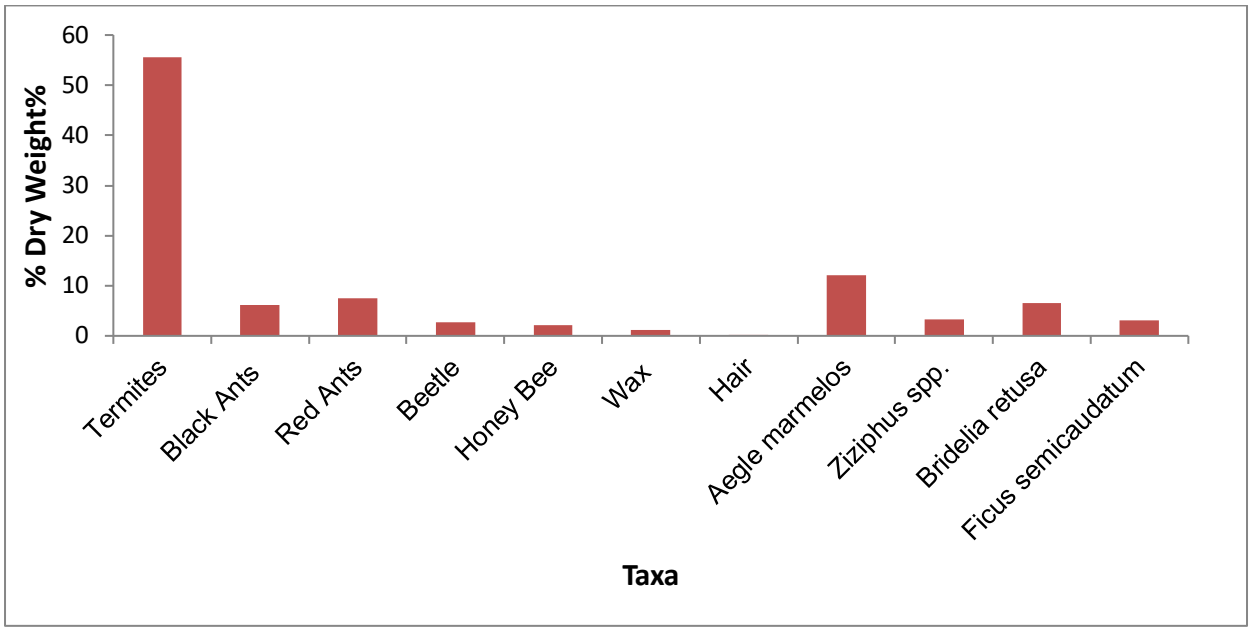


Fig. 9: Percent dry weight composition of food items in the scats of Sloth Bears during summer season.

On the dry weight basis, plant composition was found to be 25.02%. *Aegle marmelos* (12%) have highest percent dry weight composition followed by *Brideli retusa* (6.54%). Similarly, other plants were *Ziziphus spp.* (3.35%) and *Ficus semicaudatum* (3.12%). Mammalian hair contribution was found to be only 0.02% on dry weight basis.

4.1.6 Dry Weight Composition in Winter Season

The insects were found to have 81.08% dry weight of food items. Among the insects, termites (66.48%) have highest proportion followed by Black Ants (10.47%) and Red Ants (2.99%) (Fig. 10). Similarly, beetles and Honey Bees have equal contribution of 0.56% on dry weight composition.

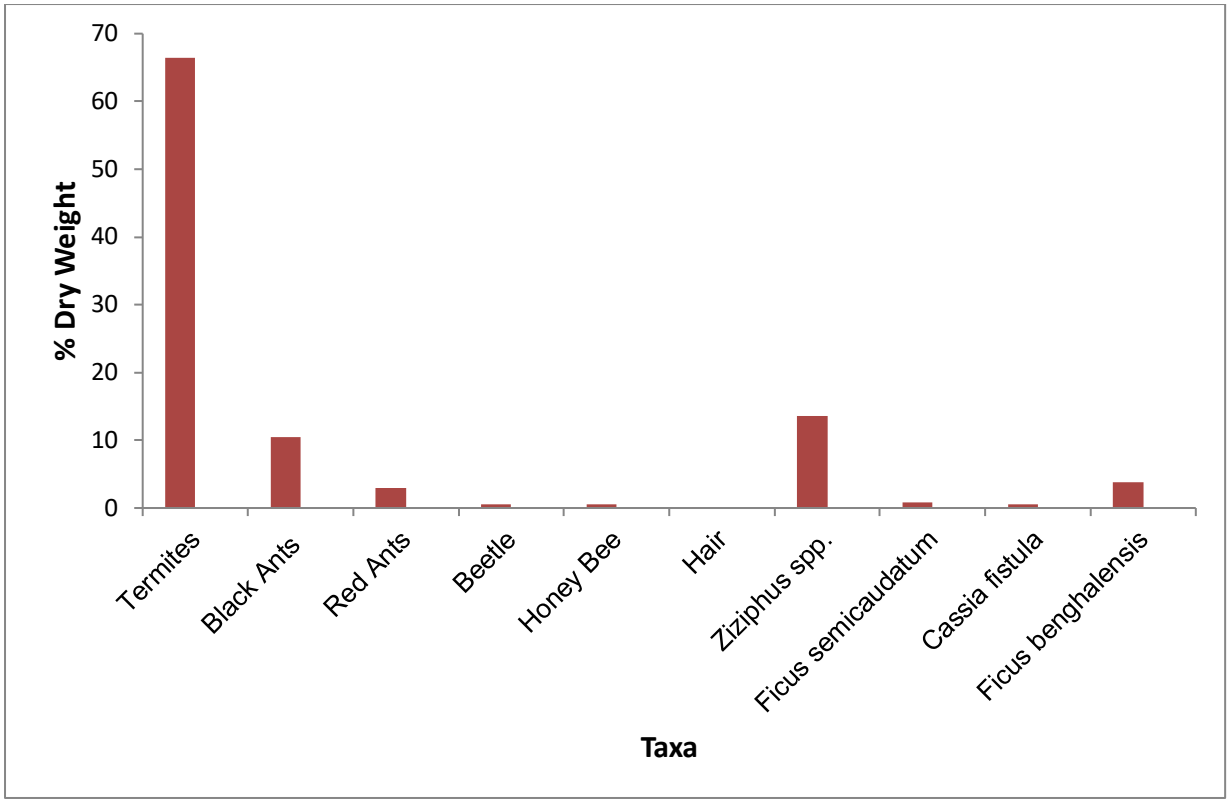


Fig. 10: Percent dry weight composition of food items in the scats of Sloth Bears during winter season.

On the dry weight basis, plant composition was found to be 18.86%. The *Ziziphus* spp. (13.65%) has highest percent dry weight composition followed by *Ficus bengalensis* (3.77%). Others *Casssia fistula and Ficus semicaudatum* have less than 1% dry weight. Mammalian contribution was found to be 0.04% on dry weight basis.

4.2 Adequacy of Sample Size

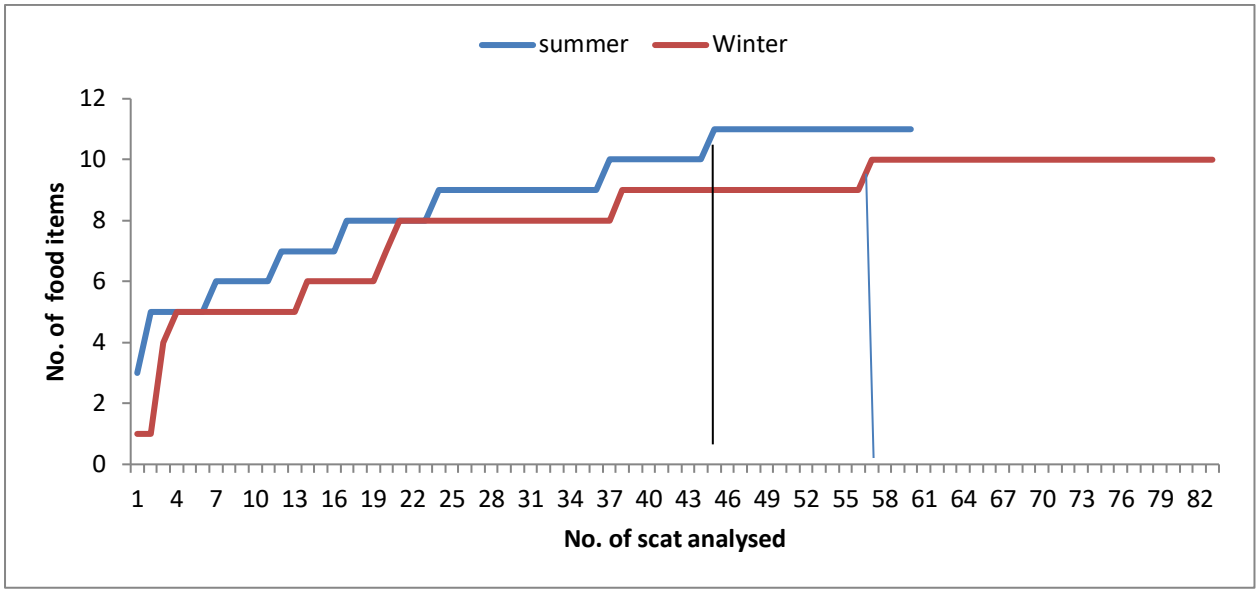


Fig. 11: Relationship between number of taxa occurred and number of scats analyzed in summer and winter season.

All the food items in the Sloth Bears diet were identified after analysis of 45 scat samples in summer season and 57 samples in winter season (Fig. 11).

4.3 Seasonal Variation of Diet Composition

Kruskal Wallis test revealed that there was no significant difference ($P>0.05$) in the composition of diet of the Sloth Bear between two seasons ($X^2=0.8586$, df= 1, $p=0.3541$, $\alpha=0.05$). Both seasons had more or less same composition of diet. Insects were the major diet followed by plants and the least as mammalian hair (Figure 12and 13).

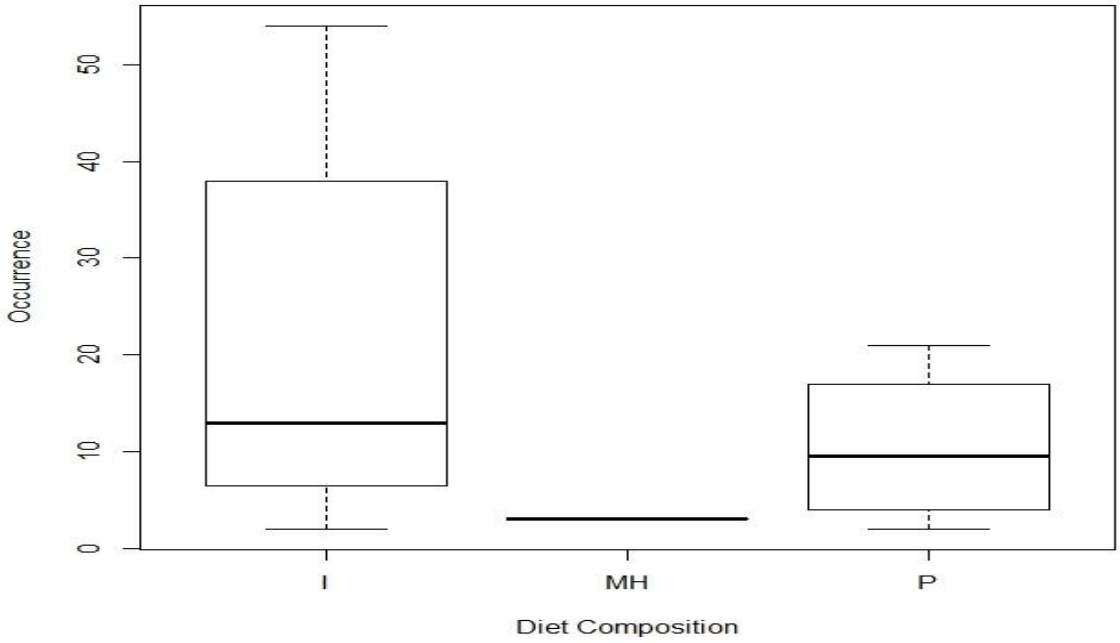


Fig. 12. Boxplots showing diet composition of Sloth Bear in summer season (I= insects, MH= Mammalian hair, P= plants). The dark line in the box plot represents the median or mid value and its arm represents the quartile value of number of diet composition.

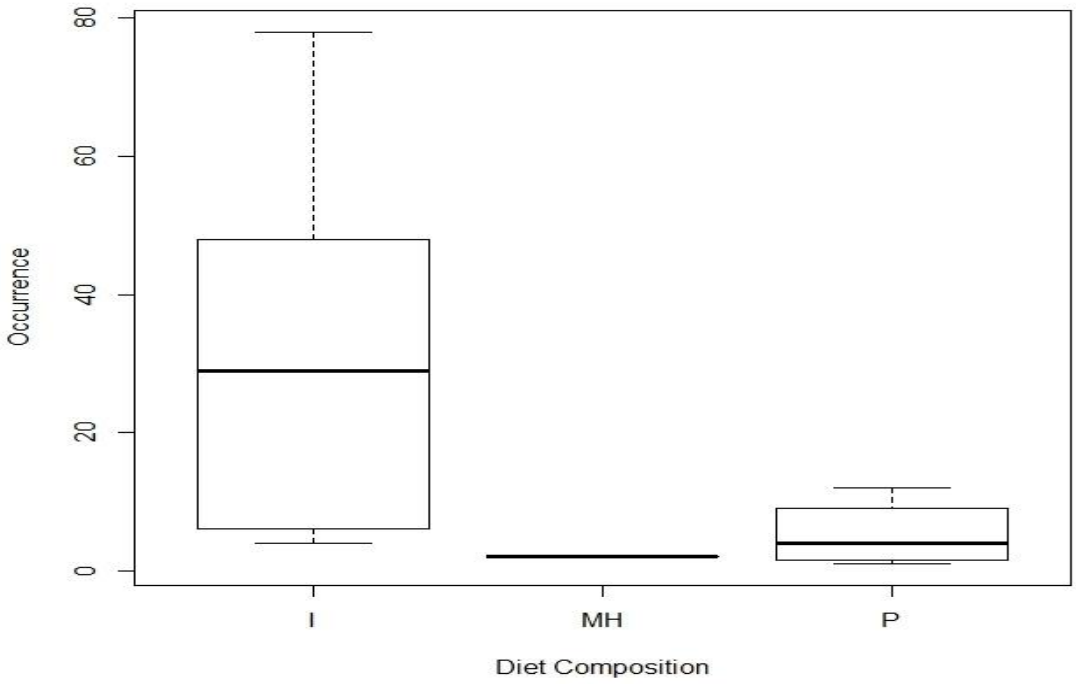


Fig. 13. Boxplot showing diet composition of Sloth Bear in winter (I= insects, MH= Mammalian hair, P= plants). The dark line in the box plot represents the median or mid value and its arm represents the quartile value of number of diet composition.

4.4 Factors Affecting the Diet Selection of the Sloth Bears in CNP

The diet selection of the Sloth Bears was found to be affected by human disturbances, livestock grazing, forest fires, availability and distribution of insect moulds and availability of various food plants (Appendices IV).

1. Human Disturbances: Out of the 32 grids sampled, human disturbances were recorded in 17 and of these three grids with no scats. The Sloth Bears were observed feeding and digging termite mould in four grids, where no human activities were recorded. In three grids, local people were found collecting the *Ziziphus* spp. and *Aegle marmelos*, other non-timber forest products as well as cutting trees. About 60% of the scats were collected from the area where human presence was not recorded. No signs of bears were recorded from three grids the eastern part (Thori area) of the park where excessive human presence was recorded.

2. Livestock Grazing: Signs of extensive livestock grazing were observed at four grids and of these no scats were recorded from the three grids.

3. Forest Fire: Of the sampled grids, seven were affected by forest fire from where only ≤10% of the scats was collected, but no scats were observed in four grids that were affected by fire. No termite moulds digging were found in the area affected by the fires. Four plant species; Ziziphus species, *Ficus semicaudatum, Cassia fistula* and *Bridelia retusa* in six grids were found burnt by the fire.

4. Distribution of Insect Moulds: Insect moulds were recorded in majority of the grids. Only two grids without insect moulds contain the scats, > 90% scats were collected from the areas that also present termite moulds.

5. Season: Termite mould diggings were found in 70% grids in the winter but ≥ 50% grids in the dry season. Plant species like *Ficus semicaudatum, Aegle marmelos* were observed fruiting in the dry season, and *Ziziphus* spp. and *Cassia fistula* in dry season which also dominant their presence in scats in their respective season.

5. DISCUSSION

Diets of Sloth Bear have been analyzed in CNP and BZ by identifying remains of undigested food particles in the scat samples. Scat analysis is widely used method for diet analysis of Sloth Bear (Laurie and Seidensticker 1977, Gokula et al. 1995, Joshi et al. 1997) and other species of bear such as Black Bear (Maehr and Brady 1984), Brown Bear (Aryal et al. 2012) and Grizzly Bear (Matlson et al. 1991) because it is a non invasive technique. However, some researcher employed both scats and stomach contents analysis for diet estimation (Day 1997). Diet composition of the Sloth Bear has been analyzed based on the frequency of occurrence and percent dry weight of different food items in scats (Gokula et al. 1995, Baskaran et al. 1997, Bargali et al. 2004) as well as through direct observations of feeding behaviour (Laurie and Seidensticker 1977, Joshi et al. 1997).

Overall, at least 13 different food items including six plant taxa, five insects as well as mammalian hair were identified in the scat samples (Table 1). The diversity of food items recorded by this study was less than that reported from Chitwan (24 items by Laurie and Seidensticker 1977; 26 items by Shrestha 1993 and 16 items by Joshi et al. (1997) and elsewhere from South Asia (Baskaran et al. 1997, Bargali et al. 2004, Mewada and Dharaiya 2010) but higher than that reported from Mundanthurai Plateau, Tamil Nadu, India (8 items; Gokula et al. (1995) (Appendices V). This difference in the diversity is probably related to the sampling season, duration of scat sampling and diversity of insects and food plants of Sloth Bear in the study area. Other researchers (Laurie and Seidensticker 1977, Shrestha 1993, Joshi et al. 1977, Bargali et al. 2004) collected scats year round but the present study represents only two seasons (summer and winter). However, Gokula et al. (1995) collected the scats for four months (Dec- March) and recorded only nine different taxas. Therefore, sampling duration and season are important factors that determine diet diversity.

Insects were dominant food items in Chitwan occurred in 100% scats. Similar results were reported by Sultan et al. (2012) from dry deciduous forests of Darrah Wildlife Sanctuary, India. Termites were the most important stable food items followed by ants. Laurie and Seidensticker (1977), Gokula et al. (1995), Joshi et al. (1997), Shrestha (1998), Bargali et al. (2004), Seekhadiya et al. (2012), Ramakrishnan and Deepalakshmi

(2012) also reported termites as most important insects food item, but Baskaran et al. (1997) in Mudumalai Wildlife Sanctuary and Yoganand et al. (2005) reported ants are more important in their study areas. Proportion of insects (i.e. almost entirely termites and ants) in Sloth Bear's diets was relatively higher in this study than previous studies, probably insects population in Chitwan are higher than others. The soft soils in Chitwan may be favourable for those insect taxas. Results of present study are close to Joshi et al. (1997) and Shrestha (1993) but different to Laurie and Seidensticker (1977).

Table 4: Frequency of occurrence of food items in Sloth Bears Scats from Chitwan

Food Items	1977*	1993**	1997***	2012****
Insects	52	74.5	91.1	100
Plants	47	24.5	32.9	39.16
Hair, bones or bird feathers	Absent	1.8	Absent	3.49

*Laurie and Seidensticker (1977), ** Shrestha (1993), *** Joshi et al.(1997), ****Present study.

Comparative analysis of various studies clearly revealed that there is increasing trends of insect's contribution in the Sloth Bear Diet (Table 4). Contribution of insects has been increased from 52% (Laurie and Seidensticker (1977) to 100% during the period of three and half decades. Such trends probably correlated with change in the habitat conditions and insect composition in the Chitwan National park. However, such increment may be due to collection of scats only in two seasons in this study. Laurie and Seidensticker (1977) have analyzed the Sloth Bear's diet just after the establishment of the park. Prior to the establishment, much of the alluvium was inhabited by people, who cultivated the land and grazed their livestock in the forests and grasslands. In establishing the park, these people were relocated and livestock grazing prohibited, enabling regrowth of tall grass, which is maintained by annual burning and cutting (DNPWC 2010). This change in habitat characters might have contributed an increase in termites density and a concomitant change in Sloth Bears diet, alluvial grassland are preferred by Sloth Bears because of high density of termites (Joshi et al. 1995). Some similarities of results those of Shrestha (1993), Joshi et al. (1997) and present study may be due to no major change in habitat composition between our study periods. Increased contribution of insect in

Sloth Bear diet might be related with the better suitability habitat for insect, grassland, that is regularly maintained by cutting and burnings. Similar higher contribution of insects in the Sloth Bear diets was reported in Jassore Wildlife Sanctuary (79.3%) by Sukhadiya et al. (2012), in Central India (77.8%) by Bargali et al. (2004) and in Mundanthurai Plateau, Tamil Nadu, India (74.55%) by Gokula et al. (1995). The higher representation of insects matter in Sloth Bear diet probably related to easier digestibility and higher nutritive value of insects. The Sloth Bears entirely depend on social insects (termites, ants) for its protein requirements (Yoganand et al. 2005a).

The proportion of plant material (39.16%) occurred in the diets of the Sloth Bear is higher than that reported by by Gokula et al. (1995) in Mundanthurai Plateau, Tamil Nadu, India and Sukhaidiya et al. (2012) in Jasore Wildlife Sanctuary, India but less than that reported by Laurie and Seidensticker (1977) and Joshi et al. (1997) in Chitwan and Bargali et al. (2004) in Central India. The variability can be explained by differences in availability and abundance of diet items in different season. Baskaran et al. (1997) collected scats during fruiting season (March – August) plants and reported relatively higher proportion of plants and lower proportion of insects. Fruits may have been more plentiful in their study area in southern India than in Chitwan and/or Chitwan supports insect community which more favourable food of Sloth Bear. Gokula et al. (1995), collected scats during December – March and recorded lower number of plant taxa. Monsoon is the main fruiting season for most of the plants but scats were not collected in this season due to some limitations probably due to which less number of plant taxa were recorded than previous studies by Laurie and Seidensticker (1977), Shrestha (1993) and Joshi et al. (1997) in Chitwan.

Presence of mammalian hairs in the diets indicates the carrion feeding behaviour of Sloth Bear. The hairs and bones (Shrestha 1993, Bargali et al. 2004, Sultana et al. 2012), hairs, bones and feathers (Sreekumar and Balakrishnan (2012), Baskaran et al. 1997, Mewada and Dharaiya 2010 were also reported in the scats of Sloth Bear). All these research indicates Sloth Bear feeding on diverse food items.

Although, diversity of food items was similar in both the season, scat analysis showed the variation in dietary composition between summer and winter season (Table 1). Seasonal variation in the diet composition of the Sloth Bear in Chitwan have been reported by Laurie and Seidensticker (1977), Joshi et al. (1997, Shrestha (1993). As in other studies,

Sloth Bears consumed insects, plant matter and carrion in different ratio and the variation related to food availability in different season and sites (Laurie and Seidensticker 1977, Gokula et al.1995, Baskaran et al. 1997, Joshi et al. 1997, Bargali et al. 2004).

During the summer season, Sloth Bear preferred insect in diet (Fig. 6). Termites (90%) and Red Ants (65%) were the most important food items and occurred in most of the samples. *Aegle marmelos* (35%) was most frequent among the plants and the important plant diet in the summer season which resembles with the finding of Bargali et al. (2004), in central India. Similarly, Laurie and Seidensticker (1977) found *Grewia asiatica*, Joshi et al. (1997) found *Syzigium jambolana*, Baskaran et al. (1997) found *Cassia fistula*, Shrestha (1998) found *Ficus glomerata*, Sreekumar and Balakrishnan (2002) found *Magnifera indica*, Mewada and Dharaiya (2010) found *ficus* species and Sajeer (2012) found *Cassia fistula* as important summer plant diet in their respective study area. Beetles and Honey Bees were the insects which unlike others occurred more in summer season. Relative importance of Honey Bees found in the bears scats during summer season may be due to seasonal flowering of some plants.

During winter season, the Sloth Bear heavily depend on insects viz; termites Black Ants and Red Ants and were the most stable food items (Fig 7). Laurie and Seidensticker (1997), Baskaran et al. (1997), Joshi et al. (1997), Bargali et al. (2004) also reported the higher contribution of insects in diet during winter, but study of Mewada and Dharaiya (2010) showed plants are more important than the insects during winter season. Although, the ratio of insect contribution increased, but was not the major contributor of the Sloth Bear diet in Vijayanagar, Sabarkantha district, India (Mewada and Dharaiya 2010). The utilization of insects was higher in comparison with summer season. Other studies (Laurie and Seidensticker 1977, Shrestha 1993, Joshi et al. 1997, Bargali et al. 2004) also reported higher insect consumption, but Baskaran et al. (1997) in Mudumalai Wildlife Sanctuary, Tamil Nadu, Southern India and Shrestha (1993) in Chitwan National Park showed the reduction in insect contribution in diet during summer season. Insect's contribution in diets in this season is higher, hard soil during the summer season probably deterred bears from digging for termites and ants (Joshi et al. 1997, Bargali et al. 2004, Sukhadiya et al. 2012, Ramakrishnan and Deepalakshmi 2012). *Ziziphus* species (14.45%) dominant among the plants in the diet as it was the fruiting season for the species. On the dry weight basis also *Ziziphus* species (13.65%) contributed more (Table 2), although it occurred (14.45%) less than Black Ants (57.83%) and Red Ants (34.93%)

as they have larger seeds than other fruits found in scats and only the head parts of the termites and ants were counted, because other body parts were broken up by the digestive process that passed through the sieves and thus were not analyzed. *Ziziphus* species was also considered important winter plant diet by Laurie and Seidensticker (1977), Joshi et al. (1997), Shrestha (1993), Sajeer (2012). Other than *Ziziphus,* Baskaran et al. (1997) referred *Syzygium cumini,* Bargali et al. (2004) referred *Ficus* species, Sreekumar and Balakrishnan (2002) and Mewada and Dharaiya (2010) referred *Cassia fistula* and Ramakrishnan and Deepalakshmi (2012) reported *Lantana camara* as important winter plant species in the diet of Sloth Bear. Plants contribution in diets was lower in winter season than in summer season. The relative importance of the plant matter in bear diets during summer season may be correlated with flowering and fruiting of trees. *Aegle marmelos* and *Bridelia retusa* were found only in summer season and other two plants *Cassia fistula* and *Ficus benghalenssis* only in winter season. This may be due to fruiting time of these fruits in the respective seasons. Fruits common in both the seasons were *Ziziphus* species and *Ficus semicaudatum* which may be due to longer fruiting period of them. Mammalian hair occurrence reduced in winter, this might be due to super abundance of various types of food (insects: termites and ants).

Adequacy of the sample size in summer (45) were obtained in lesser number of scats than in winter (57) season this is probably due to analysis of less number of scats in summer season.

Sloth Bear's diet selection in CNP was found to be affected by various factors (Table 4) viz; human disturbances, livestock grazing, fire, insect mould distribution and season. Activity pattern of Sloth Bear seem to be correlated with phenology of food plants, crop stages, food availability and anthropogenic disturbances such as non timber forest product collection, livestock grazing and human activity (Bargali et al. 2004). Absent or relatively less number of the termite mould diggings in the area with human presence shows that they probably affected the Sloth Bear diet selection, as live Sloth Bears also run away for their protection after they notice our presence in their area despite they were active in their feeding activity; termite mould digging. Collection of the *Ziziphus* species and *Aegle marmelos* by the local people also affect the diet selection of Sloth Bear, their common food habits have brought them in to the conflict with humans (Cowan, 1970). Pragash et al. (2012) reported that the higher incidences of Sloth Bear attacks on human

in areas where people are gathering honey. Cattles presence and grazing can also affect the diet selection of the species because the Sloth Bears are shy animals that do not prefer other animals in their area and the cattle also consume the plant species that Sloth Bear feed upon, creating the diet competition between the species. In addition, concentration of cattle in the grassland can affect the diet selection of Sloth Bear. Similarly, forest fire temporarily affects distribution of insects and food plants of Sloth Bear. However, the less number of scats and diggings in those areas may be due to destructions of signs by fire. As scats were collected mostly from the area that also contained the insect moulds, the primary food type, distribution of the food type may also somehow affect the diet selection of the Sloth Bear (Laurie and Seidensticker 1977). More number of termite mould diggings was found in the winter season, hard soil during summer probably deterred bears from diggings for termites and ants (Joshi et al. 1997). Plant species of the respective season dominated the scats, indicating that diet selection of Sloth Bear showed the seasonal variation as described by Laurie and Seidensticker (1977), Baskaran et al. (1997), Joshi et al. (1997) and Bargali et al. (2004).

6. CONCLUSION AND RECOMMENDATIONS

In CNP insects, plants and mammalian hair contributed to the diets of the Sloth Bear. Altogether, 13 different types of food items including six plants, six types of insects and mammalian hair represented in the scats of Sloth Bear. However, termites play important roles by contributing relatively higher frequency of food in both summer and winter the seasons.

Although, variation occurred in dietary composition between summer and winter season, there was no significant difference (X^2=0.8586, df= 1, p=0.3541, α=0.05). Overall, insects dominated in both percent composition and dry weight basis. Insects (100%) were the most stable food which occurred more frequently followed by plants (39.16%) and mammalian hairs (3.49%). Among the insects, termites (92.30%) were more important, and *Aegle marmelos* (9.79%) among the plants. In both the season, insects (100%) were heavily utilized where termites are the most preferred food item by Sloth Bear followed by Black Ants and Red Ants due to their high nutritional value as well they could be easily digested. Plant consumption was higher in the summer (63.33%) than in the winter (21.68%) season. Among the plants, *Aegle marmelos* (35%) occurred highest in summer season and *Ziziphus* species (14.45%) in winter as it was the fruiting season for respective plants. Contribution of the mammalian hair was least in both the seasons due to super abundance of various types of food (insects: termites and ants).

On the dry weight basis, overall, insects (78.98%) contributed more than plants (20.99%) and mammalian hair (0.04%). In summer season, termites (55.52%) contributed more among insects and *Aegle marmelos* (12%) among plants. In winter, insects (81.08%) contribution increased, termites (66.48%) remaining highest and Ziziphus species (13.65%) among the plants. This study showed that that Sloth Bears are much more depend on insects than documented by earlier researcher.

Diet selection of Sloth Bears in CNP was affected by various factors; human disturbances, cattle grazing, forest fires, distribution of insect moulds and season were found as the major ones. This shows that anthropogenic factors are affecting the feeding pattern of Sloth Bear in CNP.

Based on results and discussion, this study put forward following are recommendations:

- Collection of plants such as *Aegle marmelos*, *Ficus* species, *Ziziphus* species and other plant species as well as extraction of honey should be controlled because such collection limit the availability of food for Sloth bears.
- Cattle grazing and fire wood collections should be prohibited inside the park and other alternative source should be developed as such activities are limiting the activities of the species.
- Uncontrolled forest fire should be controlled that have destroyed the habitat and food items of Sloth Bears.
- Grassland management and prescribe burning should be allowed, such activities helps to maintain the termites and other insect species population supporting the Sloth Bears.
- Researches on the Sloth Bears ecology and behavior are scarce in Nepal; therefore research should be planned as soon as possible. Sloth Bears researches in Nepal has been concentrated only in Chitwan National Park so importance should also be given to other areas like Bardia National Park, Parsa Wildlife Reserve where the species has been reported and other potential areas should also be searched.
- Regular assessments of the diets and foraging behavior of the Sloth Bears are necessary to assure the best management practices aimed at CNP. Densities of the food items of the species in different seasons and their relative importance in their diet should be assessed.

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APPENDICES

I. Average Monthly Rain fall (2001-2010)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2001	*	6.8	0	113.3	283.4	380.9	*	*	293.7	*	23.0	0
2002	0	*	*	*	*	*	*	*	*	*	*	*
2003	0	*	*	*	*	*	*	*	*	*	*	*
2004	58.8	0	9.0	184.4	145.8	603.7	336.3	293.4	443.9	92.9	9.1	0
2005	41.7	6.0	24.1	24.0	218.9	215.6	479.0	532.2	115.5	192.7	0	*
2006	*	*	*	*	*	*	436.5	429.0	643.7	*	5.5	19.0
2007	0	141.5	27.5	155.5	228.4	408.4	635	576.4	1002.3	60.4	0	0
2008	4.6	2.5	43.6	23.3	122.9	267.4	422.9	374.2	179.0	44.5	0	0
2009	0	0	0	0	172.7	144.1	454.5	736.6	107.0	0	0	*
2010	5	18.0	0	55.9	254.7	282.6	704.3	484.0	342.5	63.1	0	0

II. Average Monthly Humidity % at 8:45 and 17:45 (2001- 2010)

Month	Humidity	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Jan	8:45	97.2	100.0	*	98.9	97.7	*	93.9	94.8	97.1	95.9
	17:45	77.7	96.4	*	69.3	87.4	*	89.9	88.4	74.2	73.4
Feb	8:45	99.8	98.8	*	97.8	97.7	*	92.5	89.0	88.1	88.2
	17:45	95.7	86.9	*	74.5	88.8	*	87.2	64.4	51.0	55.8
Mar	8:45	100	99.8	*	96.0	97.9	*	87.2	71.6	63.0	70.4
	17:45	97.3	77.6	*	70.0	93.9	*	59.7	61.1	35.4	42.9
Apr	8:45	100	87.4	90.6	94.3	91.5	*	73.4	65.2	53.5	59.2
	17:45	97.8	67.9	69.5	74.7	87.6	*	63.3	68.0	34.8	42.5
May	8:45	100	81.0	85.8	95.1	93.0	*	77.8	70.2	70.4	72.5
	17:45	92.9	62.9	64.4	92.4	81.7	*	73.0	66.6	57.0	57.3
Jun	8:45	100	87.4	90.9	97.8	88.3	95.8	83.4	82.5	76.2	73.9
	17:45	97.8	78.8	77.3	84.7	80.3	97.4	75.9	81.1	63.9	66.8
Jul	8:45	99.7	95.6	93.1	97.1	89.2	96.3	89.6	86.9	86.8	87.1
	17:45	95.7	86.3	82.8	90.0	83.1	95.2	89.4	90.8	80.1	78.2
Aug	8:45	100	92.3	93.9	95.5	89.0	96.4	90.4	87.7	85.1	90.2
	17:45	98.2	89.2	86.4	93.9	84.2	95.1	87.9	90.7	82.2	81.3
Sep	8:45	100	91.5	95.6	91.3	89.6	94.1	90.8	84.9	84.6	90.2
	17:45	87.2	87.1	83.3	82.6	82.2	91.9	85.1	85.7	71.5	80.9
Oct	8:45	100	92.8	96.7	88.0	93.7	95.6	88.4	81.9	85.3	84.5
	17:45	80.1	81.1	90.6	80.2	88.1	96.2	83.6	86.2	75.9	72.2
Nov	8:45	100	97.6	96.0	96.4	97.7	96.8	86.3	86.7	90.5	92.1
	17:45	91.9	80.1	90.6	90.5	94.2	95.1	84.7	81.2	73.4	71.6
Dec	8:45	99.9	98.6	99.4	94.3	*	*	93.3	95.8	*	92.5
	17:45	97.7	80.4	75.5	79.0	*	*	90.8	86.2	*	67.9

III. Average Monthly Minimum and Maximum Temperature (2001- 2010).

Month	Temp.	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Jan	Min	7.5	8.8	*	9.7	5.5	*	7.8	9.0	10.5	9.4
	Max	24.5	22.8	*	22.6	22.8	*	21.4	22.0	24.4	21.0
Feb	Min	10.9	12.2	*	11.2	6.7	*	12.2	9.2	11.9	11.0
	Max	26.3	26.5	*	26.3	25.0	*	23.9	25.2	29.6	25.8
Mar	Min	14.4	16.3	*	14.2	12.1	*	14.7	15.9	15.5	17.9
	Max	32.4	31.5	*	33.7	31.5	*	29.7	31.9	32.8	32.8
Apr	Min	20.0	21.1	22.0	14.2	15.4	*	21.3	19.7	21.7	22.2
	Max	35.6	34.1	35.3	34.0	33.4	*	34.9	36.3	37.5	37.6
May	Min	23.0	23.3	22.2	17.7	19.4	*	23.6	23.0	22.5	23.5
	Max	33.8	33.6	35.8	37.1	35.5	*	35.8	35.5	35.5	35.8
Jun	Min	24.8	24.8	24.3	17.0	20.9	18.0	24.7	25.0	25.0	24.6
	Max	33.8	34.8	33.8	34.4	38.1	35.0	34.2	34.1	36.1	35.8
Jul	Min	25.5	25.4	25.2	18.0	20.1	20.4	25.0	25.5	25.9	25.5
	Max	34.4	32.2	33.6	35.0	36.6	34.1	31.7	34.1	34.0	33.5
Aug	Min	25.1	25.2	25.3	19.2	19.7	19.0	24.8	25.3	25.2	24.2
	Max	34.0	33.5	34.1	35.6	36.9	33.8	33.4	33.8	33.0	32.7
Sep	Min	24.0	23.7	24.3	18.2	18.5	17.3	23.5	24.2	24.6	24.2
	Max	33.1	33.2	33.1	34.4	35.6	32.7	31.9	34.1	34.3	32.7
Oct	Min	21.4	19.9	20.7	16.1	14.4	14.5	21.4	20.0	20.5	20.8
	Max	32.4	32.0	32.3	32.2	31.4	31.6	31.0	32.8	31.7	31.5
Nov	Min	15.4	14.7	15.0	9.2	9.1	10.9	15.6	14.7	14.6	16.5
	Max	28.1	28.7	28.2	29.0	27.9	29.3	28.3	29.1	27.5	28.1
Dec	Min	9.7	10.8	11.2	7.1	*	*	9.8	12.3	*	9.2
	Max	22.9	24.1	25.4	25.9	*	*	23.2	25.3	*	24.3

IV. Important Factors Affecting the Diet Selection of Sloth Bear in CNP.

S.N	Sampled grid no	Number of scats	Human Presence	Cattle Grazing	Forest fires	Insect Moulds
1	9	0	0	0	1	1
2	10	0	1	0	1	1
3	16	3	1	0	0	1
4	20	6	1	0	0	1
5	30	2	1	0	0	1
6	34	5	1	0	0	1
7	36	5	1	0	0	1
8	46	3	0	0	0	1
9	47	8	1	0	0	0
10	51	4	0	0	0	1
11	54	3	1	0	0	1
12	60	5	1	0	0	1
13	61	6	1	0	0	1
14	67	4	0	0	1	1
15	68	11	0	0	0	1
16	72	4	0	0	0	1
17	73	4	1	0	0	1
18	76	0	1	1	1	1
19	80	7	1	1	0	1
20	87	5	0	0	0	1
21	88	5	0	0	0	1
22	95	4	0	0	0	1
23	98	0	0	0	1	1
24	101	2	0	0	0	1
25	105	0	1	1	0	1
26	108	6	0	0	1	1
27	109	4	0	0	1	1
28	112	0	1	1	0	1
29	115	3	1	0	0	1
30	116	3	0	0	0	1
31	122	6	0	0	0	1
32	123	3	1	0	0	0

In the table 0= absent, 1= present

V. Frequency of Occurrence of Food items in Sloth Bears Scats from Nepal and India.

Food Items	Laurie & Seidensticker (1977)	Shrestha (1993)	Joshi et al. (1997)	Present Study	Gokula (1995)	Baskaran (1997)	Bargali (2004)
Termites	19	68.8	70.3	92.3	44.14	43.3	72.7
Black ants	11	49.5	53.3	59.44	48.65	71.25	47.2
Red ants	13	45.4	43.2	47.55	3.6	*	16.5
Beetles	5	7.8	10.4	11.88	26.13	1.76	*
Crickets	1	4.6	*	*	*	*	*
Grasshopper	*	9.2	*	*	*	*	*
Grubs	*	15.6	*	*	*	*	*
Honey Bee	6	>1	*	13.28	*	7.58	>1
Wax				1.39	*		
Bones	*	1.8	*	*	*	*	>1
Animal tissue	*	*	*	*	*	*	*
Hairs	*	*	*	3.49	*	*	>1
Bird Feather	*	*	*	*	*	>1	*
Grewia asiatica	13	*	*	*	*	*	*
Grewia sclerophylla	>1	*	4	*	*	*	*
Grewia tiliaefolia	*	*	*	*	*	3.7	*
Grewia hirsuta	*	*	*	*	*	5.8	*
Ziziphus spp.				9.79	*		
Zizyphus jujuba	12	2.8	*	*	*	*	*
Zizyphus incurva	*	>1	*	*	*	*	*
Zizyphus mauritiania	*	*	1.3	*	*	4.76	10.2
Zizyphus oenoplia	*	*	*	*	*	>1	1.8
Zizphus rugosa	*	*	*	*	*	>1	*
Ziziphus nummularia	*	*	*	*	*	*	>1
Eugenia sp.	6	*	*	*	*	*	*
Ficus spp.	4	>1	1.58	*	*	*	*
Aegle marmelos	3	*	*	14.68	*	*	6.5
Anogeissus latifolia	*	*	*	*	*	*	*
Ehretia laevis	2	*	*	*	*	*	*
Careya arborea	1	*	*	*	*	*	*
Solanum indicum	1	*	*	*	*	*	*

Carica papaya	>1	*	*	*	*	*	*
Rhus semialata	>1	*	*	*	*	*	*
Callicarpa macrophylla	>1	*	*	*	*	*	*
Phoenix acaulis	>1	>1	4.5	*	*	*	*
Schleichera trijuga	>1	*	*	*	*	*	*
Schleichera oleosa	*	*	*	*	*	*	>1
Dillenia indica	>1	*	*	*	*	*	*
Murraya koeniga	>1	1.8	>1	*	*	*	*
Bombax ceiba	>1	3.2	1.8	*	*	*	*
Ficus bengalensis	*	*	*	1.39	12.61	*	20.2
Ficus cunia	*	5.3	5.7	*	*	*	*
Ficus Glomerata	*	4.3	1.3	*	1.8	*	*
Ficus virens	*	*	*	*	*	*	19.2
Ficus lacor	*	1	*	*	*	*	*
Ficus religiosa	*	*	*	*	*	*	13.9
Ficus racemosa	*	*	*	*	*	*	2.5
Ficus semicaudatum	*	*	*	9.79	*	*	*
Cassia fistula	*	2.8	1.9	4.19	*	23.8	1.6
Milius veluntina	*	3.2	2.4	*	*	*	*
Magnifera indica	*	1.4	>1	*	*	*	1.4
Maba buxifolia	*	*	*	*	2.7	*	*
Syzijium cumini	*	8.1	1.6	*	*	*	4.4
Syzijium jambolana	*	1	5.7	*	*	*	*
Agiaia roxburghiana	*	*	*	*	5.4	*	*
Bridella squamosa	*	*	*	*	*	*	>1
Bridella retusa	*	*	*	4.19	*	>1	*
Cardia domestica	*	*	*	*	*	7.7	*
Cardia obliqua	*	*	*	*	*	0.17	*
Diospyros melanoxylon	*	*	*	*	*	0.35	2.1
Diospyros montana	*	*	*	*	*	>1	*
Lantana camara	*	*	*	*	*	10.75	*
Toddalia asiatica	*	*	*	*	*	>1	*

Setaria intermedia	*	*	*	*	*	5.9	*
Sporobolus sp.	*	*	*	*	*	>1	*
Buchanania lanzan	*	*	*	*	*	>1	*
Mudhucaindica	*	*	*	*	*	*	>1
Psidium guajava	*	*	*	*	*	*	2.1
Ground nuts	*	*	*	*	*	*	13.4
Corn	*	*	*	*	*	*	2.6

VI. List of Photographs.

In the field with army personnel

Tree scratch by Sloth Bear

Researcher in the field

Scat of Sloth Bear

Forest fire

Oven dried scat

Working in the lab

Digging by Sloth Bear

Insect mould

Sloth Bear digging for insect

Pugmark of Sloth Bear

Collection of fodder from park