

Asian Elephants are Losing Their Seasonal Traditional Movement Tracks: A Decade of Study in and Around the Rajaji National Park, India

Ritesh Joshi¹ and Rambir Singh²

¹Pant Institute of Himalayan Environment & Development, Garhwal Unit, Almora, India

²Department of Science and Technology, Govt. of India, Technology Bhavan, New Delhi, India

Introduction

Rajaji National Park (RNP) was notified in 1983 by amalgamating three erstwhile wildlife sanctuaries namely, Rajaji, Chilla and Motichur. The park is a prime habitat of Asian elephants and is the northwestern most limit of distribution of Asian elephants and tiger in the Indian subcontinent. The Shivalik foothills are one of the world's most spectacular landscapes, encompassing the tall grasslands and the *Shorea robusta* (Sal) forests. This entire belt is the natural home of Asian elephants (*Elephas maximus*) besides many other mega wild animals like tiger, leopard, spotted deer, sloth bear etc. The Ministry of Environment and Forests, Government of India has declared this area as an Elephant Reserve (RNP) with the sole aim of conserving Asian elephants in their natural habitat.

The Shivalik landscape is one of the last few places in the world where Asian elephants exist, hence is in urgent need for conservation. This protected area (PA) in India's lesser Himalayan region falls under sub tropical moist deciduous forest type with extensive stands of *Shorea robusta* (Sal), *Mallotus philippinensis* (Rohini), *Acacia catechu* (Khair), *Adina cordifolia* (Haldu), *Terminalia bellirica* (Bahera), *Ficus bengalensis* (Bar), *Dalbergia sissoo* (Shisham) etc. besides many other important fodder plant species. From tourism point of view it appears to be one of the most successful National Parks in India and its development has helped boost the economy of Uttarakhand State, which lies in the Lesser Himalayan region. However, presently many of the traditional routes are denied to elephants, which are replaced by industrial area, human settlements and road network etc.

Since Independence, forests were cleared and felled and bought under the plough on a large scale. Construction of projects of public utility, for hydrel, irrigation, roads etc. entailed deforestation of large tracts and colonisation brought in its wake have resulted in significant shrinkage in the habitat of wild animals (Singh 1969). Presently, elephant habitats are destroyed by various developmental activities or for human needs. Shrinkage of habitat has forced competition among the same species for the food, shelter and other basic requirements.

The status of the elephant in the adjoining countries is equally poor. Nepal, which has the lowest country population, has lost over 80% of its elephant habitat on account of human settlement. Bangladesh, Myanmar, Cambodia, Vietnam, Laos and Sri Lanka etc. are also rapidly losing natural forest cover, specially the elephant habitats. In Thailand in spite of the elephant having been a protected species since the 18th century, over exploitation of the habitat and the pressure of human population has made the species highly vulnerable (Daniel 1996). The present study is a part of our long-term study on the behavioural biology of Asian elephant in and around the RNP area.

Study area

Rajaji National Park [29⁰15' to 30⁰31' North Latitude, 77⁰52' to 78⁰22' East Longitude] is spread over an area of 820.42 km² in and around the Shivalik foothills, which lies in the Lesser Himalayas and the upper Gangetic plains (Fig. 1). Spread across Hardwar, Dehradun and Pauri districts of Uttarakhand state, Rajaji National Park has been designated as a reserve area for the "Project Elephant" by the Ministry of Environment and Forests, Government of India

with the sole aim of maintaining a viable population of Asian elephants in their natural habitat. The Shivalik hills offer the most prominent geomorphic features of this tract. The river Ganges has cut across these hills at Haridwar. The Chilla forest area of the Rajaji National Park lies to the East of the river Ganges and is attached by the Garhwal Forest Division. The study is ongoing in Haridwar (District-Haridwar), Chilla (District-Pauri) and Motichur (District-Dehradun) forest ranges of the RNP. The altitude lies between 302 - 1000 m asl.

Methods

For studying the movement pattern of elephant three forest ranges were selected and surveyed in-depth for about 10 years. The traditional movement tracks along with feeding grounds of elephants were searched and observed and plotted on a map. Different forest blocks of concerned forest ranges were chosen one after

another sequentially and searched for elephants for about 10 – 12 h (depending upon weather conditions) in a single day search. The observations started at early hours in the morning being the best time to search and observe the elephant in open areas and four hours in the afternoon i.e. before the sunset. Field binocular was also used for observing their movement behaviour without disturbing the animal from an adequate safe distance.

The data collected is part of the animal monitoring activities. The daily record is based on direct sighting of animals, indirect evidences like feeding sign and footprints (Santiapillai & Suprahman 1986; Ramakrishanan *et al.* 1991; Dawson & Dekker 1992). The direct sightings were noted in duly prepared proformas, recording the group composition, age and sex, if observed in groups and also the place of sighting, time and vegetation type.

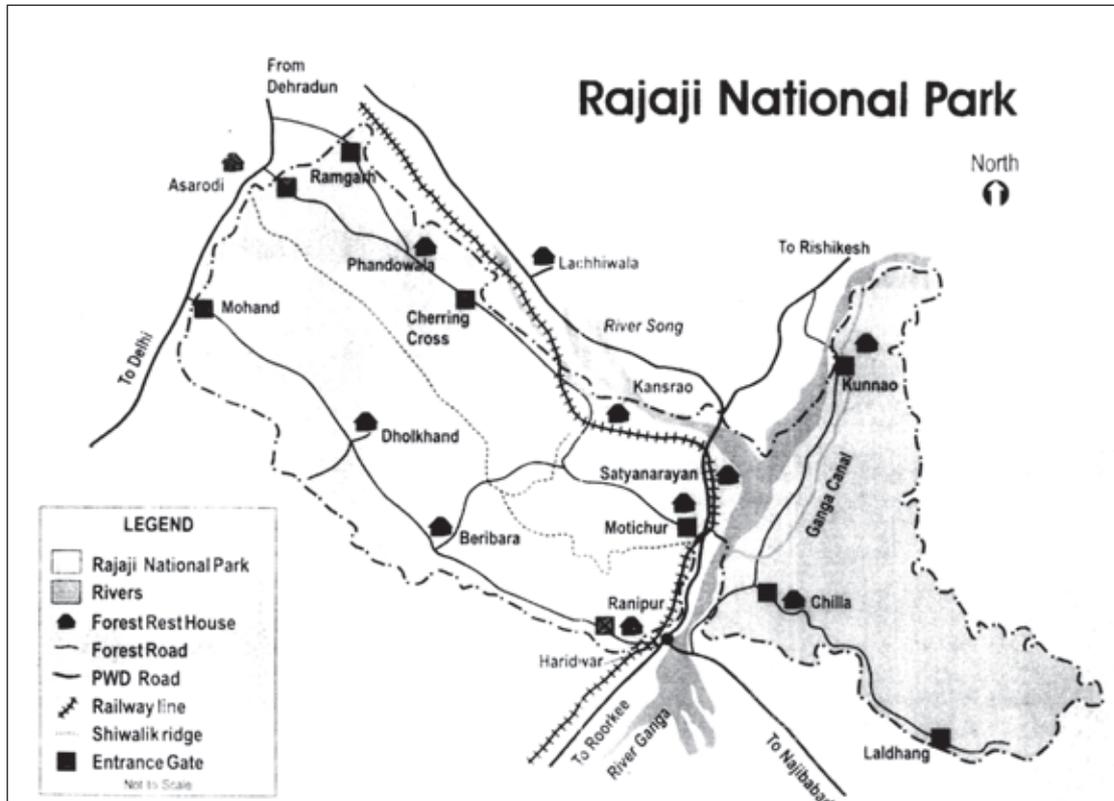


Figure 1. Map of the study area.

Besides, villagers of adjoining areas, Gujjars (where available), staff of Forest Department, the researchers from various scientific institutions and non-government organizations and other individuals working on this problem, were interviewed.

Identification of the elephants is important to verify their movement as in the same area there is a possibility that the same group was observed in the different forest beats so, for each individual bearing distinctive features, identification marks were noted like shape of the ears, tusk size and shape, scars and tubercles on the body, tail length, total number of individuals (all ages separately), body mass and nature of group or solitary bull.

Results and discussion

Movement is one of the most important ecological factors that represent the home range as well as habitat utilization of an animal. Both movement and migration depends upon the availability of natural food and water. Changes in season and scarcity of water and natural fodder species force wild animals to leave a place for a few months and reach new feeding grounds for fulfilling their feeding, water and other routine requirements. There are seasonal variations in fodder species as RNP area falls under subtropical moist deciduous forest vegetation type. Elephants use the whole of the park area as their natural habitat but mostly they leave some of the areas having less vegetation cover and water for a few months and move towards other ranges richer in fodder species and natural water. Although at that time a few of them (mostly solitary bulls) use the same feeding grounds or move frequently in all the forest beats of the park as a general rule of migration of any species. Selected range wise movement pattern of the elephants is described below.

Hardwar forest range

With the onset of winter from the month of mid-October, when there is slight scarcity of fodder species elephants move towards the Dholkhand forest range, which is situated towards south-west/north and towards Kansrao forest range,

situated south-east / north through crossing Motichur forest range. Study revealed that elephants move from Hardwar forest range to the adjoining ranges on the arrival of winter and also at the onset of summer period especially from the month of March to June, which are also known as the forest fire months. But the movements of a few of the solitary bulls and occasionally groups (very rare) have been observed in whole of the range. Most of these movements are obviously being restricted by various villages, temples, railway tracks etc. that are present in the vicinity or inside the park area. Hardwar forest range is partially covered on one side by villages (Nai Basti-Bhimgoda, Lodha Mandi, Ravli-Mehdood, Roshnabad, Aehtampur Aanaeki and Aurangabad), therefore, instances of man-elephant conflicts are relatively more in this area, than in other ranges. These conflicts may be in any form viz. crop raiding, manslaughter etc. Dudhia forest beat due to its closeness to the Haripur Kala village and river Ganges is one of the most sensitive areas as far as elephant casualty is concerned.

During the study period, occasionally the movement of solo bulls was observed in this part of the park. Despite the fact that Dudhia area is rich in *Dalbergia sissoo* (Shisham) and *Acacia catechu* (Khair) forest, being the preferred food item of elephants. Group movement is restricted in this forest pocket due to the high level of anthropogenic and developmental activities. Generally, the solo adult bulls follow the city route to reach the Dudhia forest and river Ganges by crossing the railway track and Hardwar–Dehradun National Highway (Fig. 2). They enter the city from northern Kharkhari forest beat and move towards Chilla area after the sun set and re-enter the northern Kharkhari forest beat before dawn. During this long journey of about 2 km elephants crossed many of the minor routes along with various colonies. Besides, solo bulls from Chilla forest also enter this forest beat after passing through the island in between the river Ganges. This track falls under Chilla – Motichur corridor and is one of the important habitats as far as the elephants' conservation is concerned.

During field observations it came to our notice that, this pocket of the area is very sensitive for

the movement of the elephant mainly due to huge scale anthropogenic activities. During 1999 to 2002 few cottages have been constructed in this area inhabited by about two dozens of sadhus and likes. On the other hand this pocket has been part of the traditional route for the elephants to interchange the forest. Due to rapid development and construction activities in Haripur Kala village situated peripheral to the island and in adjoining areas; the elephant movements have been disturbed. The residents of the area inferred that seven years ago an adult tusker was killed by electrocution by a villager. However, no human casualty has been reported till now.

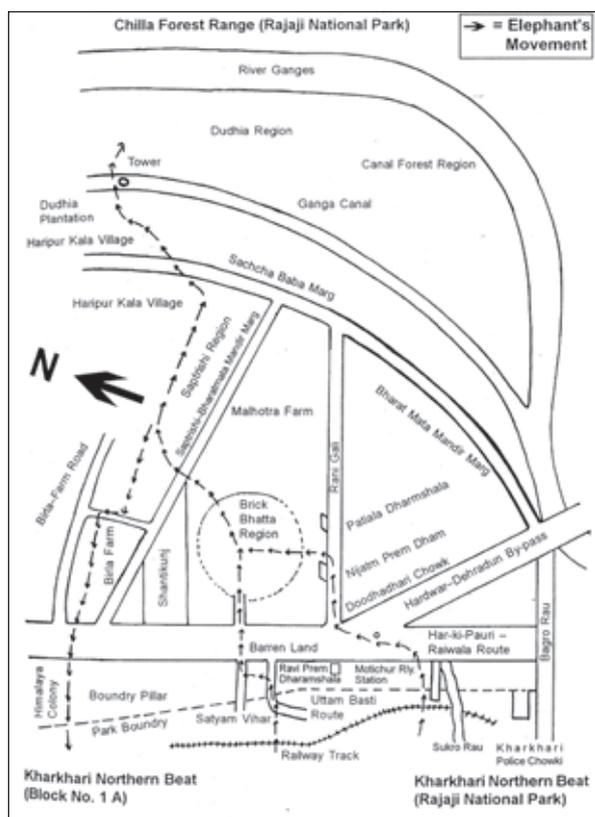


Figure 2. Range used by elephants outside the park area from Kharkhari forest beat to Dudhia forest beat of Hardwar forest range (before 2002).

Chilla forest range

Elephants use this forest range round the year because of altitude wise variation of rich fodder species. On the arrival of winter elephant's movement is towards lower areas like Chilla, Mundal and Khara forest beats. At the same time elephants also utilize the adjoining forest of river Ganga, which spreads up to Rishikesh along the

river. On the arrival of rainy season they migrate towards upper areas like Luni, Pulani, Rawasan and Kasaan forest beats and this is the time when elephants start their long term migration towards Garhwal forest division. Many of the groups and solitary bulls use all of the forest beats for their local movement. During the summer elephants also use the Gohri forest range, which is in the north of the Chilla forest range, to fulfill their various routine requirements.

A large mammal like the elephant could be expected to cover considerable distances even within a short period, and families of a clan seem broadly coordinated in their seasonal movements (Sukumar 1989). In the dry months i.e. from January to April, when no rainfall occurs, the groups seek the neighbourhood of streams and shady forests. From the month of July, after the first showers, they start roaming and feed on the fresh grass. This grass in hill tracts becomes long and coarse by July and August, and the elephants then show upward movements. The reason for the elephants and other animal's migration in to the high land continuous and uninterrupted hilly terrain, is for grazing, assured food, ideal breeding grounds and thick population (Sinha 1981).

Elephants also use the Ghasiram and Mundal water streams for visiting river Ganges especially when their local movement is frequent in and adjoining forest beats, which are attached to river Ganges along with few bridges, which are in Ganga canal of Chilla hydro electric power plant (Fig. 3). Few of the groups were also reported to use the Shyampur and Chiriapur forest ranges of Hardwar forest division during rainy season as east Ganga canal is in full flow during this period. At the same place elephants move towards river Ganges through crossing the Hardwar-Bijnor National highway. It is interesting to mention here that currently only bull elephants cross this track and no groups were reported during the last 2 years. In the past 4-5 years elephant groups were reported in the same area but rapid developmental activities have restricted the frequent movement of elephant groups towards river Ganga in this part.

During the last 4-5 years, the State Government has constructed about four flyovers on Hardwar – Bijnor National Highway. As a result of anthropogenic activities, about 18 km of forest existing on both sides of the highway has got disturbed. Besides, agricultural expansion near river Ganges has lead to the loss of forest, which has also hindered the traditional movement of elephants. This forest stretch is one of the major corridors for elephant movement and presently has got disturbed due to habitat loss around the national highway. Sometimes a few of the male elephants associate to enter the forest near river Ganges through this route.

Elephants cross the National Highway in the evening hours and come back to the forest area in early morning hours. Besides, elephants also utilize the Gaziwali bridge, Shyampurwali bridge and Pili bridge situated peripheral to the canal road in Ganga canal for their outside movement and to feed on the cultivated crops in nearby villages. During the study period all the villages suffering from crop raiding have been

investigated. The affected villages are Jagjeetpur, Mishrpur, Panjneri, Ajeetpur and Jaipota in the western side of the conservation area and all these villages are situated peripheral to river Ganges. Villages Kangri, Ghaziwali, Shyampur, Sajanpura, Pili and Rasiabad are located peripheral to the forest area and National Highway whereas villages Gaindikhata, Lahadpur, Chiriapur, Vasuchandpur and Naurangabad are also situated adjacent to the forest area and National Highway south west of the conservation area.

The villages along the river Ganges are situated on land that was once part of the elephant's home range. Therefore, the increasing elephant – man conflict is unfortunate but inevitable. The electric fence erected along with these villages and river Ganges has presently got damaged due to lack of proper maintenance. It was observed that elephants are utilizing their traditional feeding grounds in few of these areas, which are . presently denied to them and are replaced by human settlements



Figure 3. Ghasiram water stream - one of the oldest natural corridors for elephant movement in between Chilla-Motichur area.

During rainy season elephants were seen moving towards upper areas of the park. Reasons affecting local movement of elephants in the rainy season are:

- The low lying areas become swampy and unfit for free movement of elephants.
- The increase in abundance of a blood sucking fly locally called “daans” in low lying areas which irritates these elephants by hovering around their ears and trunk. This fly is commonly found affecting the cattle stock of Gujjars.

Forest fires also force elephants to areas where fire has not been so extensive.

Motichur forest range

Elephants in summer use this forest range more frequently as compared to winter but on the arrival of winter they move towards Kansrao forest range and Chilla forest range by crossing the river Ganges. In summer, elephants were observed more around the natural water hole areas like in Koyalpura west, compartment no. 4c. Besides, few of the group and solitary bulls use whole of the range for their movement related activities. Elephants use frequently the Motichur rau (seasonal water stream) as a corridor for going to river Ganges. Occasionally they also follow the forest route between Motichur Forest Range office and Raiwala area for going to river Ganges by crossing the Hardwar – Dehradun National Highway and railway track. Establishment of Satyanarayan area, Raiwala area and Khand village has created a permanent barrier on free movement of elephants to different forest ranges. In this way they are forced to restrict themselves in lowland areas as all of these areas lie in between the park area.

This is one of the important and crucial corridors for elephant movement from Rajaji to Corbett National Park. This corridor is known as Chilla – Motichur corridor. Rivers Song and Suswa flow through this range and elephants from Motichur and Kansrao forest ranges utilize the thick vegetation cover near the river especially during the dry season. Elephant movements from Kharkhari forest Beat to Motichur forest Beat

represents their seasonal movement as they leave the Kharkhari forest for a few months mainly due to scarcity of water sources.

Typical tracks

An interesting feature related to unusual movements of the elephants was observed during the study period. The elephants were seen mounting foothills and sliding down from there. They sometimes used sharp slopes for their movement over which human beings can't slide down easily. During the study period on many occasions their movement on foothills and slopes were observed. The movement of the elephants was also confirmed by examining signs and impressions like: presence of dung piles, footprints, damage of the vegetation etc. This kind of movement was seen to be exercised even by juveniles as they can also mount on foothills and use the slope areas of the forest. This type of movement behaviour of elephants sometimes may prove fatal to them, as there have been reports of death of the elephants especially calves due to falling down from these foothills.

The present study reveals that elephants utilize the whole of the park area for their movement, but leave some of the areas for a few months, as part of their seasonal migrational activities. The local movement and long term migration of elephants within the RNP shows a definite pattern. After the isolation of Chilla forest and Motichur forests the elephant population of the RNP has divided into two parts. Presently, elephants of Chilla and adjoining areas in the eastern part of river Ganges show migration between the Chilla area and Dogadda area (Garhwal forest division). Large-scale developmental activities inside the Dogadda forest area have caused hindrances in their corridor area. Seasonal movements and migratory routes have also undergone minor changes. Elephants in North Bengal are pocketed but these pockets have increased in number and also changed their locations with the passage of time. Elephants are trying to adapt themselves to the changing environment by changing their ranges, moving on to new areas and by adopting new routes (Barua & Bist 1996).

The reasons for migration of elephants can be annual fire, drought, non-availability of fodder, paucity of drinking water and absence of cool green shades in their respective areas (Ramachandran 1990). In Chilla, the elephants, which were deep in the Northern hilly terrain in the rainy season, gradually start moving towards the south due to scarcity of water in the winter season in the hilly areas. The study further reveals that the animals are directly affected by water availability and availability of fodder species inside the park area. Presence of river Ganges in Chilla area further ensures the migration of animals at the onset of summer.

Groups generally comprise adult cows, sub adult cows, infants (both sexes) and occasionally a mature bull was also seen within a group (Fig. 4). Different groups generally do not mix up except during large scale migrations. Members of a group during feeding are usually spread within an area of 50 - 100 m. However, the calves are always under direct touch and close to their mother. The young bulls on reaching the age of 12-14 years tend to prefer the solitary life, but

at times two adult bulls may associate temporarily for their mutual understanding such as feeding together and crossing of their traditional corridors now converted into high traffic zones.

Outside movement of elephants

Movement of the elephants on a few routes around the park area was studied during the study period. The areas, which are nearer to the boundary of the National Park, have been subjected to rapid development over the past 6-7 years. Elephants used to move through all of these routes traditionally and especially during the night but presently all of their routes are replaced by agricultural land and human settlements etc. The known areas are BHEL main hospital, main gate of BHEL sector 1, main gate of BHEL sector 2, Subhash Nagar Colony, Tehri Dam Colony, Provincial Armed Constabulary (PAC) campus, Aurangabad village, Aanaeki village, Aehtempur village, Ravli-Mehdood village, Roshnabad village etc.



Figure 4. Elephants in the Rajaji National Park.

During the study period few of the groups and solo adult bulls were observed regularly during whole night for checking their fixed routes for entering the populated areas and re-entering the Park. While in certain fixed places their movement could be observed by viewing them directly with the help of high power torch light (sometimes even under moon light) and the noise created by them while feeding. During dark fortnight periods, it becomes difficult to locate the wandering elephants anywhere. However, the silence of night helps villagers if elephants have strayed or encroached into their fields by their occasional munching sounds. The villagers on such occasions beat drums or other noise creating instruments to drive away these animals from their crop fields or orchards. If elephants feel any disturbance they move inside the nearby thick vegetated area. At that time it is quite difficult to observe them due to lack of sufficient light and risk of casualty. The cultivators sometimes are compelled to allow them to raid crops as they could not drive them off due to unavailability of light sources and drive off devices.

During the past decade it was observed that before 2002 elephants strayed in adjoining populated areas of Hardwar forest range of the RNP area. At that time their straying was quite frequent in Shivlok colony, industrial area, Bilkeshwar colony, BHEL area, Subhash Nagar, PAC campus, Shivalik Nagar, Tehri Dam colony, Salimpur village, Jamalpur village, Ravli-Mahdood, Roshnabad, Aahampur, Aanaeki and Aurangabad villages. Variance in routine movement was observed in Aurangabad village and Tehri Dam colony, due to their proximity to the park boundary. The straying is not only towards crop fields, but also in non-agricultural areas. It was observed that sometimes the elephants are attracted towards fodder like trees near the human settlement areas, in search of their pasture. Elephants come out from the national park boundary after sunset to reach different areas and return back before dawn. The elephants raid the paddy (*Oryza sativa*) and sugarcane (*Saccharum officinarum*) fields in different villages, which are in close vicinity of the park area. The elephants show a natural preference for sugarcane crops because of the

juicy and highly energetic nature of the crop. During this study it was found that group movement was increased during November, leading to highest frequency of raids during December being the maturity period of the sugarcane and decreases in March.

Stray behaviour among elephants has been more common for the last two years as compared to previous years (Joshi & Joshi 2001). In our observations it was conspicuous that at few places their departure was delayed by 2-3 hours after dawn. In Subhash Nagar area one particular group was seen straying continuously for about 14-15 days, which was unusual. The bulls show more individualistic or solitary straying movements. At times these bulls wander alone or in pairs of 2-3, in certain localities. A characteristic feature was that only identified solo bull elephant and groups were more frequently straying, causing damage to various categories of vegetation in the area. These crop raids are the indications of attempts by some of the elephants to use their traditional routes leading to their feeding grounds, which are now denied to them and are replaced by human settlements. Occasionally the solitary movement of an adult bull elephant was also seen outside the park area after mid-day. Dorji (1997) pointed out that one of the reasons for raiding of crops by elephants is due to unavailability of natural food.

Other developmental activities

Developmental projects such as railway track, road network, canals, industrial establishments, expansion of agricultural area and the encroachments by human habitation are also responsible for fragmentation of elephant's natural habitat and blockage of their movement tracks.

State Infrastructure and Industrial Development Corporation of Uttarakhand Limited

After the separation of Uttarakhand state from Uttar Pradesh state (2000), Hardwar city was finalized to establish one of the industrial areas of the state, which was named as State

Infrastructure and Industrial Development Corporation of Uttarakhand Limited (SIDCUL). And for this purpose the adjoining area (2034 acres) of the Hardwar forest range was selected. From 2002 rapid expansion of construction activities nearer to the forest area have caused obstruction in frequent movement of elephants besides many other wildlife in peripheral forest beats. Tiger movement was frequently recorded before 2002 whereas after the same year tiger movement in these forest tracks has got obstructed. As a result of establishment of more than a dozen industries, requirement of water is continuously going to increase and to resolve this, ground water was utilised by various industries and that has caused a major impact on the level of ground water of adjacent areas. Industries are frequently discharging the effluent to the ground because of the absence of any appropriate outlet. Hardwar forest comprises many wells constructed before the declaration of park area with the sole aim of maintaining the water quality especially during dry periods. It was observed during the present study that the water level has decreased in the wells especially during summer. According to our measurements about 1.5 m of the water level has decreased during the last 4 years.

Railway track

Hardwar - Dehradun railway track, which passes through the RNP area acts as a death trap for several wild animals and the major species - elephant. This 16 km railway track passes through the Hardwar, Motichur and Kansrao forest ranges of the Park area and the maximum number of deaths occurred in the railway track, which lies in Hardwar and Motichur forest ranges. The part of the railway track between Motichur to Kansrao (Hardwar – Dehradun rail section) has caused the accidental death of 19 elephants since 1987 besides many other wildlife (Fig. 5). This 105 year old railway track has now become very busy due to the introduction of many fast moving trains. Approximately 29 passenger trains (express/mail) and 3-4 goods trains pass daily on this track.



Figure 5. Cow elephant died through collision with train (2000).

Road network

Dehradun-Hardwar National Highway on the west bank of river Ganges and Hardwar-Bijnor National Highway are the major hurdles as far as road networks are concerned. As per a preliminary study, the average number of vehicles passing on Dehradun-Hardwar road per day is 7929 and all the wild animals, including elephants, are not in a position to cross this track at any time due to the presence of heavy traffic (Singh & Sharma 2001). Kotdwar – Lansdowne road runs parallel to the river Kho and crosses the Rajaji-Corbett corridor, the main movement track of northwestern elephant populations between the Yamuna and river Sharda. This road serves as the major transport link between Pauri town and Kotdwar area. The presence of traffic on the road, construction of steep retaining walls by the side of road and the presence of humans along the entire corridor area have restricted the migration of elephants using this corridor (Johnsingh & Williams 1999).

Hydro-electric and irrigation canal

A major developmental project, which has divided the Rajaji – Corbett elephant habitat into two regions is the 14 km long Kunaun – Chilla power channel, which was constructed on the east bank of river Ganges. In the early 1970s, this canal was twenty-two meters wide, nine meters deep and with full flow of water. The side of the canal is at an angle of 45° and cemented except for 500 m; therefore, do not offer footholds to elephants (Kumar 1995). There are three

places at which bull elephants and groups cross the power channel and go to Ganges.

- (i) Binj / Been rau (dry river bed) – in Gohri forest range.
- (ii) 60 m long aqueduct connecting Dogadda with Ganges – in the edge of Gohri and Chilla forest ranges.
- (iii) Bridge across the power channel, 2 km from Chilla – in Chilla forest range (Soni Shroath).

In summer, more bulls were observed to use these tracks for their movement but occasionally groups also followed this route for going towards riverside forest beats and for fulfilling their routine requirements. Herds generally use the Ghasiram and Mundal water streams for their movement towards river Ganges but during the

summer period herds also follow this route for their frequent movement. The elephants use Mundal stream to go to Ganges, but in the bridge, which is near Chilla-Rishikesh motor road they cross the road to re-enter the stream because they can't cross the narrow lower passage of the bridge easily whereas they used frequently Ghasiram Shroath for going to Ganges.

Another Ganga canal was constructed parallel to Hardwar – Bijnor National Highway, which has divided the protected forest in two parts. During extreme dry period elephants use the ladders constructed over the canal, to fulfill their water needs. Besides, traffic that is running over the highway also acts as a barrier to elephant movements towards Anjani forest beat (Fig. 6).



Figure 6. Bull elephants walking along the Hardwar - Bijnor National Highway.

The RNP represents one of the important sub-tropical moist deciduous protected areas for elephants in India. At present, observations from this study indicate that the elephant population is below carrying capacity of the park since there are no obvious signs of any over utilization and habitat deterioration. The long term survival of elephants and the viability of the park itself as a self sustaining eco-system would depend very much on wise management practices that incorporate both socio-economic as well as ecological considerations. This protected area serves as a good natural home for Asian elephants, but increasing crop raiding / straying tendencies, reveal their increasing uneasiness within their habitat, which is forcing them to move out of their traditional habitat, the park area. On the basis of present study, previous information available and by looking the seriousness of the man-elephant problem in this region, the following recommendations are proposed for consideration.

Recommendations

- 1) Construction of a fly-over is desirable to control the heavy traffic between Haridwar and Raiwala. This will help in reducing the road accidents and death of wild animals. There is also need to educate and convince the people not to feed monkeys in the forest stretch, which also attracts other wild animals, to feed on the remains.
- 2) Gujjar relocation from Rajaji – Corbett corridor area.
- 3) Establishment of the Chilla –Motichur corridor and strengthening of the Rajaji – Corbett corridor.
- 4) The army ammunition dump should be shifted elsewhere along with their settlements.
- 5) Island on the river Ganges should be restored and freed from any anthropogenic disturbances.
- 6) Traffic should be stopped in the Chilla – Rishikesh road during night hours.
- 7) As the park area mainly comprises of Dehradun / Hardwar region so it is proposed that the time of the night trains be shifted approximately half an hour earlier than the present schedule time. By employing this method the train could be made to move slowly and can be easily stopped in emergency, through the park area up to Hardwar.

8) Few sub-ways (elephant under path way) may be constructed on the sharp places from where elephants cross the railway track and the National Highway.

9) Artificial water holes must be created, spread within the park area at short distance. For solving the problem of water, pumps can be used to uplift the well water during the day, which will help during hot periods. Besides, a few of the water sources may be linked with Ganga canal.

Acknowledgements

Authors are thankful to the Science and Engineering Research Council (SERC), Department of Science and Technology (DST), Government of India for providing financial support. Thanks are due to Dr. R. C. Srivastava, Scientist 'G', Dr. Jagdish Chander, Scientist 'F', Department of Science and Technology, Ministry of Science and Technology, Govt. of India, New Delhi for their kind encouragement and support and advice. Thanks are to Dr. U. Dhar, Director, G. B. Pant Institute of Himalayan Environment and Development, Kosi – Katarmal, Almora and Dr. R. K. Maikhuri, Scientist Incharge of the Garhwal Unit of G. B. Pant Institute of Himalayan Environment and Development for their cooperation, support and advice during the study period. Thanks are also due to Shri Srikant Chandola, Additional Principal Chief Conservator of Forests (Wildlife), Government of Uttarakhand and Shri G. S. Pande, Director of the Rajaji National Park for permitting us to carry out the research work in the said area. Thanks are to Prof. B. D. Joshi, Department of Environmental Sciences, Gurukul Kangri University, Haridwar and to various concerned forest officials and staff of the various ranges of the RNP for providing help during the field investigations. Special thanks are to Mr. Shanti Prasad Khantwal and Mr. Radhey Shyam for their association in the team and valuable help during whole of the study period.

References

Barua, P. & Bist, S.S. (1996) Changing patterns in the distribution and movement of wild elephants in North-Bengal. In: *A Week With Elephants*. Daniel, J.C., Hemant, S. & Datye,

- B.N.H.S. (eds.) Oxford University Press. pp 66-84.
- Daniel, J.C. (1996) Conservation of Asian elephant. *Gajah* **16**: 9-16.
- Dawson, S. & Dekker, A.J.F.M. (1992) *Counting Asian Elephants in Forests. A Technique Manual*. RAPA Publication 1992/11. RAPA and FAO, Bangkok.
- Dorji, P.J. (1997) Status, distribution and conservation of the Asian elephant in Bhutan. *Tiger Paper* **24(1)**: 1-3.
- Johnsingh, A.J.T. & Williams, A.C. (1999) Elephant corridors in India: Lessons for other elephant range countries. *Oryx* **33**: 210-214.
- Joshi, R. & Joshi, B.D. (2001) Stray behaviour of elephants (*Elephas maximus*) around Rajaji National Park area, India. *Himalayan Journal of Environment and Zoology* **15(1)**: 81-85.
- Kumar, D. (1995) *Management Plan of Rajaji National Park, Dehradun. Vol. 1 (1995-96 to 2005-06)*, UNDP / WII.
- Ramachandran, P.V. (1990) Migration of elephants in Wayanad Wildlife Sanctuary. In: *Ecology, Behaviour and Management of Elephants*. Karunakaran, C.K. (ed) Wildlife Wing, Kerala Forest Department. pp 109-113.
- Ramakrishnan, U., Santosh, J.A. & Sukumar, R. (1991) Censusing elephants in forests. In: *Proceedings of an International Workshop, Technical Report No. 2*. AECC-IUCN / SSC.
- Santiapillai, C. & Suprahman, H. (1986) *The Ecology of the Elephant (Elephas maximus Linn.) in the Way Kambas Game Reserve, Sumatra*. WWF / IUCN Final Report, Bogor.
- Sukumar, R. (1989) *The Asian Elephant: Ecology and Management*. Cambridge University Press, Cambridge, UK.
- Singh, V.B. (1969) The elephant (*Elephas maximus* Linn.) in Uttar Pradesh. *J. Bom. Nat. Hist. Soc.* **66**: 239-250.
- Singh, A.P. & Sharma, R.C. (2001) Conflicts between linear developments and Asian elephants in sub-Himalayan zone of Uttaranchal. In: *Proceedings of the 2001 International Conference on Ecology and Transportation*. Irwin, C.L., Garrett, P. & McDermott, K.P. (eds.) Centre for Transportation and the Environment, North Carolina State University, Raleigh, NC. pp 423-432.
- Sinha, M.K. (1981) Elephant migration in Kaziranga. *Tiger Paper* **8(1)**: 16-18.

Corresponding author's e-mail:
ritesh_joshi2325@yahoo.com