

Evaluating the Impact of Human Activities during the Maha-Kumbh 2010 Fair on Elephants in the Shivalik Elephant Reserve

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Abstract.— Drastic ecological changes in the Shivalik Elephant Reserve and the rapid rate of developmental and anthropogenic activities are expected to lead to a severe threat and unusual behavioural changes in elephants. This notion was assessed during the Maha-Kumbh 2010 (the greatest fair on earth), which had a wide impact on the elephant populations in the lesser Himalayan zone, north-west India. To evaluate the effects of tourist pressure, developmental and anthropogenic activities on the elephant populations, 87 surveys were performed in different wildlife corridors spread across the Rajaji National Park and Haridwar forest division and on the roads that dissect across this crucial elephant habitat, during January 2010 to April 2010. Ground surveys were used from September 2009 to January 2010 in different locations where developmental work was ongoing in Haridwar city and its adjoining areas to identify the potential impact of these developmental projects and human activities before the commencement of the event. Developmental projects accounted for highest impact on the elephants as this included renovation of roads and temporary constructions in between the protected habitats. Tourist influx into the shrines situated within this area has also hindered the frequent movement of elephants to a great extent. The vehicle traffic on the roads running between the elephant habitats has also restricted the frequent movement of the elephants to and from the River Ganges. Some unusual behavioural responses of elephants were observed, and these may cause extreme changes in their distribution and movements. In addition, encroachment into the protected areas by humans (tourists and locals) has caused erratic patterns in the seasonal movements of various animals, including elephants. Therefore, understanding how elephant populations react to such vast events is essential for addressing future challenges in elephant management and conservation.

KEY WORDS: Maha-Kumbh 2010, Asian elephant, impact, motor roads, Shivalik Elephant Reserve, Rajaji National Park

INTRODUCTION

Haridwar city is entirely surrounded with forests that form part of the Shivalik Elephant Reserve (SER) in the lesser Himalayan zone and upper Gangetic plains (Fig. 1). On the east side of the City is the Chilla forest of the Rajaji National Park (RNP) and the Shyampur forest of the Haridwar Forest Division (HFD), whereas on the Southwest border of the City is the Haridwar and Motichur forests of the RNP (Fig. 2). In 2010, the holy Maha-Kumbh event was held in Haridwar City, which adversely affected the traditional seasonal

movement of elephants. The intense pressure imposed by the sheer number of people, vehicle traffic and developmental activities in and around the city and between some crucial wildlife corridors placed a significant stress on the elephant populations. Behavioural studies of individual animals in the appropriate social contexts are necessary for, and integral to, the development of effective management plans for any species (Singh and Kaumanns, 2005). Previous studies have shown that anthropogenic disturbance and developmental activities can reduce the use of wildlife habitats by limiting the animal's movement (Johnsingh and Williams, 1999;



FIGURE 1. (A) A portion of the Kumbh area (Har-ki-Padi), surrounded by the protected habitats of the Rajaji National Park (RNP) and Haridwar forest division (HFD), and (B) an overview of the Haridwar-Kharkhari by-pass running across the RNP.

Burson et al., 2000; Singh and Sharma, 2001; Pelletier, 2006; Joshi and Singh, 2007). In addition, the movement of animals is potentially restricted in places where roads and trails are present. However, as most of the roads dissect across potential habitats of the elephants, then elephants use these roads and jungle trails on a routine basis.

This study assessed the impact of developmental and other anthropogenic activities on the elephants of the RNP and HFD during the Maha-Kumbh 2010 festival, including the behavioral responses of elephants in respect of these drastic changes. There is very little scientific data available on the effect of such dramatic impacts upon elephants even though such reports are of paramount importance in evaluating and

successfully implementing elephant conservation management and in reducing detrimental elephant-human conflicts, or in understanding the failure of such programs. An adaptive management approach will be crucial, including the provision of suitable connective corridors between habitats, which is likely to be of paramount importance. Since, we are only just beginning to learn the response of elephants to such derisive impacts, the results of this study could be considered as important because currently no other published data exists that explores the impact of such a large event on the wild fauna, especially in north India.

The Maha-Kumbh 2010

Maha-Kumbh 2010 fair was held in the Haridwar city of Uttarakhand State and was the first Kumbh fair of this century. Spanning across 130 km² and covering the districts of Haridwar, Pauri, Tehri and Dehradun, the fair was the biggest Kumbh organized to date. Maha-Kumbh has a religious significance in Hindu Mythology, with this event being held every twelfth year, while the Ardh-Kumbh fair (shorter version of Maha-Kumbh) gets held every six years. In India, four cities organize the Maha-Kumbh fair alternately, of which the Haridwar Kumbh is the longest, with that for 2010 lasting for four months (January 1st to April 28th, 2010). Allahabad (Uttar Pradesh), Ujjain (Madhya Pradesh) and Nasik (Maharashtra) are the other cities that also host this fair.

The magnitude of Maha-Kumbh fair can be gauged by the fact that on April 13th and 14th – the day of ‘Shahi Snan’ (royal bathe)–Baisakhi, approximately 16.3 million people were present in the Haridwar Kumbh fair area. This record was based on satellite images and administrative records, and is a

world record for the largest congregation of human beings at a single place and time. There were three royal bathe viz. 12th February (Maha Shivratri), 15th March (Somvati Aamavashya) and 14th April (Baisakhi, the biggest bathe), while midway during the fair, the 30th March religious bathe (Chaitra Purnima) was also given the royal bathe status by Akhada Parishad, which is the national governing body of all thirteen Akhadas (representative outfits of a particular saint community). The magnitude of this event could also be seen from the fact that more than 60 million pilgrims/tourists were present in various ghats of Ganga in Haridwar. More than 22,000 security police personnel (‘Mela-Police’) were specifically stationed in this area for this mega fair, while a special ‘Mela-Administration’ was formed to oversee the fair works and preparations.

MATERIALS AND METHODS

Study Area.– The RNP (Fig. 2), located in north–west India at 29°15'–30°31' N 77° 52'–78° 22' E, elevation 250–1100 m above mean sea level (amsl), is in the lesser Himalayan zone and the upper Gangetic plains. The total geographical area of RNP is 820 km², and it is part of the SER that was established in 1983 with the aim of maintaining a viable Asian elephant (*Elephas maximus*) population. Accordingly it is designated a reserved area for ‘Project Elephant’ by the Ministry of Environment and Forests, Government of India. The dominant vegetation of the area is comprised of Sal *Shorea robusta*, Rohini *Mallotus philippinensis*, Khair *Acacia catechu*, Haldu *Adina cordifolia*, Bahera *Terminalia bellirica*, Bar *Ficus bengalensis* and Shisham *Dalbergia sissoo*. Prime fauna of

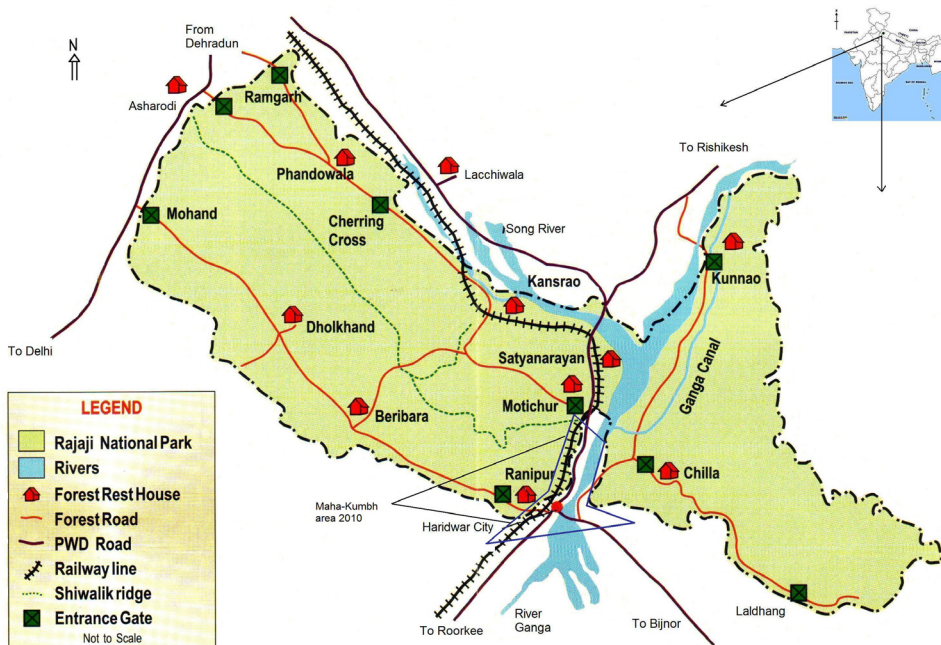


FIGURE 2. Map of Rajaji National Park (RNP) showing the location of Haridwar city and Maha-Kumbh 2010 festival.

the park consists of tiger *Panthera tigris*, leopard *Panthera pardus*, sloth bear *Melursus ursinus*, Hyaena *Hyaena hyaena*, barking deer *Muntiacus muntjak*, goral *Nemorhaedus goral*, spotted deer *Axis axis*, sambar *Cervous unicolor*, wild boar *Sus scrofa* and among reptilian fauna the mugger crocodile *Crocodylus palustris* and king cobra *Ophiophagus hannah* represents Rajaji's faunal diverseness.

HFD is located at $29^{\circ}54.602'$ North Latitude, $78^{\circ}11.982'$ East Longitude, at 271.2 m amsl and is well connected with the RNP and Lansdowne forest division (LFD) and holds a healthy population of wild animals, which the Rajaji carries. All these protected areas together make a long chain of natural habitats, allowing movement of the elephant populations between the RNP

and the Corbett National Park (CNP), and so maintains a good population size of elephants in the country without complete fragmentation. This study was conducted in the Chilla, Gohri, Haridwar and Motichur forests of the RNP and Shyampur and Chiriapur forests of the HFD. However, only the outer/buffer zones were used for field-work as most of the roads dissect across these sites. As most of the construction activities were ongoing in or adjoining to the protected areas, observations were made on the temporary construction work, which was carried out before the commencement of the event. All of these protected habitats are tropical moist deciduous forests and consist of unique topographical features, which also include part of the Shivalik foothills/landscape.

Methods.— To evaluate the effects of the developmental and anthropogenic activities, 87 surveys along the roads/national highways (No. 72 & 74) and in the adjoining forests were conducted between 1st January 2010 and 30th April 2010, inclusive. The transect distance was finalized based on the field conditions and preferences were given to the sites where the movement of elephants was frequent. Since elephants are known to predominantly emerge from the forest during the evening hours, most observations were made between 15:00 hours and 19:00 hours, but observations were also made during the early morning hours (06:00 hours to 10:00 hours) since elephants move between forests during these hours by crossing the roads. The data collected formed part of the animal monitoring activities where the daily record was based on direct sightings and indirect evidence, such as fresh signs of recent feeding, footprint impressions and fresh dung piles. In addition, discussions were made with local villagers, Gujjars (where available), staff of the forest department and the workers of various non-government organizations to gather further information and views on the aspect.

To assess the vehicular traffic pressure, the number of vehicles during three one-hour periods (early morning, mid-day and evening hours) was counted during specific occasions and royal bathe days (special bathe days). Special emphasis was also given to weekends (Saturday and Sunday), as the tourist rush was higher on these two days. Field binocular (Nikon Action series, 10X50 CF) and Nikon Coolpix 8700 Camera was used for field observations and to document photographic evidences. Garmin GPS was used to denote geographical coordinates.

RESULTS

Human alteration of the global environment has triggered the sixth known mass extinction event in the history of life and caused widespread changes in the global distribution of organisms (Chapin III et al., 2000). Understanding the effects of humans on wildlife and its populations, as well as devising strategies to ameliorate these effects, is an increasingly difficult but equally important challenge for resource managers (Steidl and Powell, 2006). With the increase in human populations across elephant ranges, the demand for land and consequential changes in the land use pattern (biotic pressure) has increased drastically, which has then in turn affected the surviving/viable populations of the flora and fauna including elephants. Moreover, human encroachment into the forest areas has put this elephants at further risk and promoted the human – elephant conflict in this area. Currently, in some ranges, the situation is of serious concern with the elephants seemingly struggling for existence. To try to mitigate this conflict the Government has taken several initiatives, which have included the rehabilitation of communities from protected habitats and restoration of ecological corridors, and ensuring community participation, amongst others.

Human activities are widely considered as a threat to the natural activities of all animals and their extinction, including elephants. Changes in the animals' activity budget, displacement from their preferred habitat, interrupted and irregular traditional seasonal movement, and energetic stresses are some of the more common effects associated with human and developmental activities. The impact of development and biotic pressure on elephant's natural activities has been summarized in Table 1.

TABLE 1. Continue.

S. No.	Regions (Habitats)/Corridors *	Elephant's Status and Reasons					Reason	2010 (up to May)	Reason	2011 (up to May)	Reason
		2000	Reason	2010 (before the festival)	Reason	2010 during the festival)					
4.	Khartham/ Bilkeshwar/ Mayapur/ Rampur forests	Large elephant's groups were observed using these forests.	Availability of sufficient fodder and water sources.	Movement of only a group and two male elephant was observed.	Elephant's movement was observed only from Rampur forest, however, occasional movement of a solitary bull was observed from Bilkeshwar and Khartham forests.	Tremendous crowd in Mansa Devi temple and vehicles, which were running across the forest, Bilkeshwar and Khartham forest (by-pass road). Tusker was also observed moving across this range to feed upon palatable items.	Only two small groups were observed from these forests and movement of two adult bulls was recorded, however, in monsoon movement of another group of four elephants was recorded.	Restricted movement of small group was noted.	Increasing rate of biotic pressure and shrinking of natural water sources.		Increasing rate of biotic pressure and shrinking of natural water sources.
5.	Motichur/ Ganga Majahara forests, Dudhna forest (small island)	Movement of groups was rare, however, bulls was observed frequent.	Well connectivity with Chilla forest and river Ganges. However, presence of Handwar-Chilla highway, Dehradun national highway, Handwar-Chilla-Rishkesh motor road, expansion of agriculture lands and anthropogenic activities were some reason observed, which impeded the group's movement.	Footprints of solo adult bull elephant was noted once.	In Winter, elephants used to stay in parts of Lansdowne and Handwar forest divisions, however, only few groups and bulls used to stay in these forests. Besides, renovation of Handwar-Chilla-Rishkesh motor road had also hindered the frequent movement of elephants.	Huge traffic pressure in Handwar-Chilla-Rishkesh motor road and anthropogenic activities in elephant's crossing points.	Occasional movement of bull elephants was recorded after dusk.	Occasional movement of bull elephants was recorded.	To visit river Ganges and to feed upon the species like Dalbergia sissoo (shisham), Acacia catechu (khat) etc.	Occasional movement of bull elephants was recorded.	To visit river Ganges and to inter change the forests.

Impact on Wildlife Corridors

Elephants' Movement in the Motichur–Kansrao–Barkot Wildlife Corridor:- From observations made over the last decade and those documented prior to that, the frequent movement of elephants in the Motichur – Barkot wildlife corridor was only recently observed for the first time and has continued since. Between March 2009 and November 2009 inclusive groups of elephants and solitary bulls were found moving from the Motichur forest to Barkot forest by crossing the River Song and Haridwar–Dehradun national highway near to Chidderwala village. During the same period the movement of elephants was enhanced near to the Gumaniwala and Dhalwala areas and several cases of the movement of elephants outside this area were observed. However, after January 2010 during the Maha Kumbh festival the movement of elephants in this area was restricted, mainly because of the level of traffic on the roads, especially during the evening hours.

Elephants' Movement in the Gohri Forest:- Congested and uncontrolled vehicle traffic along the Haridwar–Chilla–Rishikesh road formed a barrier against the movement of elephants towards the River Ganges. During the Maha Kumbh festival, between January 2010 and April 2010, elephants were observed in this track only eight times (groups of elephants on six occasions and solitary bulls only on two other occasions). Elephants were found crossing the road after dusk (20:00 hour onwards) and returning back before dawn, as they could not cross the road during day hours due to the level of traffic using the road. Elephants are known to widely use the Chilla forest from December to June, and most probably from February onwards, since with the onset of summer the natural water sources present inside the forest diminish and elephants

prefer to feed upon some riparian grass species available across the Ganges. Notably, elephants were observed diverting their movements towards the Shyampur (HFD) and Gohri forests (RNP), where other sources of water were present. The movement of elephants was found to increase about two-fold in these forests at this period. However, biotic pressure is higher in these forests as compared to other ranges because of the presence of Gujjars. In addition, the elephants' movement was found to increase near to Laxman Jhula south forest (Kumbhi chaur) and near to the riparian corridor of the Ganges, which is situated opposite the Triveni Ghat in Rishikesh.

Restricted Movements at Soni Shroath bridge:- From mid-February 2010 to April 2010, no movement of elephants was observed at Soni shroath bridge, basically due to the large amount of vehicular traffic, whereas during January 2010 elephants used this bridge five to six times to move between the forests as this belt is rich in *Dalbergia sissoo* (Shisham) – one of the favourite food items of elephants (Fig. 3). On the other hand, the movement of elephants near to the River Binj was only observed once during November 2009 to May 2010 inclusive. From the Chilla powerhouse to the Gohri forest check post (22 km long track) there is no way for the elephants to cross the canal except at two points (Soni shroath and River Binj). Two other small bridges are also situated over the canal near to Kaudia village and Kunao forest. However, the elephants' access to these two tracks was restricted. Sometimes elephants utilize the Kunao bridge to move between the forests or to visit the River Ganges, whereas movement over the Kaudia bridge was essentially stopped some 10 years ago due primarily to large amount of



FIGURE 3. (A) A bull elephant crossing a narrow bridge situated over the Ganga canal in the Haridwar Forest division (HFD), and (B) elephants drinking water from the east Ganga canal in the Shyampur Forest.

anthropogenic activities and the presence of the Kaudia and Ganga Bhogpur (talla & malla) villages at the very edge of the bridge.

Barriers in the Khara – Anjani forests stretch/connectivity.— Kumbh authority has established a temporary police check-post at Singhal-ka-pul heading East over the Ganga canal in Shyampur forest (HDF; Haridwar–Bijnor national highway) and this is situated on one of the important corridors for the elephant movement from the Khara forest to

the Anjani forest and towards the River Ganges. A tremendous amount of traffic was found to use this highway even during the night period and accordingly the elephants' movement towards the River Ganges was curtailed. In addition, the forest staff were also been assigned to deter the elephants away when they were observed near to the highway. Although elephants are known to enter agriculture fields by crossing this highway, since the implementation of this deterrence policy by the forest staff the

number of crop raiding complaints has declined to zero. These activities could be considered as causative agents for enhancing the human – elephant conflict.

Are Elephants Leaving the Anjani Forest?- Traditionally, elephants used to move towards the River Ganges by crossing the Haridwar–Bijnor national highway (Fig. 4) to feed upon riparian specific species, such as *Acacia catechu* (Khair) and *Dalbergia sissoo* (Shisham), and several grass species, such as *Saccharum munja* (Sarkanda), but their movements have dramatically diminished since 2002. Presently, only bull elephants are known to cross the highway, and do so mainly after dusk and before dawn.

About 24 km in length of this highway lies across the crucial elephant's habitat and

elephants used to cross this highway during evening hours to gain access to the other forests and to visit the River Ganges. In the last decade the government has constructed six bridges over the river in this track and this has caused about 18 km of the forest stretch along both the sides of the highway to be disrupted due to the dramatically increased levels of anthropogenic activities. In addition, agricultural expansion adjoining to the River Ganges has lead to the loss of forest area and diversity and access, which is then also hindering the traditional movement of elephants. Historical evidence supports that all these agriculture lands were formerly part of the elephants' home-range but during the last four decades as they developed from forest to agricultural lands they have become denied to the elephants.



FIGURE 4. Bull elephants crossing the Haridwar–Bijnor national highway en route to the River Ganges.

In the adjoining areas of this track various stakeholders have constructed shopping complexes, check posts and shrines, which further hinder the movement of elephants. Although elephants, especially bulls, attempt to utilize this road all year round their movements were, however, found to be more frequent in the late summer and monsoon season.

Do Elephants Continue to use the Chilla–Motichur Corridor?— Between October 2009 to May 2010 inclusive, elephants were not observed in Chilla–Motichur wildlife corridor, which includes a portion of the Haridwar–Dehradun national highway and Haridwar–Dehradun railway track. Over the last decade the movement of elephants has been congested in this corridor. Although very rare, bull elephants are known to still use this forest to move between Motichur and the Chilla forests of the RNP. This corridor is one of the crucial habitat, which links the south-western part of Rajaji with Corbett Tiger Reserve.

Impact of Human Activities

Garbage Accumulation and Elephants' Behavioral Responses.— At the very commencement of Kumbh fair (from November 2009 to December 2009), bull elephants were observed feeding on the garbage in Shyampur forest (Fig. 5). These types of reports were also highlighted in previous years from the Haridwar–Dehradun railway track, which also attracted the attention of park managers and researchers. It was noticed that tourists threw edible items from moving trains and buses that then attracted wild animals to feed upon these items, which sometimes caused wildlife mortality and risks habituation of the animals.

On the other hand, enormous garbage dumps, especially of polythene, have

accumulated inside the forest, primarily because of the tremendous influx in the number of tourists to the temple of the Goddess Mansadevi. Some patches of the forest close to the temple were observed to be completely covered on the ground with colored polythene bags. After the completion of Kumbh, the park administration took the initiative to clean the forest, and this was also performed near to the temple of the Goddess Chandidevi, where the number of tourist visitors was lower than at the temple of the Goddess Mansadevi.

Irregularity in the distribution of elephants.— Generally elephants utilize the Chilla forest from March to June, whereas at the onset of the monsoon season (July onwards) their movement is concentrated towards the Shyampur and Chiriapur forests (HFD) and Laldhang and Dogadda forests (LFD) from where some bulls commence their journey towards the Kalagarh Tiger Reserve and CNP. Noticeably, in between January and May the movement of elephants was found to be irregular with movement being chiefly observed in the Shyampur and Chiriapur forests of the HFD and the Gohri forest of the RNP, and very little movement in the Chilla forest. Notably, from the first week of June 2010 the elephants' movement then increased in the Chilla forest region.

Although a group of fourteen elephants and two solitary bulls were found moving in the Haridwar Forest (RNP), their movements were restricted up to the Ranipur area from where they returned back towards Dholkhand forest by crossing Beribara forest. Similarly, in Motichur forest the elephants' movement was observed to occur only up to the boundary of the Motichur and Kharkhari forests, where the elephants no longer moved



FIGURE 5. Bull elephant feeding on garbage near to the Shyampur Forest in the Haridwar Forest division (HFD).

towards Bilkeshwar forest (adjoining to Kumbh area).

Human Causalities.- Two people were killed by elephants during the period of the Maha Kumbh festival. One incident occurred in Bhadrakali Forest (Muni-ki-Reti area, Narendra Nagar forest division) on the 13th March, 2010 and another in the Shyampur Forest (HFD) on the 21st April, 2010. Both the incidents occurred inside the forest. However, this might have been due to the irregular movements of elephants and locals inside the forest.

Developmental Projects.- Several small-scale developmental projects were carried out during the pre-Kumbh period from September 2009 to January 2010, which included renovation of the Bhramपुरi (Haridwar)–Mansadevi–Kharkhari by-pass

and the Haridwar–Chilla–Rishikesh road with the construction of temporary huts and centers in the dry bed of the River Ganges and in the islands situated in between the banks of the River Ganges. When renovation work on the Haridwar–Chilla–Rishikesh road was ongoing, traffic was diverted to Jhabargarh Forest in the Chilla Forest range (RNP). An approximately 5 km stretch of forest was severely affected by the traffic and due to this the elephants' movement was found to be constrained. In addition, the Haridwar–Bijnor and Haridwar–Dehradun national highways were also renovated, which had a negative impact on the movement of elephants. Construction of temporary parking in the Motichur rau (Fig. 6), a seasonal water stream, and in some pockets of the



FIGURE 6. Construction of temporary car parking in the River Motichur, Rajaji National Park (RNP) during the early Kumbh period. The area lies in the Chilla–Motichur wildlife corridor, a crucial corridor for the movement of elephants between the RNP and the Corbett National Park (CNP).

Shyampur forest (HFD) also adversely affected (restricted) the free ranging ability of the elephants.

Biotic Pressure.— Approximately, 16.3 million pilgrims and tourists came to Haridwar city during Maha-Kumbh 2010 to draw merits and for a royal bathe. In addition, people from national and international organizations came to this location to join different saint communities and stayed for the whole festival period. To date no other fair of this magnitude and kind has been organized in the country, where 60 million people collected together at a same place under the flag of religion and to adore the River Ganges. This also reflects the reverence of the world's people for the natural heritage of 'the Ganges'.

The temples of the Goddess Mansadevi and Goddess Sureshwaridevi are situated in the Haridwar Forest range (RNP) and the temple of Goddess Chandidevi is situated in the Shyampur Forest (HFD). Generally, the elephants' movement is quite frequent on the outskirts of these shrines but notably during February 2010 to April 2010 during the festival, their movement was restricted in these pockets as tremendous numbers of humans were present, especially from the early morning (06:00 h) to late night (20:00 h). Vehicle traffic pressure, which was almost increased overall some 3.3-fold compared to other normal days, and specifically varied from 1.87- to 1.96-fold higher on the busy Haridwar-Dehradun and Haridwar-Bijnor roads and up to 36- to 42-

fold higher on the normally quiet Haridwar – Chilla - Rishikesh and Gohri - Swargashram – Neelkanth roads, also restricted the routine activities of elephants (Fig. 7, Table2). Furthermore, the disturbance from the loud noise emerging from loudspeakers and from the crowd prevented the elephants from staying or moving into these forest regions, but rather drove them away.

Encroachment by Saint Foreigners.- During the festival another problem is disturbances cause by visitors encroaching into the forest in movement corridors, and thereby their disturbance restricts the elephants' movement in that corridor. One example is a group of about 150 foreigners, comprised of men, women and children, who came from different countries to take

the royal bathe of Kumbh, who entered the Jhabargarh Forest (RNP) in an area within the Chilla – Motichur wildlife corridor. They resided there for eleven days (from the 4th to 14th April, 2010 inclusive), and and cooked food inside the forest and had baths in the River Ganges flowing adjacent to this forest. They were active and loud, singing and dancing to the religious hymns and folk of lord Krishna and Rama, and playing on the swings they had constructed on the trees (Fig. 8). Accordingly, these activities forced the elephants to leave the area, until these revelers were relocated outside the park.

Group dancing and playing of musical instruments (guitar, drum, violin and dhapli) by saints has also impeded the activities of wild animals. In addition, the burning of

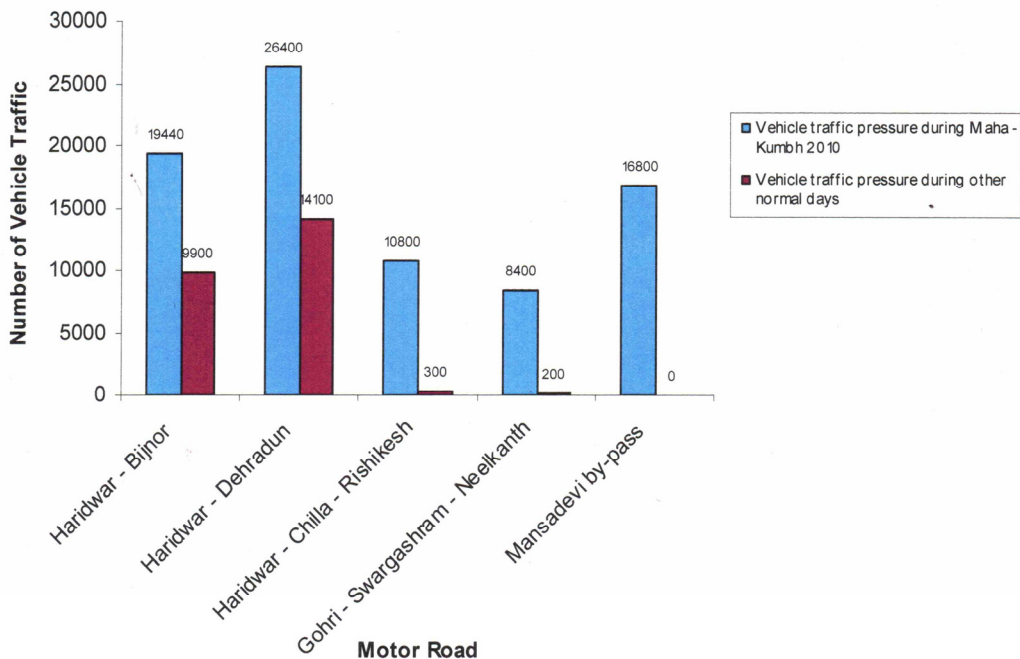


FIGURE 7. Average daily number of vehicles on different roads running across the Rajaji National Park (RNP) and adjoining habitats during the Maha-Kumbh 2010 fair (January–April, 2010) and other normal days.

TABLE 2. National highways / motor roads, which exists in parts of Rajaji National Park and Haridwar forest division, affected forest areas with distance, estimated traffic pressure and affected wildlife corridors*.

S. No.	Motor Road/National Highway	Affected forest area (from – to)	Distance (in Kms., approx.)	Vehicle traffic pressure	Affected wildlife corridor
1.	Haridwar–Bijnor	Chandidevi temple–Gaundikhatta	17.0	±19,440	Rawasan–Sonanadi
2.	Haridwar–Dehradun	Motichur range office–Ganga Majhara and River Suswa–Chidderwala/ Laltappar village	3.0&9.0	±26,400	Chilla–Motichur, Motichur–Kansrao–Barkot & Motichur–Gohri
3.	Haridwar–Chilla–Rishikesh	Chandidevi temple footway to Chilla range office, Soni shroath to Kaudia village/Binj river	2.0&9.0	±10,800	Chilla–Motichur
4.	Gohri–Swargashram–Neelkanth	Gohri check post to south Lakshman Jhula forest beat	5.0	±8,400	-
5.	Mansadevi by-pass	Complete track from Bhramपुरi to Kharkhari forest	7.0	±16,800	-

* Field data was based on the records, collected during March & April 2010, when most of the biggest royal bathe occurred and maximum number of devotees/pilgrims visited this place.

fuel woods for cooking further restricted the animals' activities. Notably, wild animals were found to not move into or across this part of the forest during daylight hours in these periods of high human activity in the area, although indirect evidence (track signs) of the nocturnal movement of some smaller herbivores (spotted deer and sambhar) and small carnivores/scavengers (jackal, hyaena, mongoose and civet) was noted in the adjoining areas for animals that came to feed upon the waste left by the humans. Some of the forest encroaching humans were also observed to be reveling in states of intoxication. They were moving from country to country to learn and experience different cultures and to spread the message of serenity and peace. They argued that as world citizens, without any hidden motive behind entering the park but to worship god and to be a part of the Maha-Kumbh, they should be allowed to stay. As some of them were also associated with the Akhadas, it put the pressure on park administration to resolve this matter. After careful examination of the Wildlife

Protection Act, 1972, they were rehabilitated outside from the park area on 14th April, 2010. This specific example illustrates some of the other more frequent and varied types of difficulties in human-wildlife conflict management.

The Activities of Tourists and Locals inside the Forests.– The Mansa - Devi by-pass runs across the RNP and has had a huge impact upon the elephants' activities. This road remained open for pilgrims and tourists from early morning (04:00 h) to evening (19:00 h) with users given some instructions on the restrictions of deviating away from the road into the forest being given on entry by the park administration. However, on several occasions, crowds moving through this stretch on foot were found to have entered inside the forest. Similar cases were also observed along the Haridwar–Chilla–Rishikesh road, which runs across one of the crucial habitats of the elephants, including tourists cooking food within the forest. Several other cases of tourists wandering inside the forests,



FIGURE 8. In search of peace: Foreigners singing and dancing inside the Rajaji National Park (RNP) area.

especially into the seasonal rivers were also noted.

The factors that contribute to the killing of humans by elephants are primarily the presence of people in the forest (often collecting firewood and fodder), conflict over water, and the cultivation of palatable crops near the forest boundary. Noticeably, elephants and human beings in the SER are increasingly entering into conflict with each other mainly because of the conversion of protected habitats into farm, urban and industrial lands. In between November 2000 to March 2012, elephants have killed 101 persons and injured 64 persons in Uttarakhand state, of which more than 65 persons have been killed in the area of the RNP, CNP and adjoining habitats since 2006. On the other hand, between November 2000–2011, 212 elephants were

killed for various reasons in Uttarakhand State.

Wildfires.- Wildfires in the Haridwar (RNP) and Shyampur (HFD) forests during Kumbh also affected the forest flora and fauna. Approximately 5.0 hectare of Haridwar forest and 7.5 hectare of Shyampur forest were severely affected by wildfires and this study's baseline post fire examination revealed that the movement of elephants in the post-fire regions was then restricted for the following two months (May and June, 2010) after the respective fires.

Vehicle Traffic and Elephant Movement

Apart from roads benefiting some wildlife as habitats for plants and corridors for travel, or as sites of carrion food, the negative impacts of roads on wildlife are well documented where they can also create

barriers to movements, eliminate and alienate habitats, and be a source of mortality (Clevenger and Kociolek, 2006). Over the last few decades, studies in a variety of terrestrial and aquatic ecosystems have demonstrated that many of the most pervasive threats to biological diversity—habitat destruction and fragmentation, edge effects, exotic species invasions, pollution, and over-hunting are aggravated by roads (Noss, 2002). Road construction affects wildlife through the direct loss and fragmentation of habitat, by introducing a source of additive mortality for wildlife populations, and by disrupting animal movement and dispersal (Jackson and Griffin, 2000).

Haridwar–Bijnor National Highway No. 74.— This highway runs across the Shyampur and Chiriapur forests and the Jhilmil Jheel conservation unit, in the HFD. About 24 km of this highway lie within a crucial habitat for elephants, and elephants used to cross this highway during the evening hours all year round, although their movement was more frequent during the late summer and monsoon seasons. On an average 19,440 vehicles, which includes trucks, bus, jeeps, car and motor cycle, used this highway per day (except for a 3 h period from 00:00 hour am to 03:00 hour) during the royal bathe days of the Maha Kumbh 2010 festival and the vehicle-traffic pressure was almost same the nocturnal period as was during day hours and so formed a significant barrier.

Haridwar – Dehradun National Highway No. 72.— This highway runs parallel to the Haridwar – Dehradun railway track up to the Gular Parao forest (Satyanarayan area) and divides the Chilla and Motichur Forests of the RNP, which is an important corridor for the elephants' movement towards the CNP. About 9 km of this road (from the Motichur river to the

Raiwala area) dissects this crucial elephant crossing. Notably, herd movement was almost totally restricted in this area with only bull elephants being observed to cross the highway. The movement of elephants in this area was observed during the dry season and late winter. Approximately 26,400 vehicles (categories as above) used this highway per day during the Maha-Kumbh festival throughout the opening time (00:00 hour to 03:00 hour), and accordingly this highway impedes the movement of elephants in the Motichur – Kansrao – Barkot wildlife corridor where principally only solo bulls (occasionally groups) were known to cross the road and even then mainly only after dusk.

Haridwar–Chilla–Rishikesh Road.— In 1972-74, construction of the Chilla hydro-electric power channel and the road parallel to the channel divided the Chilla and Motichur Forests. About 17 km of this road runs across several internal corridors (Ghasiram shroath, Soni shroath, Binj shroath and Hazara shroath) that are used by elephants to access the River Ganges. Elephants used to stay in this forest, especially during the dry months, but with a remarkable 10,800 vehicles per day using this road during the Kumbh fair from 17:00 hour to 20: hour, the passage of elephants was not observed and so seriously restricted or prevented.

Gohri–Swargashram–Neelkanth Road.— This road runs across the Gohri Forest in the RNP, and dissects an 8 km forest stretch (from Gohri Forest check post to the Chaurani gad area in the Laxman Jhula north forest and up to the Kumbhi chaur area, Laxman Jhula south forest) that is a crucial wildlife habitat and where the elephants' movement is maximum during the dry period, although their presence was noted all year round. On various bathe

occasions of the Kumbh, traffic flow along this track was an average of 8,400 vehicles a day (from 17:00 hour to 19:00 hour). Noticeably, the movement of tusked was observed to be higher compared to that for the group elephant movement.

Mansadevi by-pass Road.- The Mansadevi by-pass, which links Haridwar city with the Kharkhari and Motichur areas, was opened for tourists from dawn to dusk with some restrictions. This road is 5 km long and dissects the Haridwar forest (RNP), which is home to several threatened wild animals, such as the *Muntiacus muntjak* barking deer, *Axis axis* spotted deer, *Cervus unicolor* sambhar, *Panthera pardus* leopard and the elephant. Remarkably, no movement of animals was observed during the whole festival period, which may reflect that an average of 16,800 vehicles per day used this stretch of road from 17:00 hour to 19:00 hour during the fair.

DISCUSSION

Studies carried out on African and Asian elephants have indicated that human activities and changes in land use practices that modify the elephant landscapes adversely affect elephant populations, whilst these and human pressures influence the behavioral responses of elephants (Hoare and Du Toit, 1999; Kumar and Singh, 2010; Vidya and Thuppil, 2010). When anthropogenic activities affect the natural activities of animals then they perform typical behavioral responses associated with competing for their requirements. A study carried out on the population and individual elephant responses to a catastrophic fire in Pilanesberg National Park (South Africa), highlighted that elephants are stressed by

human-induced and natural disturbances, and that stressed animals alter their behaviour in an attempt to eliminate the stressor, including a decrease in daily displacement, shifts in their home range, social withdrawal, significantly higher stress levels and seclusion to non-tourist areas, that are predictable, adaptable responses to disturbance (Woolley et al., 2008). A profound behavioural change was reported in African elephants in response to the disturbance caused by poaching, and resulted in a reduced foraging ability of the elephants during the dry season and a reduced ability to undertake traditional seasonal migrations in response to rainfall and food availability (Ruggiero, 1990).

Traditionally, the impact of roads on wildlife has been viewed in terms of road mortality and threats to selected populations of animals. When viewed from a landscape ecology perspective, however, it is clear that highways have the potential to undermine ecological processes through the fragmentation of wildlife populations, restriction of wildlife movements, and the disruption of gene flow and meta-population dynamics (Jackson and Griffin, 2000). The direct ecological effects, such as flattened fauna are easy to see. In contrast, many indirect effects of roads are cumulative and involve changes in community structure and ecological processes that are not well understood (Noss, 2002) and may not be manifested until another stress is induced. The fragmentation effects of roads results when animals within populations are unable to approach or cross roads and so fail to connect to different habitats, access mates or meet other biological requirements (Clevenger and Kociolek, 2006). Developmental projects, mainly rail lines, roads, canals, industrial establishments, and the encroachment by human habitations, are

responsible for the fragmentation of habitat and blockade of migratory routes for elephants in the RNP (Singh and Sharma, 2001).

Highways can negatively affect wildlife by creating barriers in their habitat that leads to fragmentation of populations. Small mammal populations separated by highways may be partially or completely isolated from one another due to low dispersal capabilities, low probability of surviving highway crossing attempts and avoidance of areas adjacent to highways (Conrey and Mills, 2001). Fragmentation of mega-herbivore populations can restrict the frequent movement of individuals within their traditional home range and can separate different crucial habitats and break up the animal's population into smaller groups. In such conditions demographic and genetic consequences could affect their subsequent movement and persistence.

It was noted during long-term field observations on the elephants' behavior that bull elephants are now changing their tendency to utilize these traffic laden highways in that they now not only use these roads to access the other forest fragments or the River Ganges and to enter the farm lands, and that this occurs most markedly during dusk and dawn. Typically, they used to arrive in the forest adjoining to roads in afternoon hours (near to 14:00 h) and stayed there to almost dusk (16:00 h) and thereafter start crossing the highway in groups. However, in case of crop raiding they observed to be getting habituated and used to face heavy traffic. Currently, it was observed on several occasions that when bull elephants (especially older bulls) were crossing the road they didn't have any fear of the traffic present there. Sometimes they spent a few minutes standing on the road facing the traffic and on several occasions

they performed mock charges to threaten the crowd standing there.

The negative effect of motorized traffic was observed on the behaviour of the various deer species (white tailed deer, elk, moose, mule deer and bighorn sheep) in the Mountain protected area, where the deer were observed to use alternative habitats away from the areas that were disturbed by the high traffic volume and human activities, especially during weekends compared to weekdays (Pelletier, 2006). A study carried out on the impact of road and train networks in the Jasper National Park in Canada revealed that collision rates were influenced by, and influenced changes in, the wildlife behavior and these changes depended on the species, but migration to winter ranges adjacent to transportation corridors were the main influence on collision rates (Bertwistle, 2001).

The area around the RNP has a number of natural attractions, which have a high potential for eco-tourism and the presence of rich flora and fauna and unique topography further ensures the feasibility of the area for tourism. Elephants are one of the key attractions for tourists here, especially when the park remains open for tourists. The Jhilmil Jheel Conservation Reserve (Swamp deer's habitat) in HFD, Rishikesh city, Dehradun city, Neelkanth temple, world famous Gayatri teerth Shantikunj, Har ki Pauri in Haridwar, Mussoorie Wildlife Sanctuary, Patanjali Yogpeeth/Vishwavidhyalaya of Yog Guru Swami Baba Ramdev, Mansadevi temple inside the RNP area, Chandi-devi temple inside the HFD, Daksh Mahadev temple and Sati Kund are some of the main places of tourist interest. More than 600,000 to 700,000 people visit the Mansadevi temples every year, whilst the other temples receive more than 50,000 people annually. Large

crowds of people were present, especially on the occasion of Shivratri and Sawan Purnima fairs. More than 4 million people visited Haridwar during the Sawan Purnima and Kaanwar Mela occasions (Sawan Purnima fair) during 2008, which falls in the months of July and August every year.

The Haridwar–Dehradun and Haridwar–Bijnor national highways, which are located between these reserve forests, the Chilla hydro-electric power channel/plant, the Raiwala area, Army dump, Khand village, and the Satyanarayan area, are some of the key obstructions that now restrict the elephants' movement in their traditional corridors. Similarly, villages that are situated parallel to the Laldhang–Kotdwar forest track (Laldhang, Sigaddi, Nalgaddi, Papidanda, Kham, Chillarkhal, Mandevpur and Kishanpur), Kotdwar–Lansdowne road (15 km long) and Kotdwar–Kalagarh forest road (24 km long) are all other important barriers that impede the frequent movement of elephants within the RNP–CNP.

Although elephants used to regularly migrate in the Gohri, Chilla, Laldhang, Kotdwar, Shyampur, Chiriapur, Dogadda and Sonanadi forests, now group movement is rare and is found as isolated instances in both the RNP and the CNP areas as both these protected areas are disconnected, mainly due to huge amount of anthropogenic and developmental activities. Although bull elephants were observed crossing the Kotdwar–Lansdowne road group movements were almost completely non-existent in this area. Group movement of elephants was observed from the Gohri and Chilla forests of the RNP to the Dogadda forest of the LFD, which is a well connected zone, but the steep terrain and heavy vehicle flow on the Kotdwar–Lansdowne road prevents the elephants from crossing the road and moving towards

the Corbett Tiger Reserve. Only bull elephants regularly make the attempt to cross the road, and so have the chance to move across the Sonanadi Wildlife Sanctuary and Kalagarh Tiger Reserve forests.

A number of wildlife habitats have already undergone, or are being threatened with, fragmentation due to various anthropogenic factors and this has adversely affected the large mammal populations residing in them (Johnsingh et al., 1990). The movement of elephants has been restricted across the RNP–CNP corridor by the Kotdwar–Lansdowne road parallel to the River Koh as with its steep edges and walls built to prevent landslides, as well as the heavy traffic using the road, serve to impede elephants from crossing it and so this hilly corridor is only used by some bulls. Some herds, especially those in the eastern and western regions of Corbett Tiger Reserve, showed distinct seasonal movements, whilst others, such as the elephants in the Kalagarh region, show little seasonal movement (Sunderraj et al., 1995; Singh, 1969). The elephants' movement in the SER was drastically effected in the recent past primarily due to the increasing road network across the different elephant habitats and the anthropogenic disturbances in traditional corridors (Joshi et al., 2010).

CONCLUSION

In the last decade the landscape of and around the Haridwar district has undergone a drastic change, primarily due to the rapid increase in the human population and industrialization as well as seasonal influxes into the area. As this is a holy place and the River Ganges, a symbol of religious belief, flows across this area then huge crowds can

be seen on different occasions all year round. As some parts of the RNP and HFD are bounded by cities in all directions and several roads run across this landscape, some key corridors have been detrimentally affected. Moreover, the increasing rate of vehicle traffic has divided the various habitats and disrupted wildlife movement between them. Long migratory journeys of elephants in this region are now completely prevented because of the habitat fragmentation and establishment of human settlements and agriculture lands between the remaining elephant habitats and ranges leaving them presently pocketed in smaller forested habitats. For fulfilling their biological requirements, elephants were found to perform erratic movements and responses. Understanding these could be helpful in proposing conservation actions and in taking initiatives. In the future, the continuing worldwide increase in the human population and, therefore, dependency of people on local forest resources will be increased and anthropogenic disturbance will inevitably increase. More field oriented studies addressing the impact of anthropogenic and developmental activities on wide ranging elephants are needed to address the acute changes in the elephants' behaviour. It is, therefore, appropriate to develop a scientific based protocol for conducting in depth analysis of these ecological impacts. Managers of protected areas must address the impacts of human activities by looking at the effects of those activities on the animal populations and behaviour.

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LITERATURE CITED

- Bertwistle, J. 2001. Description and analysis of vehicle and train collisions with wildlife in Jasper National Park, Alberta Canada, 1951-1999. In: Irwin, C.L., Garrett, P. and McDermott, K.P. (Eds). Ecology and transportation, Centre for Transportation and the Environment, North Carolina State University, Raleigh, NC, 433-434.
- Burson III, S.L., Belant, J.L., Fortier, K.A. and Tomkiewicz III, W.C. 2000. The effect of vehicle traffic on wildlife in Denali National Park. *Arctic*, 53(2): 146-151.
- Chapin III, F.S., Zavaleta, E.S., Eviner, V.T., Naylor, R.L., Vitousek, P.M., Reynolds, H.L., Hooper, D.U., Lavelle, S., Sala, O.E., Hobbie, S.E., Mack, M.C. and Diaz, S. 2000. Consequences of changing biodiversity. *Nature*, 405: 234-242.
- Clevenger, A.P., Kociolek, A.V. 2006. Highway median impacts on wildlife movement and mortality: State of the practice survey and gap analysis. Technical Report, California Department of Transportation, Sacramento, California, 118.
- Conrey, R.C.Y. and Mills, L.S. 2001. Do highways fragment small mammal populations? In: Irwin, C.L., Garrett, P. and McDermott, K.P. (Eds). Ecology and transportation, Centre for Transportation and the Environment, North Carolina State University, Raleigh, NC, 448-457.

- Hoare, R.E. and Du Toit, J.T. 1999. Coexistence between people and elephants in African Savannas. *Conservation Biology*, 13(3): 633-639.
- Jackson, S.D., Griffin, C.R. 2000. A strategy for mitigating highway impacts on wildlife, In: Messmer, T.A. and West, B. (Eds.). *Wildlife and highways: Seeking solutions to an ecological and socio-economic dilemma*, The Wildlife Society, 143-159.
- Johnsingh, A.J.T., Narendra, P. and Goyal, S.P. 1990. Conservation status of the Chilla-Motichur corridor for elephant movement in Rajaji-Corbett National Park area. *Biological Conservation*, 52: 125-138.
- Johnsingh, A.J.T. and Williams, A.C. 1999. Elephant corridors in India: lessons for other elephant range countries. *Oryx*, 33(3): 210-214.
- Joshi, R. and Singh, R. 2007. Asian Elephants are losing their seasonal traditional movement tracks: A decade study in and around the Rajaji National Park, India. *Gajah*, 27: 15-26.
- Joshi, R., Singh, R., Dixit, A., Agarwal, R., Negi, M. S., Pandey, N., Pushola, R. and Rawat, S. 2010. Is isolation of protected habitats the prime conservation concern for endangered Asian elephants in Shivalik landscape? *Global Journal of Environmental Research*, 4(2): 113-126.
- Kumar, M.A. and Singh, M. 2010. Behaviour of Asian elephant (*Elephas maximus*) in a land-use mosaic: implications for human-elephant coexistence in the Anamalai hills, India. *Wildlife Biology in Practice*, 6(2): 69-80.
- Noss, R. 2002. The Ecological effects of roads. Technical Report, Dead Trees EF!, c/o 6 Tilbury Place, Brighton, BN2 2GY, UK. <http://www.eco-action.org>, downloaded on 9th February, 2012.
- Pelletier, F. 2006. Effects of tourist activities on ungulate behaviour in a mountain protected area. *Journal of Mountain Ecology*, 8: 15-19.
- Ruggiero, R. 1990. The effects of poaching on elephant behaviour. *Pachyderm*, 13: 42-44.
- Singh, V.B. 1969. The elephant (*Elephas maximus* Linn.) in Uttar Pradesh India. *Journal of the Bombay Natural History Society*, 66(2): 239-250.
- Singh, A.P. and Sharma, R.C. 2001. Conflicts between linear developments and Asian elephants in sub-Himalayan zone of Uttaranchal, India. In: Irwin, C.L., Garrett, P. and McDermott, K.P. (Eds). *Ecology and transportation*, Centre for Transportation and the Environment, North Carolina State University, Raleigh, NC, 423-432.
- Singh, M. and Kaumanns, W. 2005. Behavioural studies: a necessity for wildlife management. *Current Science*, 89(7): 1230-1236.
- Steidl, R.J. and Powell, B.F. 2006. Assessing the effects of human activities on wildlife. *The George Wright Forum*, 23(2): 50-58.
- Sunderraj, S.F.W., Mishra, B.K. and Johnsingh, A.J.T. 1995. Elephant use of the Rajaji-Corbett forest corridor, north west India. In: Daniel, J.C. and Datye, H.S. (Eds). *A week with elephants*, Bombay Natural History Society, Mumbai, India, Oxford University Press, pp. 261-269.
- Vidya, T.N.C. and Thuppil, V. 2010. Immediate behavioural responses of humans and Asian elephants in the context of road traffic in southern India. *Biological Conservation*, 143(8): 1891-1900.
- Woolley, L.A., Millspaugh, J.J., Woods, R.J., Rensburg, S.J.V., Mackey, R.L., Page, B. and Slotow, R. 2008. Population and individual elephant response to a catastrophic fire in Pilanesberg National Park. *PLoS ONE*, 3(9): e3233 1-10.
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