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Case Study

Train–elephant collisions in a biodiversity-rich landscape: a case study from Rajaji National Park, north India

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Abstract: Linear developments like railways and highways have a negative impact on ecological processes of wildlife species at a landscape level. The impacts in terms of wildlife mortality and threat to surviving populations of species have been well-studied; however, less work has been done to understand the potential causes of train–wildlife collisions, particularly large mega-fauna such as Asian elephants (*Elephas maximus*; elephant). In this case study, we review train–elephant collisions (TECs) that occurred in Rajaji National Park (RNP) and discuss some potential causes of TECs along with mitigation measures. The RNP, located in the upper Gangetic plains of northern India, has been an elephant conservation stronghold. However, 25 elephants have been killed from 1987–2018 in TECs along 18 km of the Haridwar-Dehradun railway track, which connects the RNP with the Corbett Tiger Reserve. Most of the collisions occurred during night and in summer months. Preliminary observations suggest that the social bonds among the groups of elephants and their relatively large home ranges, coupled with the speed of the trains and sharp turning radius, appear to be related to the collisions. Based on this information, mitigation measures should include reducing the speed of the train in high-risk areas and periods as well as habitat modifications such as developing recharging natural water sources. These measures could be coordinated with railway managers and wildlife officials. Scientific studies and related outreach programs that increase awareness among local communities and railway managers about the causes, impacts, and measures could also be organized to minimize negative human–elephant interactions.

Key words: Asian elephant, behavior, *Elephas maximus*, human–wildlife conflicts, India, Rajaji National Park, species conservation, train–elephant collisions

In India, linear developments such as roads, railway tracks, and power lines are expanding rapidly, which is negatively affecting the contiguous large habitats and landscapes, annual home ranges of wildlife. Specifically, the development and operation of railway infrastructures in India has increased the frequency of wildlife–train collisions (Borda-de-Água et al. 2017*a*). Little is known about the specific impacts of railways on wildlife compared to other transportation systems (Bennett et al. 2011, Borda-de-Água et al. 2017*b*, Santos et al. 2017). Studies of wildlife mortality and associated behavioral responses to habitat loss and fragmentation from railway systems in India are scarce (Barrientos and Borda-de-Água 2017, Santos et al. 2017). We believe there is a critical need to assess wildlife responses to railway lines, especially to understand the causes of collisions and address reduction strategies and long-term conservation of species such as the Asian elephant (*Elephas maximus*; Roy and Sukumar 2017). Such linear developments may also cause the segregation of elephant populations, resulting in changes in their social behavior.

Asian elephants tend to be the most noticeable because they are considered a national heritage animal and a flagship species of Indian forests (Venkataraman et al. 2002). Historically, the elephant populations of north India used to migrate across the Yamuna and Brahmaputra rivers in the foothills of the Himalayas, traveling a maximum distance of about 1,300 km annually (Singh 2001). The northwestern elephant population in India once had a continuous range (most likely before the 1970s), from Katerniaghat Wildlife

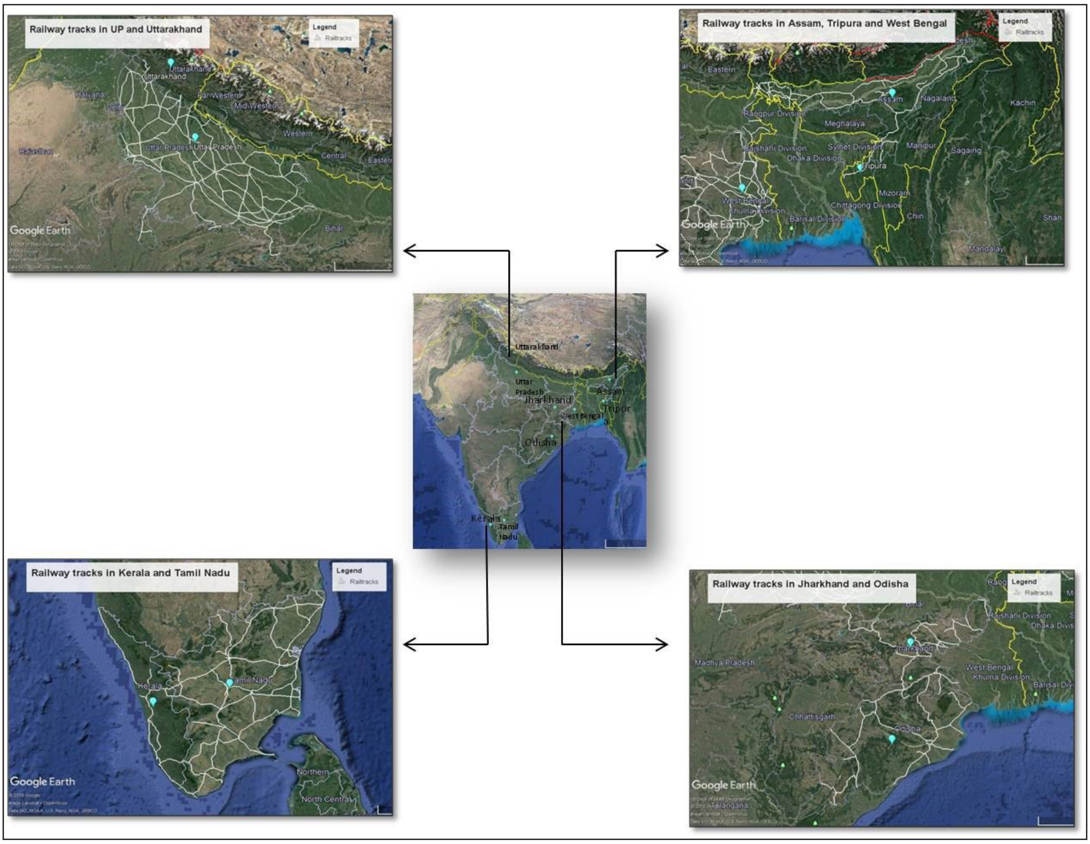

Figure 1. Map of India, indicating states (n = 9) and railway tracks and rivers.

Sanctuary in the east to the Yamuna river in the west (Johnsingh et al. 2006). However, over time, human population growth and the resulting development has fragmented their habitats, and now the northwestern population survives in 6 isolated sub-populations, creating a non-continuous distribution in the northern, eastern, and southern forest ranges of India (Singh 1978, Johnsingh et al. 2006, Joshi and Singh 2009).

Although elephants require large landscapes for movement, feeding, and breeding, Joshi (2017) reported that the elephants have demonstrated an ability to adapt to environmental changes. Some of the environmental changes include conversion of agricultural lands to industrial areas adjacent to forests, expansion of national highways, disconnectivity of migratory corridors, and undesired human–elephant interactions in the forests.

Of the total reported mortality of 388 elephants in India between the years 2010 and 2015, 79 (20.4%) were the result of collisions with trains (World Wildlife Fund-India 2017). Since 1987, India has documented the loss of 150 elephants in train–elephant collisions (TECs), of which 36% were recorded from Assam, 26% from West Bengal, 14% from Uttarakhand, 10% from Jharkhand, 6% from Tamil Nadu, and 3% from Uttar Pradesh and Kerala, respectively, and 2% from Orissa (Rangarajan et al. 2010).

The East Central, East Coast, Northern, Northeast Frontier, South Eastern, and South Western railways in India traverse across about 30 protected areas located in the state of Assam, Jharkhand, Kerala, Odisha, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand, and West Bengal (Figure 1). Among these 6 railways, the Northeast Frontier is at higher risk for the accidental deaths of elephants. Of the 88 identified elephant corridors in India (27 of Priority I and 61 of Priority II), 40 have national highways running through them, 21 have railway tracks, and 18 have both, creating high potential for TECs (Open Magazine 2013). Roy and Sukumar (2017) reported that >200

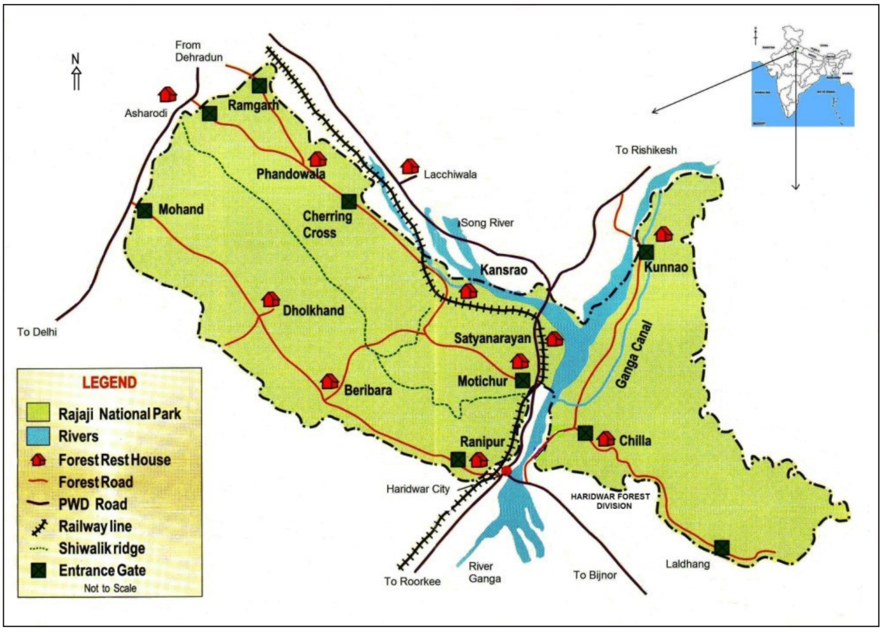

Figure 2. Map of the Rajaji National Park, Uttarakhand, India, indicating the location of the Haridwar-Dehradun railway track and perennial rivers.

Figure 3. A family group of elephants (*Elephas maximus*) crossing the Haridwar-Dehradun railway track at Kansrao forest of the Rajaji National Park, north India, May 13, 2018.

elephants were killed in TECs between 1987 and 2015.

In this case study, we identify the factors contributing to increasing TECs in Rajaji National Park (RNP). The RNP, located in the upper Gangetic plains of northern India (Rodgers et al. 2002), has been an elephant conservation stronghold. We also identify research needs and mitigation measures that could be implemented on a broader scale to mitigate TECs and enhance elephant conservation in the RNP.

Study area

The RNP (29°15′–30°31′N 77°52′–78°22′E, 302–1000 m; Figure 2) is among the crucial wildlife habitats in the northwestern Shivalik landscape, forming the northwestern limit of the range of elephants in India. A major portion of the area is dominated by tropical moist and dry deciduous forest (Champion and Seth 1968). The RNP has 3 distinct seasons: the winter with frost from October to mid-March, the summer with average temperatures of 40–44º C from mid-March to mid-June, and the monsoon season with average temperatures of 25–30º C from mid-June to September. The majority of rainfall (average annual rainfall is 2,000 mm) occurs during the monsoon season, from mid-June to September, when humidity is very high, though some winter rains are also known to occur (Environmental Information System of India 1998). To manage a viable population of the Asian elephants in their natural habitat, the RNP has also been designated as a reserved area for "Project Elephant" by the Ministry of Environment, Forest and Climate Change (2015). Four crucial wildlife corridors exist across the RNP, which connect it with the Corbett Tiger Reserve, namely Motichur–Kansrao–Barkot (2.5 km long x 2 km wide), Chilla–Motichur (3.5 km long x 1 km wide),

Figure 4. Overview of a part of Haridwar forest range in Rajaji National Park, north India, showing the Haridwar-Dehradun railway track and Haridwar City, December 27, 2006.

Rawasan–Sonanadi (10 km long x 5 km wide), and Motichur–Gohri (4 km long x 1 km wide; Joshi 2017).

Four stretches of the Haridwar and Dehradun railway line in the RNP have the highest number of observations of elephant crossing (Joshi and Joshi 2000, Singh et al. 2001; Figure 3). According to a recently published report, these 4 stretches are most susceptible to TECs in the Haridwar-Dehradun railway track (World Wildlife Fund-India 2017).

An 18-km-long railway track from Motichur to Kansrao railway stations in Haridwar-Dehradun railway track traverses the RNP (Figures 2 and 4).

Results and observations

TEC mortalities in the RNP

Between 1987 and 2018, 25 elephants were reported to have been killed in TECs on the Haridwar-Dehradun railway track that traverses the RNP. Most of the TECs occurred between 1930 hours and 0230 hours (n = 17) most likely because elephant activity peaks at night. However, 2 mortalities occurred during dawn, between 0400 hours and 0500 hours, and 5 mortalities occurred during daytime, between 0500 hours and 1800 hours. The highest rate of deaths (88%), which occurred during night hours, were of the elephants in a group; however, deaths that occurred during daytime hours (12%) were of solitary male elephants. It was observed that elephant mortalities were greater in the Haridwar and Motichur forests of the RNP, respectively (n = 9), followed by Kansrao forest (n = 7). Of the total elephant mortalities, 16 were adult or subadult animals, whereas 9 were juveniles or calves. Further, it was noted that female elephants were involved in TECs more commonly than male elephants (Table 1). Notably, between the years 2003 and 2012, the number of reported TEC mortalities declined. This was largely due to measures implemented by the state forest department and other organizations working to address the problem of elephant mortality. Warning train drivers about the movement of elephants near the railway track through wireless headsets was among the most effective steps (Singh et al. 2001).

TEC factors

There are several factors that have cumulatively contributed to TECs in India. These include: (1) railways bisecting traditional elephant movement corridors, (2) train operational changes, (3) railroad and elephant habitat proximity, (4) elephant social bonds and behavior, and (5) increasing agriculture and human activities.

Railways bisecting traditional elephant movement corridors

The railway track from Haridwar to Dehradun is within the Motichur-Chilla wildlife corridor, which connects the RNP with Corbett Tiger Reserve. This is one of the traditional corridors for elephant movements from the eastern to the southwestern portion of the Reserve (Joshi and Singh 2007, Joshi 2017). Before 2000, a few elephant groups were recorded in this corridor. Thereafter, their movements were restricted, mainly because of increased traffic on Haridwar-Dehradun railway track, the expansion of 2 national highways (Haridwar-Dehradun and Haridwar-Bijnor), the expansion of human settlements, and the proximity of an army dump to the park's boundaries (Joshi and Singh 2007, Joshi 2017).

Train operations and TECs

Increased train speed is believed to be a major factor contributing to TECs and death of elephants (Bindra 2011, The Tribune 2016, Wildlife Trust of India 2017). In most of the cases where TECs were reported, the speed of the trains was estimated at >50 kph (Joshi and Joshi 2000, Singh et al. 2001). Haridwar

Table 1. Forest ranges where elephant (*Elephas maximus*) mortalities have been documented in train collision, date, time, sex, and age of elephant, between the years 1987 and 2018, Rajaji National Park, north India. Source: Rajaji National Park office, director; self-observations.

S. No.	Forest range	Date	Time	Sex and age of elephant
1	Motichur	April 28, 1987	2200 hours	Female, 13 years
2	Motichur	March 16, 1988	0220 hours	Female, 30 years
3	Kansrao	February 24, 1989	2045 hours	Male, 4 years
4	Motichur	January 1, 1992	1730 hours	Female, 80 years
5	Haridwar	May 2, 1992	0210 hours	Female, 45 years
6	Haridwar	May 2, 1992	0210 hours	Male, 4 years
7	Haridwar	May 4, 1992	0210 hours	Female, 45 years
8	Motichur	November 22, 1992	2200 hours	Female, 35 years
9	Kansrao	May 10, 1994	2040 hours	Male, 8 years
10	Motichur	May 17, 1994	1950 hours	Male, 55 years
11	Kansrao	September 28, 1998	1950 hours	Female, 1 year
12	Kansrao	September 28, 1998	1950 hours	Female, 40 years
13	Kansrao	September 29, 1998	1950 hours	Female, 8 years
14	Motichur	April 3, 1999	2230 hours	Female, 30 years
15	Haridwar	May 2, 2000	2140 hours	Female, 18 years
16	Motichur	June 4, 2000	2210 hours	Male, 10 years
17	Haridwar	May 29, 2001	2230 hours	Female, 18 years
18	Haridwar	January 25, 2002	0515 hours	Female, 3 years
19	Haridwar	March 12, 2002	not known	Male, 3 years
20	Haridwar	January 13, 2013	0530 hours	Female, 15 years
21	Haridwar	January 13, 2013	0530 hours	Female, 18 years
22	Motichur	October 15, 2016	0530 hours	Male, 20 years
23	Kansrao	February 17, 2018	0430 hours	Male, 4 years
24	Kansrao	March 20, 2018	0500 hours	Female, 5 years
25	Motichur	June 26, 2018	1200 hours	Female, 35 years

railway station is located at an altitude of ~294 m, whereas Dehradun railway station is located at an altitude of ~637 m, which induces the train driver to move the train quickly toward Dehradun from Haridwar. Similarly, the trains that move toward Haridwar from Dehradun tend to travel faster because of elevation gradient and downhill track (~40–50 kph).

This has remained a contentious issue between railways and forest authorities specifically because it has been shown that slowing the train to 30–35 kph can facilitate a stop prior to a collision. In 2015, the Standing Committee of the National Board for Wildlife recommended restriction of the train's speed up to 35 kph during night and 40 kph during daytime (Ministry of Environment, Forest and Climate Change 2015). Joshi and Joshi (2000) and Singh et al. (2001) reported in some of the TEC cases, where the speed of the train was found beyond the prescribed limit, coaches of the train were derailed (Figure 5).

Grilo et al. (2011) measured the functional connectivity of the landscape in southern Portugal and its relation to stone marten (*Martes foina*) road mortality. They reported that the large number of alternative crossing structures coupled with relatively low traffic volumes suggests a lower mortality risk, but curved roads with shorter visibility sight lines suggests an increased risk of road-related mortality.

Figure 5. An adult female elephant (*Elephas maximus*) badly crushed by a speeding train in Rajaji National Park, north India, May 2, 2000.

Figure 6. An adult female elephant (*Elephas maximus*) died in Haridwar forest range of the Rajaji National Park, north India, while crossing a narrow path along the Haridwar-Dehradun railway track, May 29, 2001.

Figure 7. A male elephant (*Elephas maximus*) struggling to stand after being hit by a train in Motichur forest of the Rajaji National Park, north India, October 15, 2016.

The railway track from Motichur to Kansrao railway stations includes 10 sharp curves, which limits the visibility of train drivers to see elephants on the tracks from an adequate distance (at least 200–300 m before), especially at night. Further, this depends on weather conditions; during summer, visibility was found clear (up to about 500 m). However, during winter, visibility can be poor because of the dense fog (<100 m).

Most of the reported TECs occurred at night, when the train was speeding and neared the group, unable to stop suddenly upon approaching the animals. In addition, elephants are not able to approximate object distance at night, and the sudden reflection of high beam engine lights over the elephant causes disorientation among the elephant group.

Exacerbating the poor visibility are small dirt mounds on both the sides of the track (about 80–100 m long and 5 m elevated). While crossing the track, elephants walk along the short measured track for a while to reach the wide path, which leads downward after these mounds. Due to the height and steepness of the mounds, elephants cannot climb over the high mounds on 1 side of the track. In 2001, an adult female elephant was hit and killed by a train after being flanked between the embankments (Figure 6). As she ran along the track to escape the embankment, the train, which was traveling at a high speed, was unable to stop in time.

Railroad and elephant habitat proximity

Elephants need several water reservoirs as well as large ranges to move and feed in the ecosystems where they live (R. Joshi, personal observation). Although there are several natural water sources near the Haridwar-Dehradun railway track, the Song and Suswa rivers are 2 perennial water sources that support wild animals year-round in the RNP. These rivers flow through the Motichur and Kansrao forests of the RNP. The Song River flows parallel to the Haridwar-Dehradun railway track for 1.5 km. Most of the TECs occurred during summer months when natural water sources inside the park dwindled and the elephants started moving toward the Song and Suswa rivers (Figures 2 and 7). Both sides of the railway track fall under the park area, which has herbaceous

plant species highly palatable to elephants. Food plant species like *Mallotusphillipinensis* (kamala), *Ehretialaevis* (chamror), *Brideliaretusa* (ekdana), *Senegalia catechu* (khair), *Desmodiumoojeinense* (sandan), *Lanneacoromandelica* (jhingan), and *Tinosporamalabarica* (giloe) are abundant along the railway track. It has been observed that presence of mixed forest along the railway track attracts elephants to move across the track (R. Joshi, personal observation).

Elephant social bonds and behavior

Elephants are highly social animals and live in a matriarchal society where the oldest female usually leads the group (Joshi 2019). In contrast, male elephants prefer to lead a solitary life, especially after the pubertal stage (an age of about 15 years). Male elephants are known to use a wide range of habitats and travel farther distances compared to the family groups (Joshi 2019). It has been observed that the strong social bond among the group is a contributing cause of TECs (R. Joshi, personal observation). Adult and subadult female elephants and calves have the highest reported rate of mortalities (~92%). It has been observed that loud train horns and disorientating train lights cause panic among the group of elephants (R. Joshi, personal observation). When encountering train disturbances the calves and juveniles present within the group scatter in confusion. This often divides the groups on both sides of the track, which can result in collisions with the train.

Singh (2001) suggested that a sudden encounter with trains causes matriarchs to feel threatened and to protect the infants, often attacking the train with fatal consequences. Because the movement of pregnant elephants is generally slower, their chances of collision with train may be higher. In southern India, 2 elephants were killed while trying to save one of their companions. During the incident, a female elephant from the group, who was pregnant, got frightened due to the sudden approach of the train and was not able to cross the track. The 2 elephants that had crossed the track turned back to help their companion, which resulted in the deaths of all 3 elephants (Chowdhury 2018). However, a study carried out in northeast India has revealed that male elephants were much more prone to the TECs in that region (Roy and Sukumar 2017).

Increasing agriculture and human activities

Nine villages are located along the northern axis of the park, which grow cash crops like wheat (*Triticum* spp.), paddy (*Oryza* spp.), and sugarcane (*Saccharum* spp.) as part of their livelihood. This stretch of villages lies across the Motichur-Kansrao-Barkot wildlife corridor, which connects the RNP with Dehradun and Narendranagar forest divisions.

The presence of palatable crops between the corridor and along the Song River has also been implicated as a cause for elephant use of the railway track (R. Joshi, personal observation). Some of the villages, which are situated across the boundary of the park, have the largest area under sugarcane and paddy cultivation. Interestingly, the congregation of elephant groups also takes place during the same period toward the crop fields by crossing the railway track (Singh et al. 2001). Expanding human settlements, cultivation near forest areas, and construction of 4-lane flyover in between the park area is exacerbating the human–elephant conflict. In the southwestern ridge of the RNP, such conflict situations are being experienced in some of the villages.

Discussion

TEC mitigation and research

To mitigate TECs, railway authorities implemented new mitigation measures, which included flattening of steep mounds adjoining the tracks to facilitate elephants escaping oncoming trains, clearing of vegetation at animal crossings for better visibility, and sensitizing the train drivers about animal movement. Joint patrolling of railway tracks at night (since 2001), especially in the summer months by the staff of the Forest Department and Wildlife Trust of India (WTI), has increased the information regarding elephant seasonal movement. This information and the ability to warn the train drivers through walkie-talkies (wireless phone sets), has decreased the number of deaths of elephants. Periodic workshops organized by WTI in cooperation with RNP authorities for train drivers, guards, and frontline staff of the wildlife department have also mitigated TECs.

The Parliamentary Standing Committee on Railways of India meets periodically to discuss TEC issues. A permanent coordination

committee has been constituted at the zonal railway level in the Ministry of Railway and the Ministry of Environment, Forest and Climate Change to monitor and review the measures taken to control incidences of elephant mortalities on railway tracks across the country. During 2007–2008, 2 elephant overpasses were proposed on the Haridwar-Dehradun national highway and railway track to facilitate the movement of elephants within Motichur-Chilla wildlife corridor. However, due to the high costs and undocumented risks of utilization of an elevated corridor by the elephants, the proposal was denied. While we agree with the measures being taken to reduce TECs in the RNP, we also suggest the need for additional management measures. The measures are presented below.

1. To reduced TEC mortalities, the locations along the railway track where elephants frequently travel must be identified and marked. Large signage could be placed to warn train drivers at these vulnerable points.
2. Adult female elephants could be radio-collared from identified groups to obtain real-time data on group location and movement near the railway track throughout the year. A proper census of elephants in the southwestern part of the park and movement of groups of elephants in Motichur and Kansrao forests would strengthen our efforts to control the deaths of elephants on railway tracks.
3. While more environmentally sound, the increased use of electric locomotives, which have no air and noise pollution, could potentially increase wildlife mortality because they are quieter and produce less ground vibrations than diesel locomotives. By restricting the speed of electric trains to 30–35 kph in the sensitive zones and mandating train whistles at each low-visibility turn, elephants could be alerted before the train gets too close and causes panic.
4. The mounds present along the track should be leveled. Similarly, vegetation along the railway track has to be cleared for better visibility and ability of train drivers to observe the presence of wildlife from a stoppable distance.
5. At least 10 artificial water reservoirs should be constructed along the southern axis of the track. These reservoirs have to be channelized with a natural water source and managed. Two water sources should be placed in Kansrao forest (in Koelpura and Bahera forests) so that elephants would no longer have to cross the tracks to reach water.
6. At certain spots along the railway line, underpasses large enough for elephant use are needed to avoid TECs. These will need to be managed regularly and researched for use and accessibility.
7. The schedules of night trains should be shifted to arrive approximately 30 minutes earlier at sensitive zones. These zones include Motichur-Kansrao, Raiwala, and Kansrao railway stations, where the highest rate of TECs occur. Implementing this schedule change would allow the train to move more slowly to Haridwar from Dehradun, decreasing TEC risks.
8. Raiwala, Doiwala, Motichur, and Kansrao railway stations should be equipped with high frequency radio headsets for warning the drivers about the presence of elephants. This tool has already proven to be effective in reducing TECs.
9. Training workshops should be organized for train drivers and frontline wildlife staff to teach about mitigation tactics for reducing TECs.
10. The provisions of the Indian Wildlife (Protection) Act, 1972, should be effectively implemented through the participatory approach, which would be helpful in monitoring elephant movement in remote areas of the park. Road and railway expansion planning should be carried out in such a manner that the wilderness of the protected area is maintained.
11. In the last 2 decades, the RNP has been experiencing a stable population of elephants, as the park has been considered as the favorable habitat for the elephants. As Lansdowne and Haridwar forest divisions are adjacent to the RNP, a habitat management plan based on landscape-level planning should be formulated to strengthen the movement

of elephants across Rajaji-Corbett Tiger Reserves. Further, the Rajaji-Corbett wildlife corridor should be restored to facilitate elephant movement across Rajaji-Corbett Tiger Reserves. The Chilla-Motichur and Rawasan-Sonanadi wildlife corridors should also be restored on a priority basis, avoiding anthropogenic and developmental activities.

12. In 2010, Animal Equality, an animal rights organization in Britain, suggested a campaign to install radar sensors in trains to prevent elephants from being hit by the trains. According to the organization, the device is effective in detecting the presence of elephants on railway tracks and activates a signal system that would alert the station master to warn train drivers to slow down or stop the train (Animal Equality 2012). Mathur et al. (2014) have put forward an approach based on wireless sensor networks. This approach aims to prevent elephant mortality due to trains and simultaneously to monitor the integrity of the railway track. It proposes the use of infrasonic sound for deterring the elephants from crossing the railway track. Similarly, some sensor-based technology is being developed by the Indian Institute of Technology and Indian Institute of Science to prevent the train and road accidental deaths of wild animals. The efficacy of such devices must be tested and if found useful, could be implemented.
13. Studies on the ecology and behavior of elephants are advisable to reinforce our management approaches and conservation of elephants. The few studies that have been published regarding wildlife mortality on railway tracks have focused primarily on a few large mammals, with no overall assessment of population impacts (Santos et al. 2017). There is no literature available that suggests that TECs have changed behavioral responses of elephants toward humans in protected areas having railway lines or other linear infrastructure. Research priority should be placed on studying the behavior of various groups of elephants that were involved in a TEC that resulted in mortality. This may provide new insights into how TECs affect animal behavior toward humans.
14. Last, research coordination between the RNP and railway authorities would be of paramount importance to minimize TECs and save our national heritage animal. For instance, Babinska-Werka et al. (2015) evaluated the effectiveness of acoustic devices (UOZ-1) to deter animals and reduce the risk of animal–train collisions in central Poland. Their research suggests that such devices are more effective at reducing the risk of animal–train collisions by prompting animals to leave the railway track faster and with great frequency.

Conclusions

Restricted access of elephants to Ganges River, disconnectivity of migratory corridors across Rajaji-Corbett National Parks, and biotic pressure inside the forests are among some of the reasons for increasing train–elephant conflict in north India. Haridwar-Dehradun railway track, which exists across the RNP, is one of the major hurdles, which is affecting the frequent movement of elephants within their home range. To decrease TECs, various mitigation measures should be considered, including reducing the speed of the train in high-risk areas, habitat modifications such as development of natural water sources and construction of corridors around railways. Further, conducting scientific studies and related outreach programs that increase awareness among local community and railway managers about the causes, impacts, and mitigation tools could decrease TECs. In particular, training should be provided to the train operators who frequently conduct trains in sensitive zones. Educating these operators on speed restriction and train whistle use could further mitigate TECs. Furthermore, restoration of large fragmented forest stretches and corridors for elephant migration and habitat management would provide elephants a wider corridor to move across the landscape. To aid in the conservation of elephants, it is imperative that scientific studies of elephant biology and movement be carried out on a long-term

basis. This would include restoring the Chilla-Motichur wildlife corridor, which will enable elephants to move across the RNP and Corbett Tiger Reserve. Finally, human population and anthropogenic disturbance studies would be of paramount importance to address the impact of developmental activities on the behavior of elephants.

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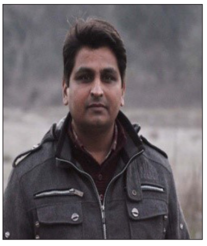

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