AN ASSESSMENT OF ELEPHANT MORTALITY DUE TO TRAIN HITS IN INDIA

SUBMITTED BY

WILDLIFE TRUST OF INDIA

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F-13, Sector 8, NOIDA –201 301, Uttar Pradesh.

Tel: +120 4143900 Email: info@wti.org.in Web: www.wti.org.in

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Project Investigator

Dr. Rahul Kaul

Project Teams

Dudhwa Tiger Reserve, Uttar Pradesh

Dr. Anil Kumar Singh

Dr. Prabal Sarkar

Subrat Kumar Behera

Tamil Nadu and Kerala

Dr. Anil Kumar Singh

S. Rathna Kumar

Dr. B. Ramakrishnan

Jharkhand

Dr. Anil Kumar Singh

West Bengal

Dr. Anil Kumar Singh

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DFO, Porhat, Shri. B.N. Singh, R.O., Goelkera Range, Porhat Forest Division, Shri. Noon Ram Manjhi, R.O. Chaibasa Range, Shri Manoj Gupta, R.O., Goelkera Range, Kolhan Forest Division, Shri. A.K Nayak, Forester, Goelkera Range, Kolhan Forest Division. Shri. Suresh Prasad, R.O. Saraikela Range. Porhat Forest Division, and Shri. Budhan Ram, Forest staff, Dhalbhum Forest Division were extremely helpful and supportive during field work. We acknowledge our sincere thanks to all of them.

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Executive Summary

In India, large numbers of wild species die annually due to accidents on rail tracks and highways. The impact of railways on wildlife is both direct and indirect as it causes a direct loss of habitat, degrades the habitat quality, fragments the habitat, isolate and reduces access to vital habitats. In areas where the railway network transgresses protected areas, the impact on the wildlife and its habitat is even more destructive.

Death and injury of endangered animals like elephants (*Elephas maximus*), tigers (*Panthera tigris*), leopards (*Panthera pardus*) and gaur (*Bos gaurus*) due to train hits has raised serious concern. Elephant deaths due to train accidents are a major issue and most cases have been recorded from Assam, West Bengal, Uttarakhand and Jharkhand, Tamil Nadu, Uttar Pradesh, Kerala, Orissa and Tripura.

With increasing expansion of railways, conversion of meter-gauge to broad-gauge and the construction of new tracks further have posed serious and imminent conservation threat to the many priority species and hence, must be addressed immediately.

Considering the magnitude of this problem, Wildlife Trust of India (WTI) initiated conservation actions in Rajaji National Park, Uttarakhand in collaboration with the Uttarakhand Forest Department and Northern Railways. The mitigation measures implemented jointly helped in reducing elephant mortality to zero since 2002. At the same time situation in other Indian states was worsening gradually. Based on the experience gained through the conservation actions in Uttarakhand, WTI initiated conservation actions in Assam with financial support from Elephant Family.

It was necessary to identify and address the problems in states with this problem so that site specific mitigation plans could be developed. In this regard WTI approached the Ministry of Environment and Forests (MoEF) for financial support to undertake the survey. From MoEF supported project we undertook surveys in accident prone sites of Tamil Nadu, Kerala, Uttar Pradesh, Jharkhand and West Bengal to identify the accident

prone areas, find possible factors responsible for accidents and suggest mitigation measures.

Methodology for the current study was multipronged. Firstly, literature and secondary information were collected from the Forest Departments about the mortality cases involving each species impacted by train hits. Secondly, formal interactions were held the forest officials and field staff of the Forest Department and thirdly, rigorous and extensive field surveys were carried out to study the impact of railway on wildlife.

Survey was conducted to understand the ecological influences (on both sides of the track) responsible for frequent elephant movements across the track. To identify the critical elephant movement areas, information was collected on encounter rate from direct sighting and elephant sign along the railway track. Information was collected on habitat and landscape attributes like water bodies, sharp turnings, and steep embankments along the track. The other contributing factor which increases the possibilities of train hits like speed and frequency of the trains and edible items along the track were also recorded.

Questionnaire survey were conducted for villagers, forest and railway staff to obtain information on elephant movements, seasonality, influences and factors responsible for elephant mortalities due to train hits.

From the results it is evident that other than elephant several endangered species like tiger, leopard, leopard cat, fishing cat, civet, sloth bear, hog deer and gaur are also killed due to train accidents. The figure of elephant mortality in these states especially in West Bengal, Tamil Nadu and Kerala is alarming.

Seasonal pattern of elephant mortality due to train accidents seems to coincide with the crop season in most of the areas. In the winter season accidents tend to happen because of reduced visibility due to presence of thick fog in some of the areas. In

addition to the habitat and corridors, water availability and crops in close vicinity to the track also influences elephant movement.

Several factors contribute to these accidents and the resultant animal mortality by train hits and these range from Physical factors (Curve of the railway track, Elevated track, visibility), Ecological factors (Presence of water along railway tracks, Crops and farmlands, Grasslands) as well as the frequency and speed of the train, which was found to be high in the night hours.

Our survey has identified critical accident prone and high elephant use areas along the railway track. Identification of these spots is expected to help in implementation of short and long term mitigation measures.

The state forest department and Indian Railway have taken several initiatives to minimize the problem. Railway has imposed a permanent speed restriction (30-45 Kmph) in accident prone areas of Dudhwa National Park, Uttar Pradesh, Kolhan Forest Division (between Manoharpur and Posotia), Jharkhand, between Walayar and Kanjikode section in Kerala and few areas of West Bengal and caution orders are being given to loco pilots in either direction to keep sharp look for animals and blow long whistle throughout these sections. Railway and Jharkhand Forest Department has installed 7 Km long fence made of discarded rail scraps on one side of the railway track in accident prone area between Manoharpur and Posotia to stop the movement of elephant on the track. The cost of fence has been jointly shared by the Railways and Forest Department, Similarly to restrict the elephant movement on the railway track, the Kerala and Tamil Nadu Forest Department has on its part fenced approximately 10 km of railway track between Walayar and Kanjikode and five Km near Podnaur respectively.

Other than these the Railways has put up elephant signage in critical areas along the railway track in Kerela, Tamil Nadu and Jharkhand. In Kerala and Tamil Nadu Railway has also put up small awareness signage for the passengers on the railway stations,

initiated announcement for the train passengers at Palakkad and Coimbatore railway stations and patrolling of the track by their gang man.

Such initiatives by Railway and Forest Department have helped in reducing the problem to some extent. But there is a need to undertake more comprehensive and firm steps to implement both short and long term mitigation measures jointly by the Indian Railway and Forest Departments. It is very important to implement long term mitigation measures in all these states which includes leveling of critical cuttings, fencing of some of the accident prone areas using discarded old rails, construction of underpasses using existing bridges or by elevating the track, installation of caution signage along the track, habitat improvement (improving water sources), improving visibility along the curve, improving lights of the locomotives and installing animal detection device on the track. At the same time it is also important to undertake short term mitigation measures like, providing speed limits, joint night patrolling, regular improvements of the visibility along the track, awareness activities for the loco pilots and train passengers etc till the long term measures are put into place. However, in the area like Dudhwa National Park, re alignment of the railway track outside the park area will be the only long term solution of this problem.

Contents

CHAPTER 1

Elephant Mortality Due to Train Accident India: An Approach to develop mitigation plan

1. Introduction

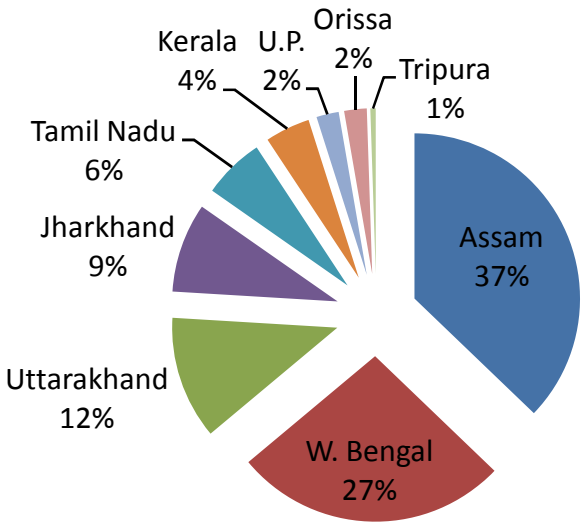
Railways and highways have been recorded to be major sources of wildlife mortality (Clevenger, 1997; Buckingham, 1997; Van der Grift 1999; Jackson, 1999), threatening wildlife populations throughout the world. These are a potential threat to the survival of several endangered species and affect their populations (Maehr *et al.,* 1991; Fisher, 1991; Rudolph *et al.,* 1999) in many ways like, acting as barriers to the wildlife movement (Gibeau and Heuer, 1996; Menon *et al.,* 2005), reducing access to the vital habitats (Jackson, 2000), disrupting their social activities (Gibeau, and Heuer, 1996) and creating population isolation (Reh and Seitz, 1990; Gibeau, and Heuer, 1996; Jackson, 2000). Railways and highways also cause direct loss of habitat, degradation of habitat quality and habitat fragmentation (Van, 1998).

Several ecological drivers have been identified as a source of wildlife mortalities on the railway and highways. Biologists studying road-related black bear mortality in Canada have concluded that the growth along highway and railway right-of-ways of plant species that are attractive to bears contributes significantly to this mortality (Munro 1999, Gibeau and Heuer 1996). In the Bow River Valley (Canada), grain spilled from rail cars have been found as the primary attractant on the railway track. Seven radio-collared bears in the Bow River Valley who came into contact with the rail line, were found feeding at one time or another on spilled grain (Gibeau and Heuer 1996). In Rajaji National Park (Uttarakhand), perennial water sources near the railway track and eatable wastes thrown by the train passengers were found as one of the major attractants for the wild animals (Singh *et al.,* 2001). Dussault *et al.* (2006) also noticed an increased rate of moose-vehicle accidents (by 80%) with moose density, in the presence of at least one brackish pool.

A seasonal pattern in wildlife mortalities due to railway and highways has been recorded by several researchers throughout the world. In Lauren-tides Wildlife Reserve, Quebec (Canada), Dussault *et al.,* (2006) recorded the highest number of moose-vehicle accidents between mid-May and late August. He also recorded that 65% of the railway mortalities occurred in May, a time when black bear use of railway and highway right-of-ways is greater than expected. Similarly in Rajaji National Park (Uttarakhand) elephant mortality due to train hits mostly took place during summer season between January and June (**Singh *et al*., 2001).**

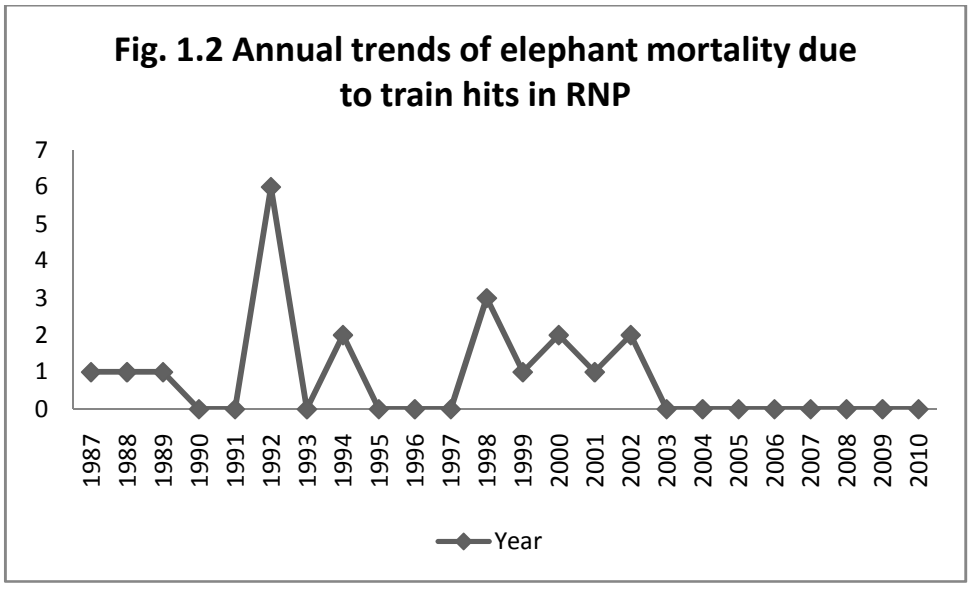
In India, a large number of wild animals are killed annually due to accidents on the railway tracks (Kumar, 1995; Johnsingh and Williams, 1999; Singh *et al.*, 2001). Mortality of endangered animals like elephants (*Elephas maximus*), tigers (*Panthera tigris*), leopards (*Panthera pardus*) and gaur (*Bos gaurus*) due to such causes has raised considerable concern. Elephant deaths due to train accidents are a major issue, as the country has lost 183 elephants due to train hits since 1987 (Fig 1.1). Majority (85%) of the cases have been recorded from Assam, West Bengal, Uttarakhand and Jharkhand. Rest (15%) cases have been reported from Tamil Nadu (6%), Uttar Pradesh (2%), Kerala (4%), Orissa (2%) and Tripura (1%).

Fig. 1.1 Elephant mortality due to train in India (1987- Jul 2011)



In a developing country like India, where expansion of railways and roadways is inevitable, such accidents pose an additional threat to elephant populations especially in the wake of already existing threats like large scale habitat degradation, loss of habitat quality, fragmentation, and conflict with humans. These accidents are also a major cause of worry for passenger safety and a drain on the resources of the Railways.

Considering the magnitude of this problem, Wildlife Trust of India (WTI) undertook a scientific study in Rajaji National Park (RNP), Uttarakhand, one of the hotspots in the country and later followed this up with implementation of mitigation measures in collaboration with the Uttarakhand Forest Department and Northern Railways. In Rajaji National Park, 20 elephants died in several train accidents between 1987 and 2002 on an 18 km long track that passes through the core area of Park. This was about 18 % of the total recorded elephant mortality in the Park during the same period. The mitigation measures jointly implemented in close association with the Forest Department and Railways helped in reducing elephant mortality to zero since 2002 (Fig 1.2).



Although these joint conservation actions in RNP solved this problem, the situation in other Indian states was worsening gradually. Anticipating further impacts of doubling of existing railway tracks, conversion of meter-gauge to broad-gauge and the construction of new tracks through prime elephant habitats

we envisaged that this could be a bigger problem for animals in future. The work in Rajaji demonstrated that it was possible to mitigate this problem by first understanding the issue, identifying the underlying causal factors and then managing these to lower the mortality.

Therefore, a proposal was submitted to the MoEF to survey critical areas prone to rail accidents and suggest measures of mitigation. The states where this work was undertaken were Tamil Nadu, Kerala, Uttar Pradesh, Jharkhand and West Bengal. Additionally, work has already been done by WTI in the states of Uttrakhand and Assam.

2. Objectives

The proposed project aims to suggest mitigation measures on the problem of elephant mortality due to train hits in India. The generic issues are similar for most areas but all sites also have unique specific problems which may be equally important to address. Following are the objectives of the project:

(1) To survey and identify the animal specifically elephant accident prone areas on rail tracks in the states of Tamilnadu, Kerala, West Bengal, Jharkhand and Uttar Pradesh.
(2) To identify possible factors responsible for the accidents.
(3) To suggest site specific mitigation measures.
(4) To look into and review new proposals by the Railways to lay tracks through wildlife habitats.

3. Methodology

Forest departments of the states of Tamil Nadu, Kerala, Jharkhand, West Bengal and Uttar Pradesh were visited and details of accident sites were taken. These sites were then visited physically and information was collected on critical areas prone to accidents, elephant movement zones along the railway tracks and factors responsible for accidents. Data was collected on ecological, technical and other important factors responsible for elephant mortalities due to train hits. Data collection was done at three levels, an initial field survey, a questionnaire surveys from villagers, forest staff and railway staff and literature surveys and collection of secondary information.

3.1 Literature surveys and collection of secondary information

This included collection of details of elephant mortality due to train hits, data on rainfall, waterholes, temperature etc. Information was collected from the Railway department on the frequency of passenger and goods trains and their time and speed in the identified stretches.

3.2 Field Survey

The frequent movement of elephants across the railway track makes them vulnerable to train hits. The reasons for elephants crossing rail tracks may be several - food, water, agriculture crops, movement corridors etc. There were also several other contributing factors like turnings, steep embankments, speed and frequency of the trains, edibles along the track etc. which increase to the possibilities of train hits.

Survey was conducted to understand the ecological influences on both sides of the track responsible for frequent elephant movements. To identify the elephant movement zones and critical areas, information were collected on encounter rate from sighting and elephant dung along the railway track. Habitat and landscape attributes like availability of water bodies along the track, sharp turnings, and steep embankments on the sides were recorded. Information was also collected on the average speed of the trains and unmanaged disposal of the edible waste and garbage thrown on the track in sensitive elephant habitats.

3.3 Questionnaire survey

In order to get information on elephant movements, seasonality and influences questionnaire survey were also conducted for villagers. Similarly, to know the reasons for elephant mortalities due to train hits, questionnaire survey were conducted for forest and railway staff.

Detail of methods adopted for each state are dealt in their respective chapters.

CHAPTER 2

Survey Report of Dudhwa Tiger Reserve

1. Introduction and Study area

The Dudhwa Tiger Reserve falls in central region of the Indian Portion of Terai Arc Landscape (TAL), (Johnsingh *et al.* 2004)) covering an area of 1362 km^2 in the state of Uttar Pradesh. The Tiger Reserve is comprised of three protected areas viz. Dudhwa National Park (490 km^2), Kishanpur Wildlife Sanctuary (204 km^2) and Katerniaghat Wildlife Sanctuary (400 km^2), along with buffer zones of around 298 km^2 of North Kheri and South Kheri Forest Divisions.

The Reserve has a very long history. In order to protect swamp deer population, an area of 64 km^2 was declared as Sonaripur Wildlife Sanctuary in the year 1958. Subsequently, in 1968 an area of 212 km^2 was declared as Dudhwa Wildlife Sanctuary. Further in 1977 Dudhwa National Park was created, and in 1987 Kishanpur Wildlife Sanctuary was brought together to constitute Dudhwa Tiger Reserve covering an areas of 884 km^2. During 1999-2000, the Katerniaghat Wildlife Sanctuary was brought under the DTR increasing the area from 884 km^2 to 1362 km^2 (Semwal 2005).

1.1. Dudhwa National Park:

Dudhwa National Park (DNP) is situated on the Indo-Nepal border in Lakimpur-Kheri district of Uttar Pradesh (Fig 1.1), within the *Terai-Bhabar* bio-geographic subdivision of the Upper Gangetic plan (7a) (Rodgers and Panwar 1988). It lies between 28°18' and 28°42'N latitude and 80°28' and 80°57'E longitude and covers an area of 680.3 km^2 (490.3 km^2 core and 190 km^2 buffer). River *Suheli* and *Mohana* forms the natural boundaries of the park with the Himalayan foothills about 30 kms north of the park.

The diverse vegetation and wetlands of DNP supports diverse fauna and is the home to large number of endangered species. The faunal diversity is represented by 47 species of mammals, 418 species of birds, 35 species of reptiles and six species of amphibians (Inger and Dutta 1987; Ray 1992; De 2000 and Maheswaran 2005). *It has several charismatic mammal species including tiger*

(*Panthera tigris*), *leopard (Panthera pardus), elephant* (*Elephas maximus*), *rhinoceros (Rhinoceros unicornis),* sloth bear (*Melursus ursinus*), *swamp deer* (*Rucervus duvaucelii*), *chital* (*Axis axis), hog deer (Axis porcinus), barking deer (Muntiacus muntjak), otter (Aonyx cinerea*) *etc.*

1.2. Kishanpur Wildlife Sanctuary :

Kishanpur Wildlife Sanctuary (KIWLS) lies in Lakimpur-Kheri and Shahjahanpur district of Uttar Pradesh and covers an area of 204 km^2 and is situated about 15 kms to the south of Dudhwa National Park (Fig 1.1).

The sanctuary is rich in vegetation comprising of terai and bhabar sal forest, dry tropical riverine forest and grassland. It is the home of tiger (*Panthera tigris*), leopard *(Panthera pardus)*, elephant (*Elephas maximus*), sloth bear (*Melursus ursinus*), sambar (*Rusa unicolor*), chital (*Axis axis*), wild boar (*Sus scrofa*) etc..

1.3. Katerniaghat Wildlife Sanctuary :

Located near the Indo-Nepal Border in the Bahraich district of Uttar Pradesh, Katerniaghat Wildlife Sanctuary (KTWLS) is a fragile eco-system spread linearly over an area of around 400 km^2 with sal and teak forests, interspersed with lush grasslands and wetlands along with the Girwa River draining the landscape (Fig 1.1).

The sanctuary is the home to a large number of mammals. These include the tiger *(Panthera tigris),* leopard *(Panthera pardus),* elephant *(Elephas maximus),* rhinoceros *(Rhinoceros unicornis),* Chital *(Axis axis),* wild boar *(Sus scrofa),* otter *(Aonyx cinerea),* Gangatic Dolphin *(Platanista gangetica).* The sanctuary is an important breeding area of the gharial.

The landscape is terai plains consisting fine alluvial soil with high water table. The vegetation of the reserve comprises a mosaic of dry and moist deciduous forests and productive alluvial grasslands that harbor diverse and rich fauna including several endemic and globally endangered species.

1.4. Distribution of railway track in DTR

A stretch of 106 km long meter gauge railway track of Gonda-Mailani railway section under North Eastern Railway runs through the core areas of all three

protected areas of the DTR between Mihipurwa and Mailani railway stations. The total track length inside the Kishanpur Wildlife Sanctuary, Dudhwa National Park and Katerniaghat Wildlife Sanctuary is 11 Km, 33 Km and 62 km respectively. There are 16 railway stations across the entire stretch out of which 10 stations fall inside forested areas (Table 1.1).

In Dudhwa National Park three railway stations namely, Dudhwa, Sonaripur and Reheta, while in Katerniaghat Wildlife Sanctuary five railway stations namely Manjhrapurab, Bichhia, Nishangarha, Murtiha and Kakraha are inside the forest areas (Fig 1.2). In Katerniaghat, a road runs almost parallel to the track from Bichhi to Nanpara, which connect Lakhimpur district to the Bahraich district. Similarly in Kishanpur, a state highway runs parallel to the track which connects Mailani to Bhira.

This railway track is very old and was overlaid in 1890,s for the purpose of timber extraction. The land was transferred to the Railways through vide G.O. No. 934/787-a, dated December 13, 1894. The present railway track is of 75 R category to run the train at a high speed.

Table 1.1: Railway track distributed over three protected areas and different stations

Sl. No	Station Name	Km Pole No	Distance in Km	Protected Area
1	Mailani Junction	194/3-4	00.00	Kishanpur WLS
2	Rajnarayanpur	257/0-1	08.64	
3	Bhira Kheri	249/5-6	07.74	Outside
4	Palia Kalan	235/7	13.81	Dudhwa NP
5	Dudhwa	222/10	12.84	
6	Sonaripur	215/4	07.32	
7	Reheta Halt	206/0	09.25	
8	Belrayan	192/10	21.64	
9	Tikunia	187/6	06.26	Outside
10	Khairhtia	180/4	07.13	Outside
11	Majharapurab	171/12	08.52	Katerniaghat WLS
12	Bichhia	158/9	13.78	
13	Nishangarha	148/3	09.84	
14	Murtiha	139/10	08.58	
15	Kakraha	129/1	10.58	
16	Mihipurwa	118/9	10.52	

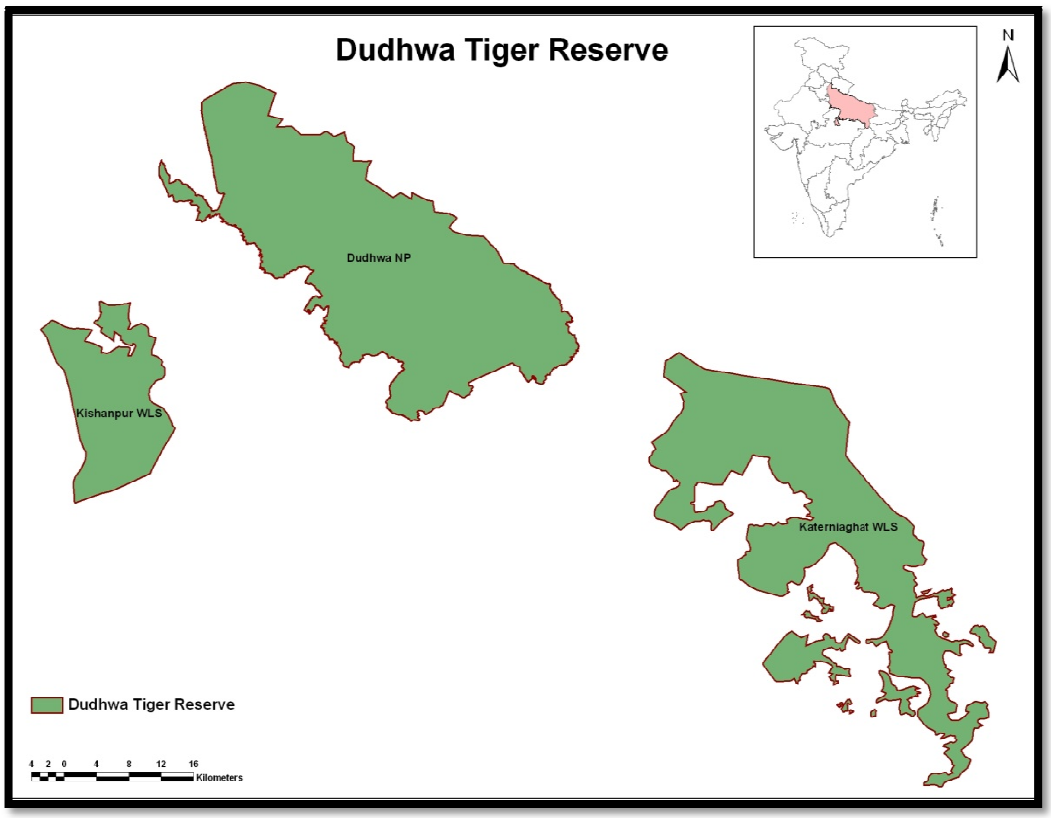


Fig. 1.1 Map of the Dudhwa Tiger Reserve

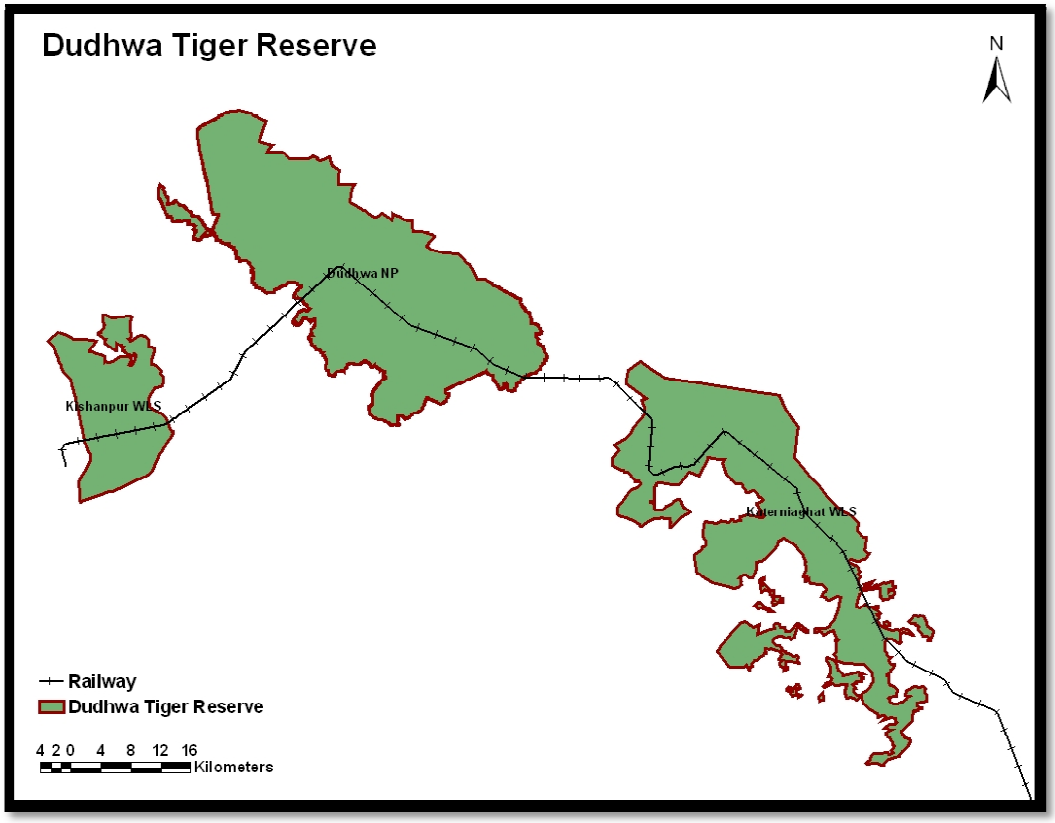


Fig. 1.2 Railway line passing through Dudhwa Tiger Reserve

2. Methodology

Methods adopted for the study are as follows:

2.1. Collection of secondary information

All the mortality records, maps and information on management practices were collected from the respective forest areas. The mortality records provide information on date of the train accident events, species with their number and location. This information also provides insights into areas or sections of the tracks more prone to accidents. Information was also collected from the Railway department on the frequency of passenger and goods trains, their time table and speed limit in the identified stretches. Information was also collected on the effort taken by the stakeholders to reduce the animal mortality.

2.2. Field Survey

For a long-term solution to this problem it was important to identify the critical accident prone sites, animal movement along the railway tracks, physical attributes of the accident prone sections and various ecological factors responsible for the accidents.

All accident sites were verified with the help of forest and railway staff in the field. Railway and forest staff were also consulted to get detail information on animal mortality using their past knowledge on the issue and to get their opinion on solution of this problem.

To carry out the intensive field survey we took support of the field staffs from concerned forest ranges, having prior knowledge of the area and animal mortality sites. WTI Field staff walked the entire stretch of 106 Km long railway track passing through all three protected areas on several occasions (Fig. 2.1). Direct and indirect evidences (scat/ dung/ pellets, animal tracks, feeding sign, kills, carcass etc.) of wild animals were recorded to know the animal movement and habitat use by different species along the railway track (Fig. 2.2). Information on scats and pug/ foot mark was collected to get information on various carnivore species like tiger, leopard and sloth bear. Elephant dung decayed completely with

growth of grasses over it was categorized as old and dung with more or less intact boles as fresh. Feeding evidences of elephants on plant species distributed along railway track were marked during survey.

Previous studies have found correlations between wild animal-vehicle collisions and a number of landscape and traffic variables (Singh et al. 2001; Sharma et al. 2006; Baskaran and Boominathan 2010; Found and Boyce 2011). We visited all the accident sites to collect information on landscape features like steep embankments, curve, elevation of the railway track from ground level etc. Information were also collected on vegetation, water bodies, crop, other habitat parameters and wildlife use pattern. Similar information was also collected from the control sites. GPS locations of the important landmarks were taken and transferred into the GIS domain to prepare maps and undertake analysis.

Fig. 2.1 Field Officers collecting various information while undertaking survey along the railway track in Dudhwa Tiger Reserve

Fig. 2.2 Elephant dung and tiger scat recorded on the railway track.

High speed trains curtail the chances of wild animals being able to escape from the deadly track. We travelled in trains and used a GPS to measure speed of trains. Information was collected on visibility along the track especially on turnings.

2.3. GIS and Remote Sensing

Satellite image of year 2010 was used for this study. These images were downloaded from glovis.usgs.gov.

Software Used:

Software	Function
Erdas Imagine 9.1	Image processing, layer stacking, classification, radiometric correction, recoding, sub setting, change detection etc.
Arc GIS 9.2	Spatial analysis, digitization and thematic map preparation.
Quantum GIS	Support .kml file and conversion of .kml file into shape file.
Map Source	Support the data recorded from GPS.
Garmin etrex vista H GPS	For latitude and longitude locations, track length and various routes and waypoints.

The image was classified into seven broad classes- Dense forest, Open forest, Grassland, Water body, Farmland, Settlements and River bed/Sandy area (Fig 2.3 & 2.4).

The habitat information at Accident Prone Areas (APA) and control sites was verified with ground truthing for detailed analysis. Influence of land use on accidents was also taken into consideration from LULC map by creating 2 km buffer around the APA and control areas. The ecological variables of APA were compared with the control areas. Locations of curves, accident prone sections and animal movement areas were then plotted on the classified images.

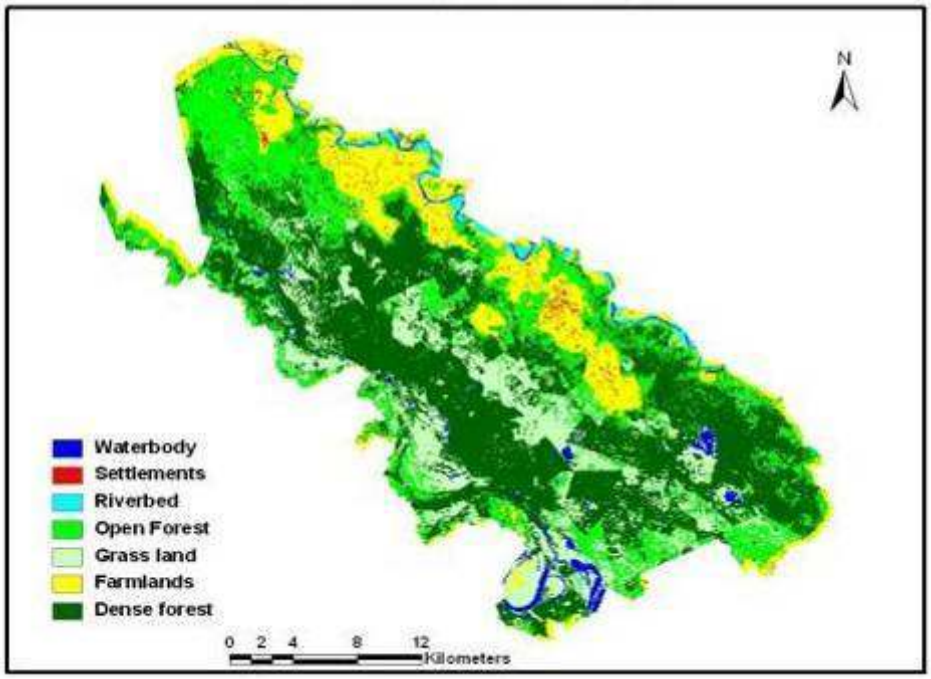


Fig 2.3 LULC map of DNP of year 2010

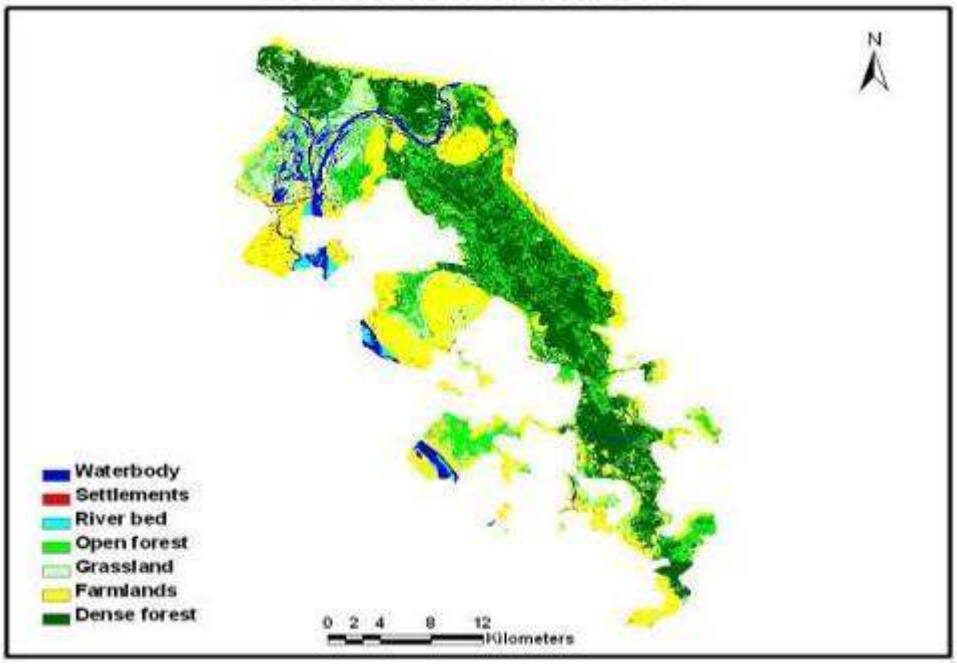


Fig 2.4 LULC map of KAT of year 2010

3. Results

3.1. Land-use and land-cover classes of Dudhwa Tiger Reserve

In Dudhwa National Park, percentage land cover categories under dense forest (41.74%), open forest (22.67%) and grassland (16.50) are higher than the Katerniaghat Wildlife Sanctuary, where it is only 32.71%, 17.76% and 12.99% respectively (Table 3.1).

Table 3.1: Area statistics for different land-use land-cover for DNP and KTWLS 2010

Land-use land-cover classes	Dudhwa NP		Katerniaghat WLS	
	Year2010		Year2010	
	Area (sq.km)	Area %	Area (sq.km)	Area %
Dense forest	285.89	41.74%	181.15	32.71%
Open forest	155.28	22.67%	98.35	17.76%
Grassland	113.00	16.50%	71.95	12.99%
Water body	15.52	2.27%	28.97	5.23%
Farmland/ Agriculture	100.71	14.70%	165.08	29.81%
Settlements	5.03	0.73%	2.40	0.43%
Riverbed	9.58	1.40%	5.95	1.07%
Total	685.01	100.00%	553.86	100.00%

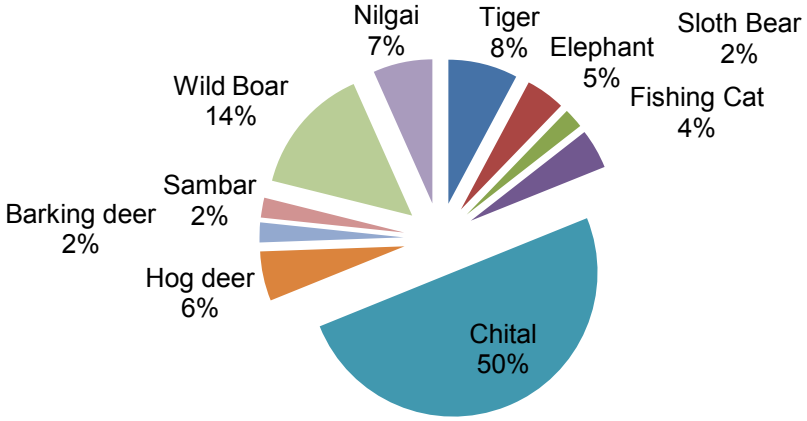
3.2. Animal mortality due to train hits

A total of 90 wild animals belong to 10 mammalian species died due to train accidents in Dudhwa Tiger Reserve between 1993 and 2011 (Table-3.2; Appendix-1). Out of the total, 43 were recorded from DNP, 45 from KTWLS and two from KIWLS. Among these, there were several species in the endangered category, including seven tigers, four elephants, five hog deer and four fishing cats. Chital death was highest amongst all (50%), followed by wild boar (14%), tiger (8%), nilgai (7%), hog deer (6%), elephant (5%), fishing cat (4%), sambar (2%), barking deer (2%) and sloth bear (2%) (Fig 3.1). Most of the accidents took place during night hour between 18:00 and 06:00 hours.

Table 3.2: Number of wild animals died in train accidents in Dudhwa Tiger Reserve

Species	Dudhwa National Park	Katerniaghat Wildlife Sanctuary	Kishanpur Wildlife Sanctuary	Total
Tiger	3	4	0	7
Elephant	4	0	0	4
Sloth Bear	2	0	0	2
Fishing Cat	4	0	0	4
Chital	23	21	1	45
Hog Deer	5	0	0	5
Barking Deer	2	0	0	2
Sambar	0	2	0	2
Wild Boar	0	12	1	13
Nilgai	0	6	0	6
Total	43	45	2	90

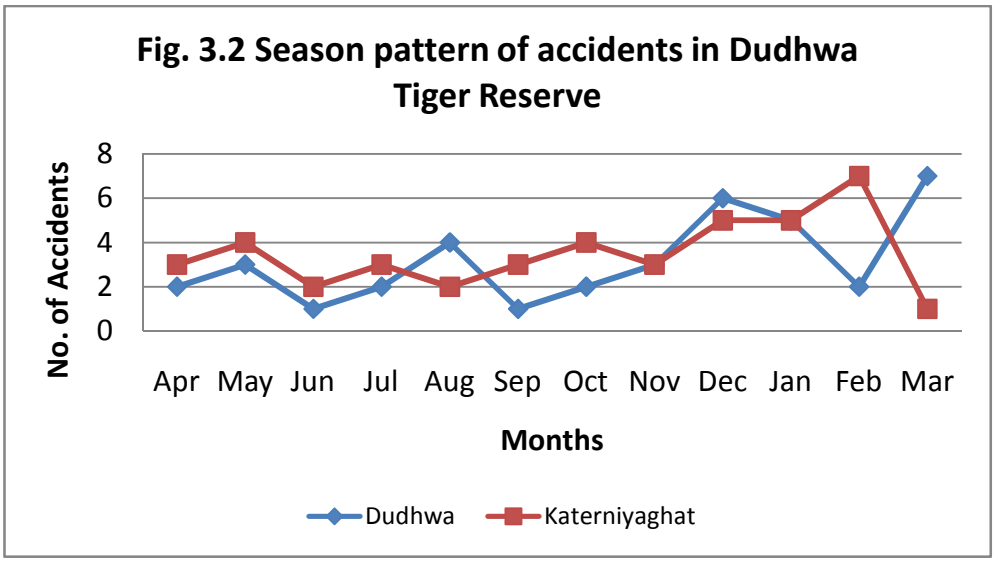
Fig. 3.1 Mortality of different species in train accidents in train accidents in DTR



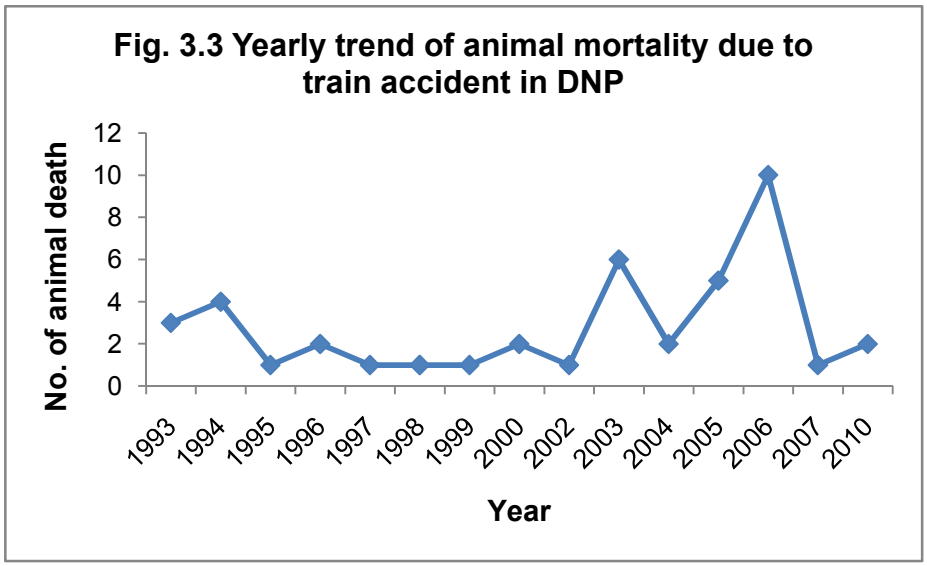
Other than mammalian species large number of amphibians and reptilians were also found dead on the railway track whose records have not been maintained. These include snakes, frogs, monitor lizard, turtle, crocodile etc.

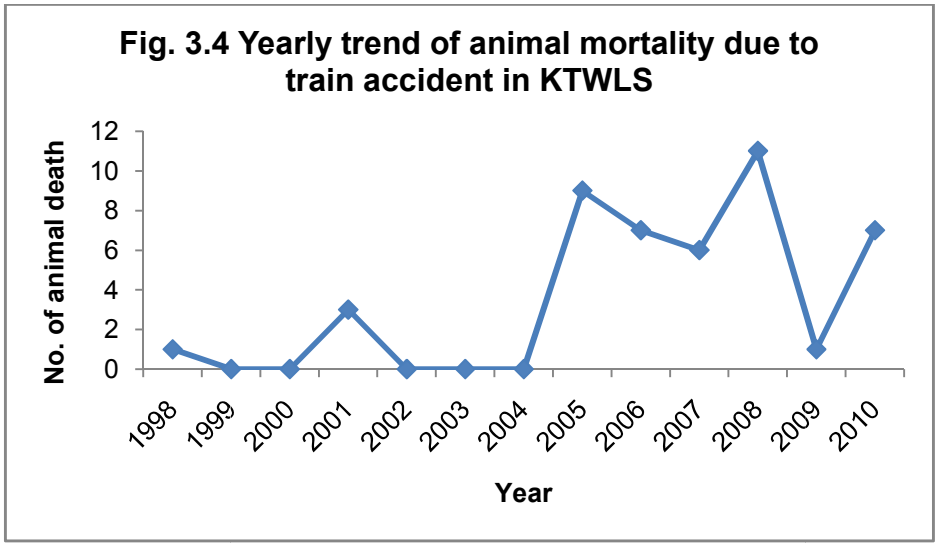
Seasonal mortality pattern showed a clear peak during winter season between months of December and March in DNP and between December and February in KTWLS (Fig 3.2) when thick fog and growth of dense grasses decrease visibility drastically along the railway track, increasing chance of accidents with trains

running during night hours. There are two small peaks during in the months of May and August in DNP and May and October in KTWLS.



Since 1993, animal deaths due to train hits have been recorded every year in DNP. In the year 2003, 05 and 06 it was high as compared to other years (Fig. 3.3). In KTWLS also except few gaps mortality has been recorded all most every year but it was very high during 2005, 06, 07, 08 and 10 (Fig. 3.4). In the year 2010, animal mortality recorded in DNP and KTWLS is mostly chital, wild boar and hog deer.





3.3 Animal movement pattern and habitat utilization

Survey undertaken between April and December 2009 recorded indirect evidences of tiger, leopard and elephants in almost every section of the railway track in DNP (Fig. 3.6). But in KTWLS evidences of tiger and leopard were recorded only between Km 136 and 146 (Fig. 3.7). Evidences of several small mammals were also recorded during the survey. Animals like barking deer, chital, wild boar, rhesus macaque and hanuman langur were often found to cross the railway line (Fig. 3.5).

Fig. 3.5 Regular crossing and animal movement recorded along the railway track in Dudhwa Tiger Resrve

Fig. 3.6 Animal movement recorded along the railway track in Dudhwa National Park (Nov. 2009)

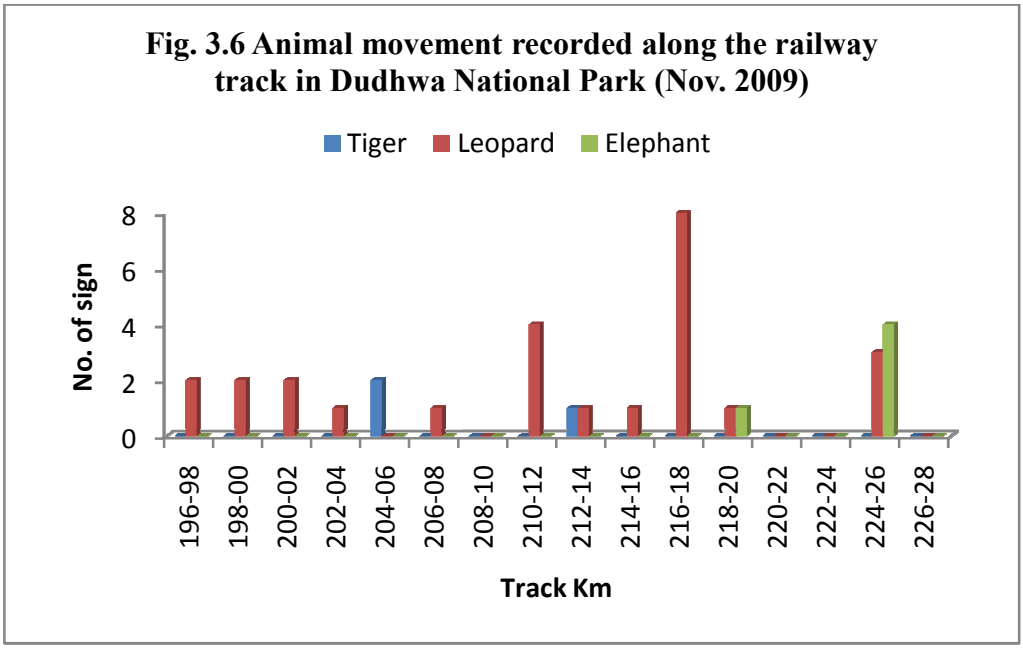
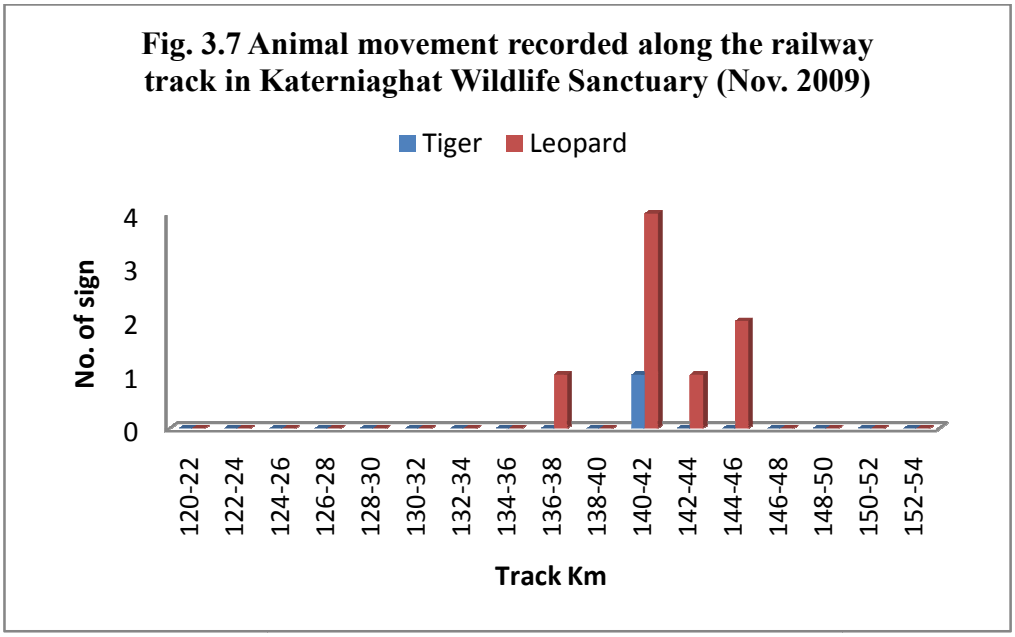


Fig. 3.7 Animal movement recorded along the railway track in Katerniaghat Wildlife Sanctuary (Nov. 2009)



Animal movement evidences collected between November 2010 and January 2011 recorded the presence of eleven species of wild mammals i.e. tiger, leopard, jackal, sloth bear, elephant, hanuman langur, chital, barking deer, nilgai, wild boar, porcupine along the railway track. In DNP, fresh elephant signs were recorded in two stretches i.e. between km pole no 202/04 and 208/07 (6.3 km), and 221/00 and 226/02 (5.2 km) however old evidences were between 210/03 and 216/08 (6.5 km) (Table 3.3).

Table 3.3 Elephant evidences encountered along railway track

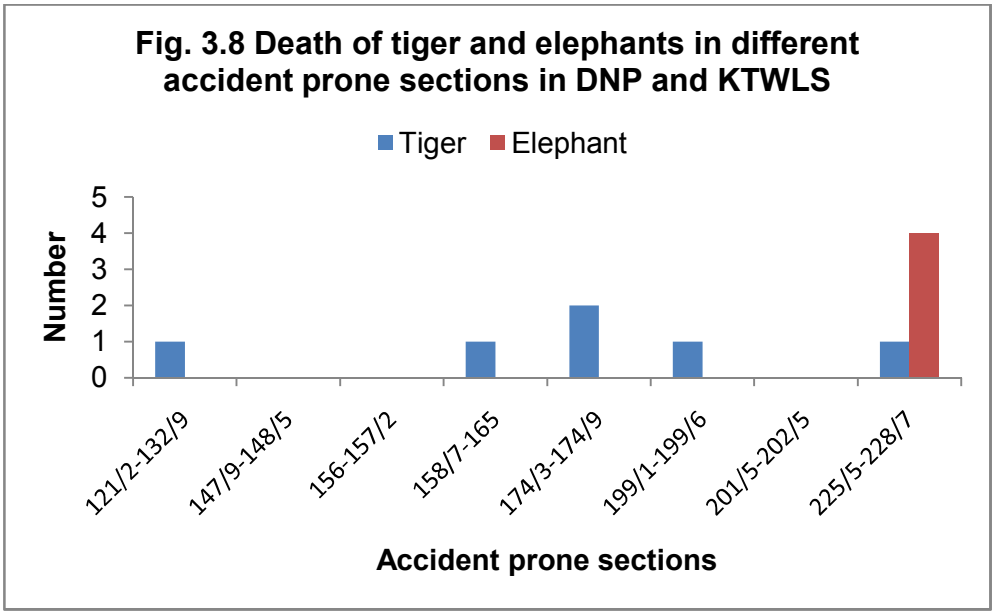
Km Pole No	Presence of evidences (1=yes, 0=no)			Category of evidence
	Foot mark	Dung	Feeding signs	
202/04	1	0	0	Fresh
206/07-09	1	1	1	Fresh
208/07	1	1	0	Fresh
210/03	1	0	0	Old
212/05	1	1	0	Old
212/10	1	1	0	Old
216/08	0	1	0	Old
221/00	1	1	0	Fresh
222/03	1	1	1	Fresh
224/06	1	1	0	Fresh
226/02	1	0	0	Fresh

3.4 Identification of critical accident prone sections

Based on frequency of animal death in Dudhwa National Park and Katerniaghat Wildlife Sanctuary eight different sections of the railway track were found critically prone to accidents, comprising a total length of 25 Km. Out of this three sections (Km 121/3 to 132/9, 158/7 to 165 and 174/3 to 174/9) in Katerniaghat and two in Dudhwa (Km 199/1 to 199/6 and 225/5 to 228/7) were found highly critical (Table 3.4, Fig. 3.9, Fig. 3.10 & Appendix 2). A total 21, 15 and 5 animal deaths respectively were recorded from Km 121/3 to 132/9, 158/7 to 165 and 174/3 to 174/9 which also include tiger death in each of these sections (Fig. 3.8). Similarly in Dudhwa National Park, sections between Km 199/1 to 199/6 and 225/5 to 228/7 recorded 16 and 9 animals deaths respectively in a small stretch of 0.5 and 3.1 Km. These two sections has experienced death of endangered species like tiger, sloth bear, elephants, fishing cat and hog deer.

Table 3.4 Critical accident prone sections in Dudhwa NP and Katerniaghat WLS

Area	Section	Length (in Km)	Animal death	Species
Katerniaghat WLS	121/2-132/9	11.6	21	One tiger, two samber, 11 wild boar, two chital & five nilgai
	147/9-148/5	0.6	2	Two chital
	156-157/2	1.2	3	Three chital
	158/7-165	6.3	15	One tiger, 13 chital & one wild boar
	174/3-174/9	0.6	2	Two tiger,
Dudhwa NP	199/1-199/6	0.5	16	One tiger, one sloth bear, four hog deer, two barking deer & eight chital
	201/5-202/5	1	6	Six chital
	225/5-228/7	3.1	9	One tiger, four elephant, one fishing cat, one hog deer & two chital



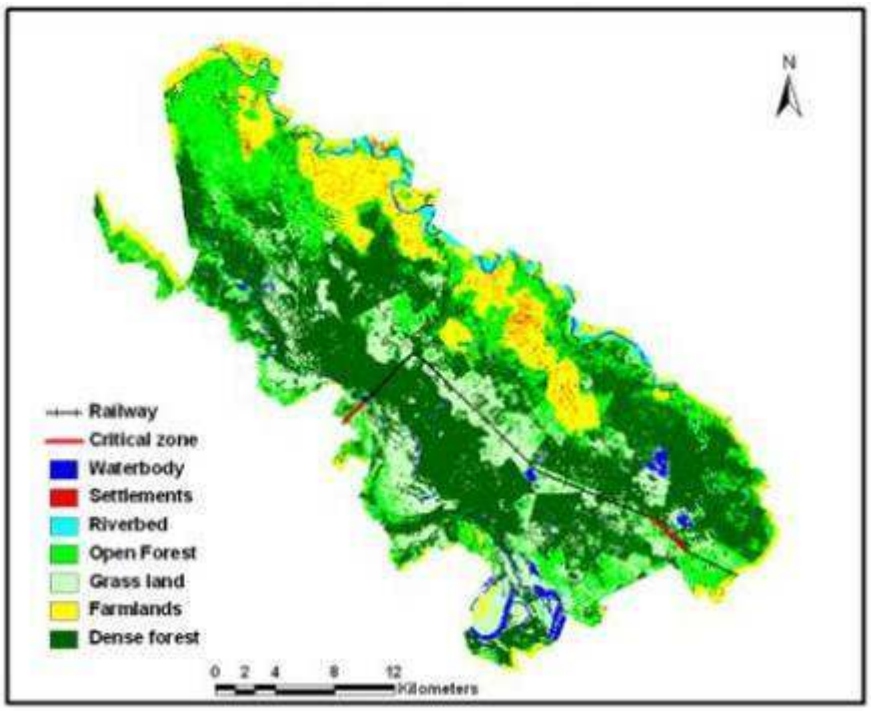


Fig. 3.9 Critical accident prone areas in Dudhwa National

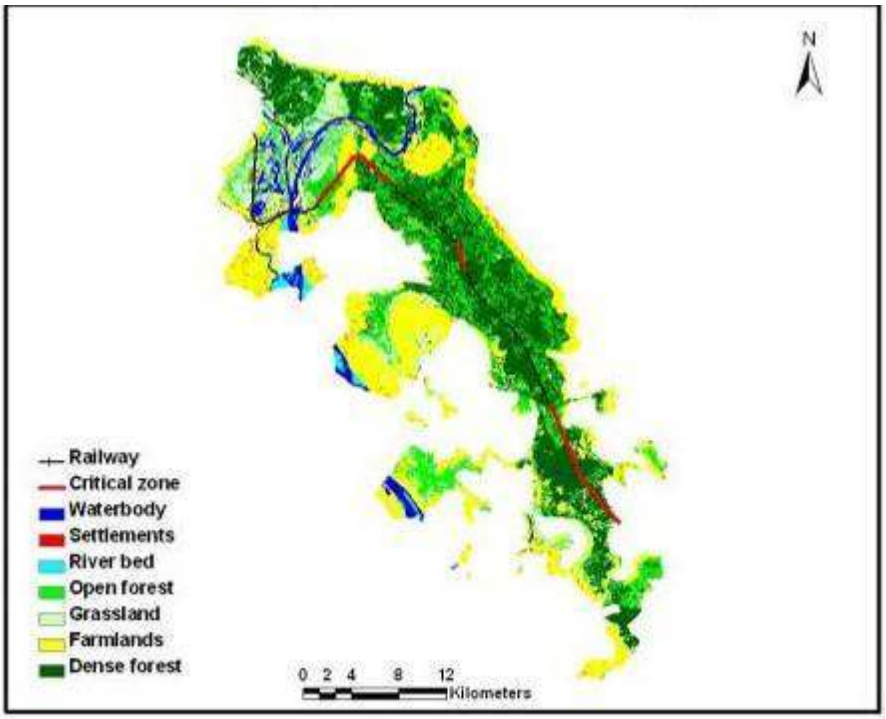


Fig. 3.10 Critical accident prone areas in Katerniaghat Wildlife

In Dudhwa National Park highest animal mortality was recorded from South and North Sonaripur ranges followed by Dudhwa and Bilreyan (Fig. 3.11) and in Katerniaghat Wildlife Sanctuary highest animal mortality was recorded from

Katerniaghat followed by Motipur, Kakaraha, Dharampur, Murtiha and Nishangarha (Fig 3.12).

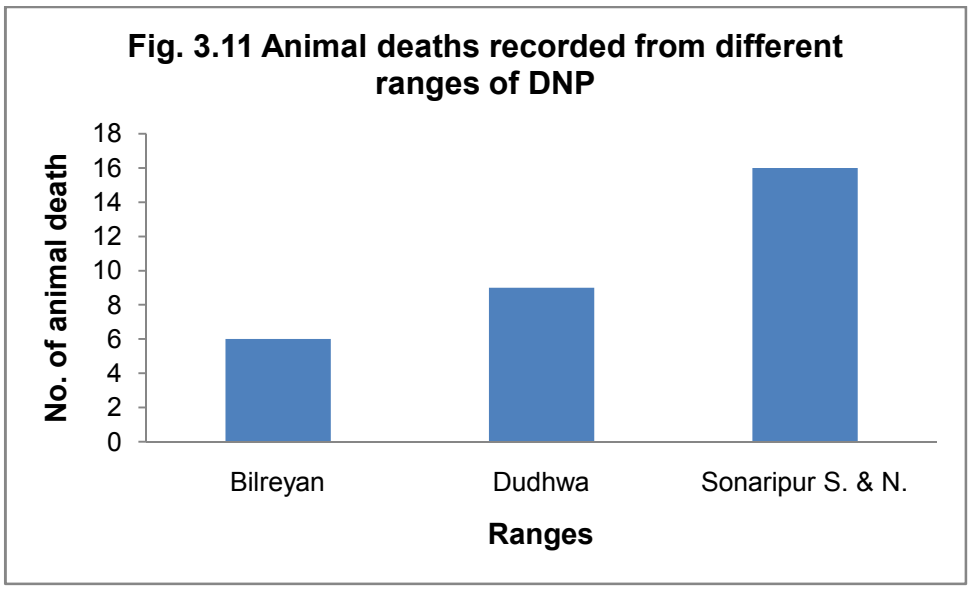


Fig. 3.11 Animal deaths recorded from different ranges of DNP

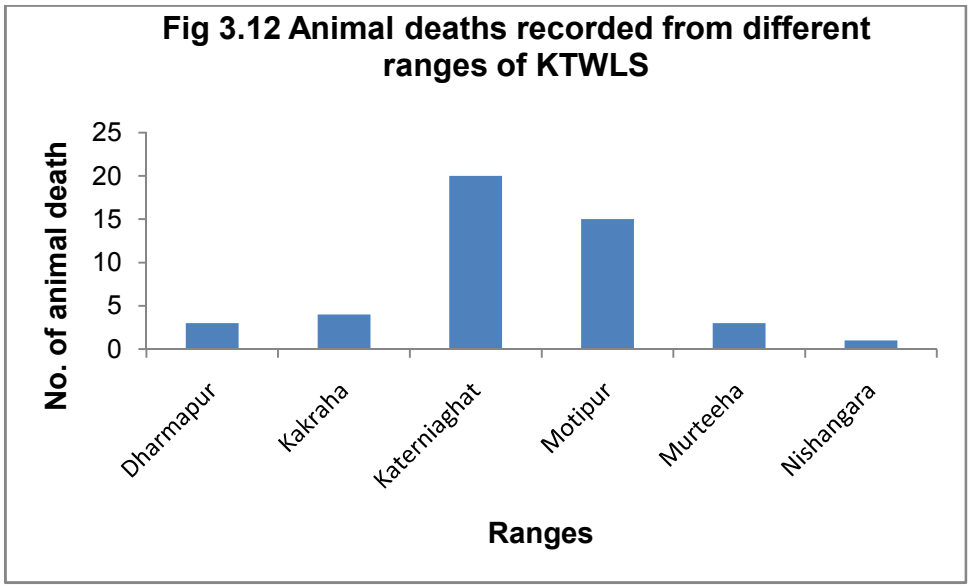


Fig 3.12 Animal deaths recorded from different ranges of KTWLS

3.5 Factor Responsible for Accident

3.5.1 Physical factors

3.5.1.1 Curve

In Dudhwa National Park and Katerniaghat Wildlife Sanctuary a total of 16 critical curves have been recorded (Appendix-3). It is found that the several wildlife mortalities have taken place on sharp curves. The frequency of wildlife mortality in Dudhwa National Park on curves no 22, 23, 26 and 27 to be found very high as

compared to the other areas (Fig. 3.13). Curve number 26 is one of the most critical curves among all. Similarly curve no 6 between km 159/2 to 161/1 in Katerniaghat WLS accounted regular animal mortalities. One or more than one curve has been noticed in all most all accident prone sections (Table 3.5 & 3.6).

Fig. 3.13 Critical curves in Dudhwa National Park

3.5.1.2 Elevated track section

Elevated track section has been also found responsible for animal deaths in train accidents especially on curve. In case of train movement it becomes very difficult for large animals like elephants to get off quickly from the track. In Dudhwa National Park railway track between Km 226 and 227 is 6 to 8 meter elevated above the surrounding ground level and all four elephant death in two incidences has taken place in this section (Fig. 3.14 & Table 3.6). One tiger was also killed in this section.

Table 3.5 Physical/ ecological attributes at critical sections in Katerniaghat WLS

Accident prone sections	Attributes					
	Curve	Visibility	Water body	Habitation	Agriculture	Elevation
121/2-132/9	2	Medium	No	No	Agriculture	No
158/7-165	2	Low	Perennial	Seed Farm	Agriculture/ open	High
174/3-9	0	High	Perennial	No	No	No

Table 3.6 Physical/ ecological attributes at critical sections in Dudhwa NP

Accident prone sections	Attributes					
	Curve	Visibility	Water body	Habitation	Agriculture	Elevation
199/1-199/6	1	Low	No	No	No	No
201/5-202/5	1	Low	No	No	No	No
225/5-228/7	2	Low	River	No	Negligible	High

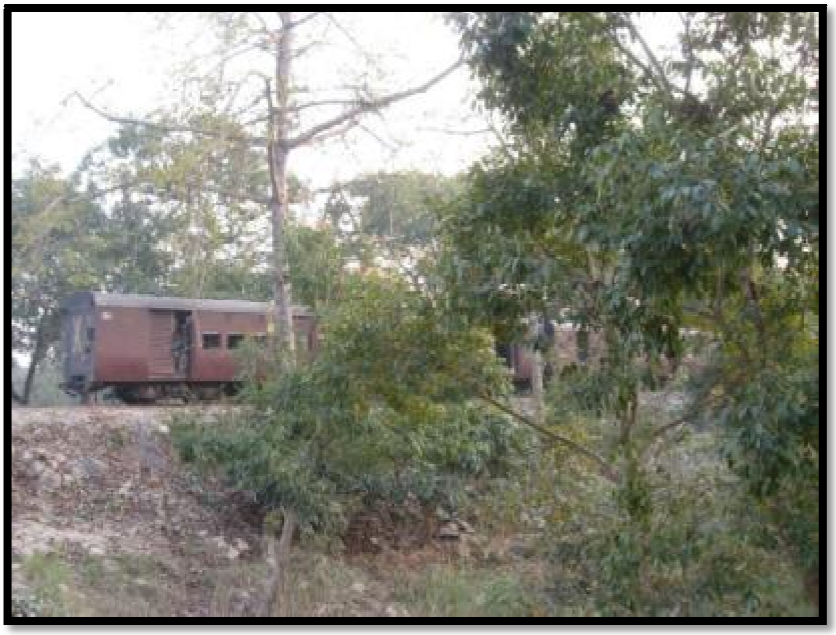


Fig. 3.14 Elevated railway track in Dudhwa National Park

3.5.2 Ecological factors

3.5.2.1 Visibility

Visibility along the railway track especially on the curve is one of the important factors behind most accidents. During winter season due to thick fog visibility decreases drastically. In Dudhwa National Park and Katerniaghat Wildlife Sanctuary, 44% and 43% wildlife death due to train accidents respectively happened during winter season between months of November and February (Appendix 1 & Fig 3.2). Growth of grasses and thick foliage on the sides of the track further decreases the visibility and thereby increases the chances of accidents. In most of the accident prone areas visibility were found to be very low (Fig. 3.15, Table 3.5 & 3.6).

Fig. 3.15 Growth of grasses and foliage decrease the visibility

3.5.2.2 Water

In summer, water becomes a limiting factor for wild animals, and the railway track running through perennial water sources turns into a big threat. In Dudhwa National Park death of four elephants, two chital, one each of a tiger, a fishing cat and a hog deer occurred between Km 225/0 to 228/7 where the track passes through a water body and crosses two rivers i.e. Suheli and Nakwaha (Table 3.6 & Fig. 3.16). Death of one tiger and three elephants in this section occurred during summer season in the months of April and May. Similarly two incidences of tiger death in Katerniaghat occurred in an area where the track passes through water bodies.

3.5.2.3 Crops and farm land

Agriculture and farmlands in close vicinity of railway track were one of the attractants for wild animals. Two critical accident prone sections in Katerniaghat Wildlife Sanctuary pass close to agriculture or farmland areas with various cropping activities (Table 3.5). One of these between km 121/2 and 132/9 is situated on the outer border of the Sanctuary with crop fields in close vicinity and another between 158/7 and 165/0 passes through Central State Seed Research Farm having farmland and agriculture activities. Approximately 78% of animal death in Katerniaghat WLS has taken place in these two sections only. In October 2010, a herd of five chital (1 male and 4 female) died within the seed farm area in one accident.

Fig. 3.16 Water bodies between Km 225/0 and 228/7 in Dudhwa National Park

3.5.2.4 Influence of grassland

Influence of various land use attributes on accidents was taken into consideration from LULC map by creating 2 km buffer around the accident prone areas and at control sites (Table 3.7 & 3.8). Accident intensity (Conflict intensity) was plotted with the percentage of grassland for each accident prone areas. The data indicated that conflict increases with the increase in grassland percentage. The statistical analysis **(**Spearman Correlation, two tailed test, r^2= 0.44 (alpha=0.05)**)** showed a non significant correlation between grassland and intensity of accidents in Katerniaghat while with the small data of Dudhwa statistical analysis was not possible.

Table 3.7 Ecological attributes at accident prone sections in Katerniaghat Wildlife Sanctuary

Landuse	**Critical sections**					
	121/2-132/9		**158/7-165**		**174/3-9**	
	Area (sq.km)	**Area %**	**Area (sq.km)**	**Area %**	**Area (sq.km)**	**Area %**
Forest cover	31.87	80.79	22.31	59.36%	2.67	19.17%
Grassland	3.51	8.90%	5.20	13.84%	7.53	54.06%
Water body	0.33	0.84%	0.85	2.26%	2.25	16.15%
Farmlands	3.74	9.48%	9.17	24.41%	1.47	10.55%
Settlements	-	-	0.04	0.11%	-	-

Table 3.8 Ecological attributes at accident prone sections in Dudhwa NP

Landuse	Critical sections			
	199/1-202/5		225/5-228/7	
	Area (sq.km)	Area %	Area (sq.km)	Area %
Forest cover	12.76	62.98%	8.43	74.01%
Grassland	6.92	34.16%	2.32	20.37%
Water body	0.58	2.86%	0.29	2.55%
Farmlands	-	-	0.34	2.99%
Settlements	-	-	-	-

3.5.3 Frequency and Speed of trains

Higher speed and frequency of trains especially during night hour has been also found responsible for animal mortalities due to train accidents. There are around 14 passenger trains that run every day on Gonda-Mailani railway track passing through the Kishanpur WLS, Dudhwa National Park and the Katerniaghat WLS (Table 3.9). In addition to this, two to three goods trains also run occasionally through these areas. The number of good trains however increases during sugarcane harvesting period. Of the passenger trains, seven trains run during night hour between 6:00 PM to 6:00 AM. Goods trains were also found to running through these protected areas at night hours.

The speed measured for the passenger trains running through the park areas during day hours were found to be between 40-50 km/hr. Trains running during night hour were found significantly faster.

Table 3.9 Number of passenger trains passing through Kishanpur WLS, Dudhwa NP and Katerniaghat WLS

UP Trains		Down trains	
Train No.	**Train Name**	**Train No.**	**Train Name**
5315	Gonda Jn to Mathura	5316	Mathura to Gonda Jn
5319	Palia Kalan to Aishbaag	5320	Aishbaag to Palia Kalan
173	Trikonia to Aishbaag	174	Aishbaag to Trikonia
187	Gonda Jn to Melani Jn	188	Melani Jn to Gonda Jn
189	Gonda Jn to Bareki Jn	190	Bareki Jn to Gonda Jn
191	Gonda Jn to Melani Jn	192	Melani Jn to Gonda Jn
193	Gonda Jn to Melani Jn	194	Melani Jn to Gonda Jn
219	Palia Kalan to Melani Jn	220	Melani Jn to Palia Kalan

4. Implementation of mitigation measures

Following initiatives have been undertaken by the Uttar Pradesh Forest Department and North Eastern Railway to reduce elephant and other animal mortality in the park.

4.1. Declaration of accident prone areas as caution zones and speed limit

Railway declared seven caution zones (Table 4.1) to reduce wildlife mortalities and put the speed limit of 20-30 km/hr in each of these sections. Details of these caution zones have been incorporated in to the loco pilot's instruction book. To avoid the further accidents Loco Pilots were asked to follow the speed limits and blow whistle frequently while passing through such areas. During night hours loco pilots were instructed to switch off harsh lights, often disorient animals and also to blow horn after seeing an animal close to the railway track. Caution zones were only issued for the Dudhwa National Park.

Table 6.1 Caution Zones and speed limit for Loco Pilots

Sl No	Between Railway Station		Between Km		Speed	Reason
	From	To	From	To		
1	Tikunia	Belrayan	193/00	194/00	30	Wildlife
2	Belrayan	Sonaripur	193/10	215/04	On the Alert	Wildlife
3	Belrayan	Sonaripur	194/00	194/05	30	Wildlife
4	Belrayan	Sonaripur	207/06	215/08	30	Wildlife
5	Sonaripur	Dudhwa	215/08	221/04	30	Wildlife
6	Sonaripur	Dudhwa	222/05	222/10	30	Wildlife
7	Dudhwa	Palia Kalan	228/05	228/07	30	Wildlife

4.2. Meetings and liaison with the Railway and Forest Officials

The Uttar Pradesh Forest Department had several rounds of meetings with the North Eastern Railway to discuss an effective solution for this problem. As a result of such initiatives the Railway have now reduced the train speed in some of the critical sections declaring these as caution zones.

5. Inferences

Train passing through the Dudhwa Tiger Reserve has taken toll to several animal species but there is serious concern about the death of tiger and elephants for such accidents. These species are already under serious threat due to various conservation problem related to habitat degradation, fragmentation, conflicts and poaching. Railway track further aggravate the problem. The tiger number in the country has already shown a decline in recent years. In such situation it is very important to address this issue to save these species.

Railway lines also cause habitat fragmentation and reduced access to vital habitats (Jackson, 1999). Railroads are barriers that may decrease survival probability of several wildlife populations when the animals can not cross them. In Arizona, fenced railroads fragmented pronghorn habitat, isolated populations and prevented seasonal migration (Ockenfels *et al.* 1997). The presence of railways in the elephant habitat creates new habitat edges, alters the dynamics of the ecosystem, and creates barrier to movement of the elephants, leading to habitat loss, splitting up of elephant population and death due to train hit (Menon *et al*., 2005).

In Dudhwa NP, Kishapur WLS and Katerniaghat WLS, the train line pass through a prime tiger habitat. Census conducted in 2010, estimated about 112 tigers in the Dudhwa Tiger Reserve landscape. The park also has elephant, swamp deer and leopard populations. Unfortunately over 16 trains and 100 vehicles (Palia-Gauriphanta road, Dudhwa-Chandan Chauki, Chandan Chauki-Dingania, Bhira-Mailani and Chandan Chauki-Mornochani roads, Nanpara-Bichhia road) passes through the core area of the parks and make the entire belt unsafe for the wild animals.

Analysis of accidents revealed that the large number of animal deaths happened during winter season, due to presence of thick fog and grasses which thereby further decreases the visibility drastically. This was also raised by the loco pilots as one of the major factors for accidents. Hence improvement of visibility is necessary to reduce the animal deaths on the track.

Factors responsible for accidents includes the sharp curves, elevated track sections, poor visibility due to growth of grass/foliage on the sides and thick fog during winter, speed and frequencies of the train. Poor visibility along the track is one of the important factors for the accidents. The other important ecological factors responsible for accidents are presence of water along the railway track, cropland and grassland. Presence of water bodies along the railway track attracts the animals especially during summer. Frequent animal movement for water increases the chances of accidents. Similarly cropland and grassland are also favored by the herbivores and increases the chances of accidents due to frequent movement across the railway track.

Identification of critical sections will help implementing the mitigation measures effectively. Sections from Km 121/3 to 132/9, 158/7 to 165 and 174/3 to 174/9 in Katerniaghat Wildlife Sanctuary and from Km 199/1 to 199/6 and 225/5 to 228/7 in Dudhwa National Park is very critical as each of these has experienced large number of animal deaths which also include death of endangered species like tiger, elephants, fishing cats, hog deer, black bear.

6. Suggested Mitigation Measures

To mitigate this problem site specific mitigation measures need to be implemented in different sections.

6.1. Short-term mitigation measures

In Dudhwa National Park and Katerniaghat Wildlife Sanctuary total eight accident prone sections have been identified, out of which following five are highly critical.

A. Katerniaghat Wildlife Sanctuary

1. Km 121/3 to 132/9 – Length -11.6 Km
2. Km 158/7 to 165 – Length – 6.3 Km
3. Km 174/3 to 174/9 – 0.6 Km

B. Dudhwa National Park

4. Km 199/1 to 199/6 – Length – 0.5 Km
5. Km 225/5 to 228/7 – Length – 3.1 Km

Focus in these sections will help to tackle this problem effectively.

6.1.1 Declaration of accident prone areas as caution zones and speed limit

Railway has declared seven caution zones in Dudhwa National Park and has put speed limits to avoid further accidents and wildlife mortalities. It is also important to declare three caution zones in Katerniaghat Wildlife Sanctuary and put speed limit in these sections (Km 121/3 to 132/9, Km 158/7 to 165 and Km 174/3 to 174/9).This is being followed up.

6.1.2. Improving visibility

Low visibility is one of the major problems for loco pilots and contributes to the accidents. It is important to improve the visibility especially on curves/turnings (Appendix 3) and in accident prone areas (Table 3.4) by clearing bushes/ grasses in at least 20 -30 feet width on both sides of the track. Bushes should be cleared at least twice in a year and must before the winter season.

6.1.3. Joint night patrolling

Joint night patrolling should be initiated in the accident prone areas to avert the accidents. It has been established that the most of accidents took place during winter season between the month of November and February, joint night patrolling

by forest and railway staff should be undertaken in the five critical sections (between Km 121/3 to 132/9, 158/7 to 165 and 174/3 to 174/9 in Katerniaghat Wildlife Sanctuary and Km 199/1 to 202/5 and 225/5 to 228/7 in Dudhwa National Park). Though it is difficult to undertake night patrolling on foot in a tiger habitat like DTR, the staff are exposed to such patrolling during monsoon period.

Patrolling teams should be equipped with wireless, mobile sets, search lights, special signal to stop the train in emergency. A minimum of four members should be in each patrolling teams. Patrolling team should be also equipped with the fire arms for safety. In case of elephant and tiger movement along the railway track these patrolling teams shall inform the railway authority about the location to caution the loco pilots. In such cases all trains in that particular stretch should proceed slowly with caution. This method has been tested on the ground in Rajaji National Park and Assam and has yielded good result.

6.1.4. Raise awareness among the Loco Pilots

Awareness workshops for key railway staff like Loco Pilots, Loco Guards, and Stationmasters should be organized to provide them better information about this problem, elephant behaviour and precaution during time of emergency. Such activities can be organized by the Wildlife Trust of India in crew lobbies at important railway stations in this section at regular intervals. Awareness activities should be also undertaken in the railway training school.

6.1.5. Initiate Stakeholder coordination

Regular meetings between railway and forest officials in the field are very important to share information, implement mitigation measures and its monitoring. It is recommended that a Task Force comprising of representatives from North Eastern Railways and Uttar Pradesh Forest Department should be constituted to improve the stakeholder coordination.

6.1.6 Installation of Signage in accident prone areas

There is need to install at least 18 to 20 signage along the accident prone areas to alert the loco pilots about animal movement. Eight signages has been already prepared rest 10 to 12 should be installed on priority basis.

6.2. Long-term planning

In Dudhwa National Park, all the railway stations are away from the human habitations and are not used by the local people residing in nearby villages. Hence, as long term solution it is suggested to relocated the railway track outside the park area. This will help in saving wildlife and their habitat and will also cater the need of more public which lives outside the park.

Unfortunately, there is a proposal to convert this meter gauge track into broad gauge. This will further aggravate the problem as frequency and speed of the trains will increase. It is therefore urgent to take a decision on this issue before situation goes out of hand. This section is also running in loss. Hence railway must take a bold step to relocate the track outside for wildlife conservation and financial sustainability.

CHAPTER 3

Survey Report of Tamil Nadu and Kerala

1. Introduction: Elephant mortality due to train accident in Coimbatore-Palakkad section of TN and Kerala

The Coimbatore and Palakkad Forest Divisions of Tamil Nadu and Kerala (Southern Railways, Coimbatore-Palakkad section) are facing an acute problem of elephant mortality due to train hits. Between 2002 and 2010, 13 elephants have died on the railway track in this section. Since 2006, accidents have taken place every year. In the year 2009, three accidents took place in which four elephants lost their life. These accidents have occurred between Podnaur and Kanjikode railway stations of this section.

Between Podnaur and Kanjikode, there are three railway stations namely, Madukkarai, Ettimadai and Walayar. Podnaur, Madukkarai and Ettimadai railway stations are in Tamil Nadu and Walayar and Kanjikode are in Kerala. The Coimbatore-Palakkad section has busy train traffic and a double line to cater for it. After Ettimadai, both the tracks diverge. The A line passes through 6.5 kms of forests between Kanjikode and Walayar and two kms between Walayar and Ettimadai. Between Ettimadai and Podnaur the track goes completely outside the forests. The B line mostly runs through the forests between Ettimadai, Walayar and Kanjikode. The length of the track of the B line passing through forests between Kanjikode and Walayar is approximately 11.5 Km and between Walayar and Etimadai is five Km. (Fig. 1)

The gradient on the B line is less as compared to the A line. The B line was constructed by the Railways in 1974 to cater to the need of growing traffic of passenger and goods trains. The A line is a very old establishment in existence since 1861. Since the B line passes mostly through forests, most of the accidents have taken place on this line.

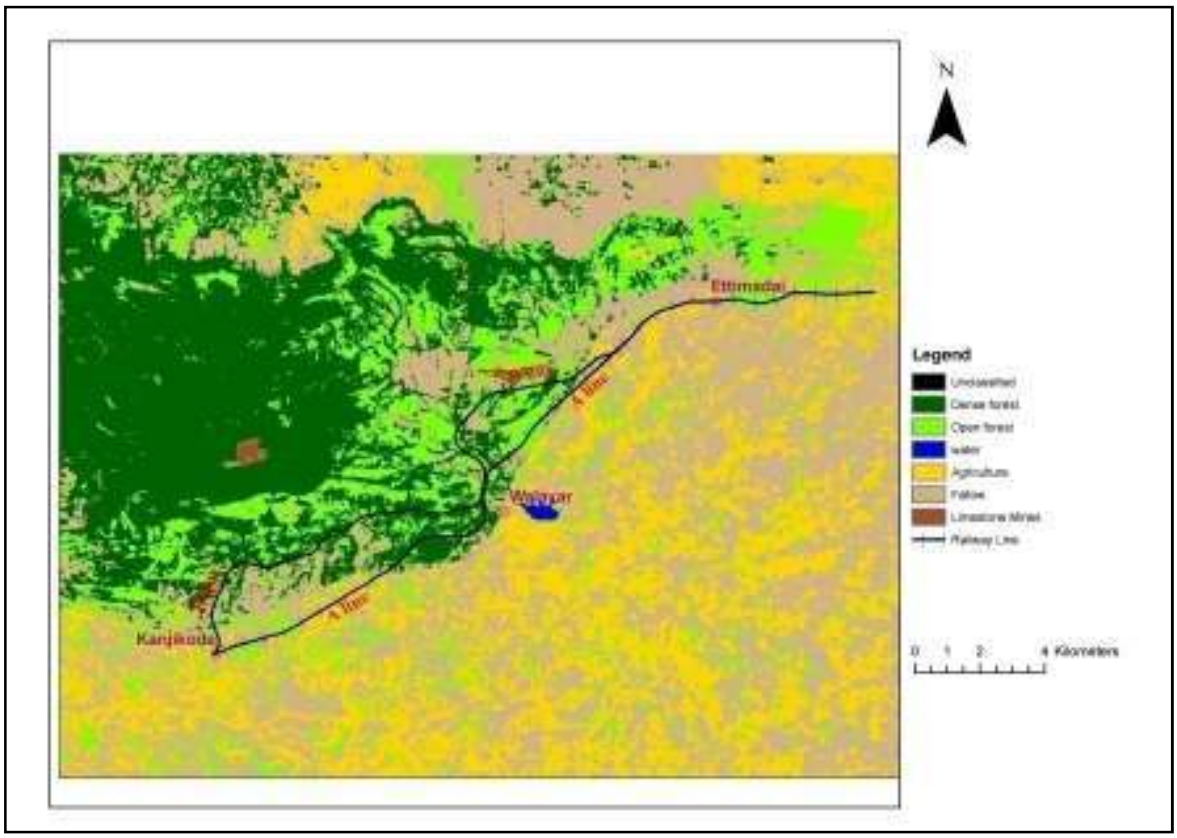


Fig. 1: Map of the critical section of the track showing A and B lines

2. Methodology

WTI initiated field work in this area to collect information on habitat availability, elephant movement, habitat utilization and human-elephant conflict in this region. For undertaking this study a biologist, a sociologist and field assistant were engaged for full time data collection. In addition to this a senior biologist from the field and a scientist (coordinator) from headquarter also contributed periodically to the data collection and monitoring of the project activities. The Executive Director, WTI also visited the conflict sites in the month of August 2010 to monitor project activities and suggest ameliorative measures.

For a long-term solution to this problem it was important to know the elephant movement in this area at a landscape level in relation to habitat availability and other ecological parameters. The mitigation measures and its effectiveness will be based on the knowledge of habitat availability, its utilization by the animal, other ecological attractants and disturbances. Keeping these issues in mind WTI collected data on such parameters in the region.

The data was collected through temporarily marked transects in the habitat available between A and B lines and in the region. On each transect, circular plots of 10 m radius were laid after every 250 m to assess and measure presence of tree and shrub species, elephant food species, elephant signs (dung piles, feeding sign), and disturbances (human presence, cattle presence, cattle dung) (Fig. 2.3). Records were also made on the broad vegetation type and canopy cover. Data on the availability of water were also collected.

Fig 2.1: Data collection along the railway track

Fig 2.2: Field Officer conducting questionnaire

In order to get information on land use changes, elephant movements, seasonality, influence of crops available in the fringe area on elephant movement a questionnaire survey was conducted in more than 20 villages (Fig. 2.2).

Information was collected to identify critical areas prone to accidents, elephant movement zones along the railway tracks, bridges used by elephants and physical features responsible for accidents. GPS locations of the important landmarks were collected and transferred in a GIS domain to prepare maps.

Identification of elephant movement areas is important for placement of signage along the railway track to alert the drivers as well as for developing a mitigation strategy. To identify the elephant movement zones and critical areas, encounter rate from direct sightings and elephant dung along the railway track was collected (Fig. 2.1). Records were also made on the presence of other elephant signs (feeding and tracks). Habitat and landscape attributes like availability of water

bodies along the track, sharp curves, and steep cuttings on the sides have also been recorded. Data was also collected on attractants like crops and plantations along the track in conflict prone areas. Elephant mortality record, seasonality and accident locations have been collected from the Railway and Forest Departments (Fig. 2.4).

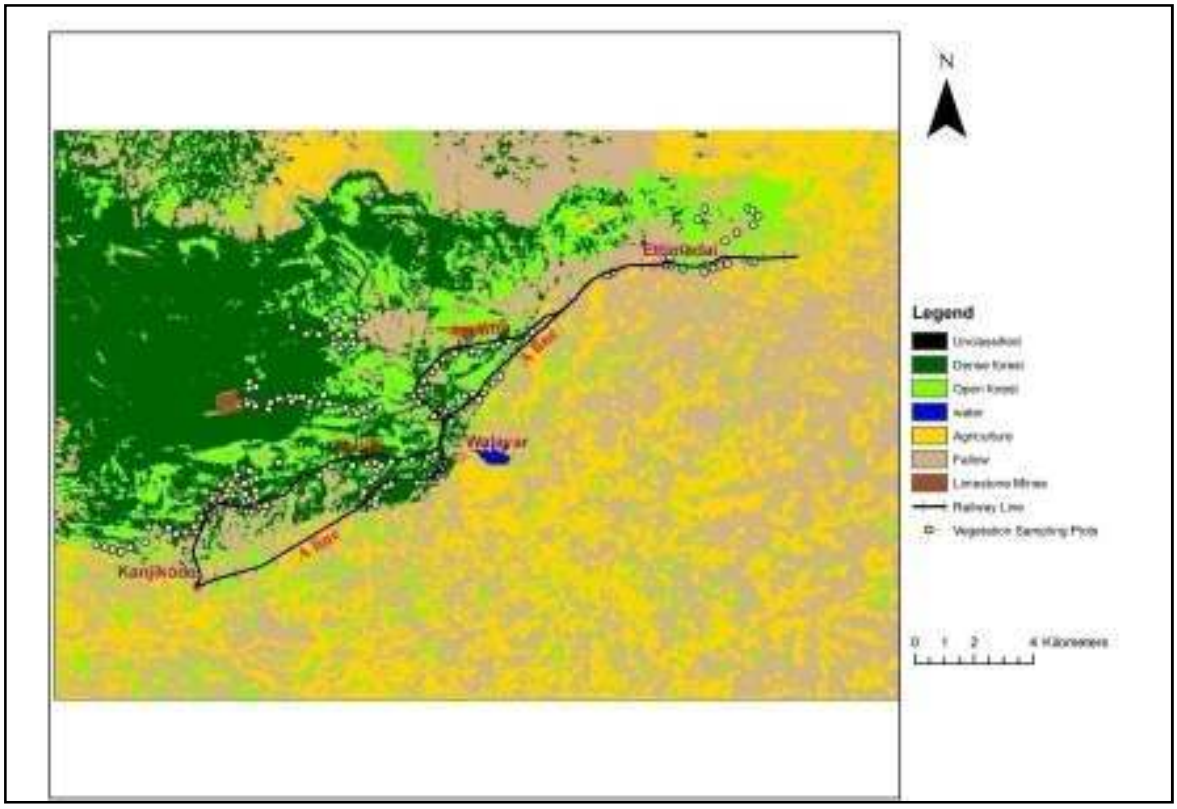


Fig. 2.3: Sampling plots shown on the landscape

Data was also collected on disturbances like mining, industrialization and urban development in the area.

Information was collected on mitigation measures undertaken by various stakeholders and their effectiveness in reducing elephant mortality. Recently erected power fences were evaluated to check their maintenance status, impact on animal movement and effectiveness.

A digital satellite imagery of Landsat 5 of 1990 and 1999 was used for GIS mapping, change detection and analysis. Landuse classes were broadly classified and area was calculated. Different layers were overlaid to get outputs and produce maps.

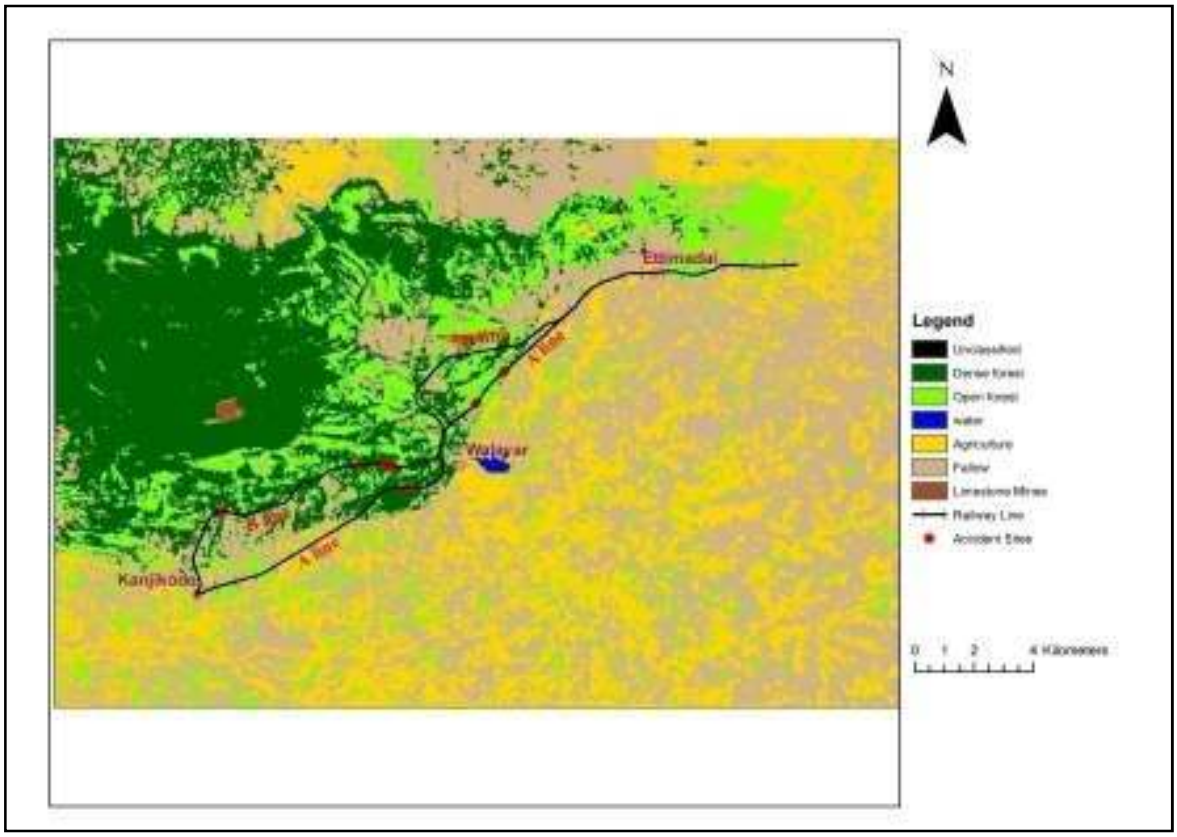
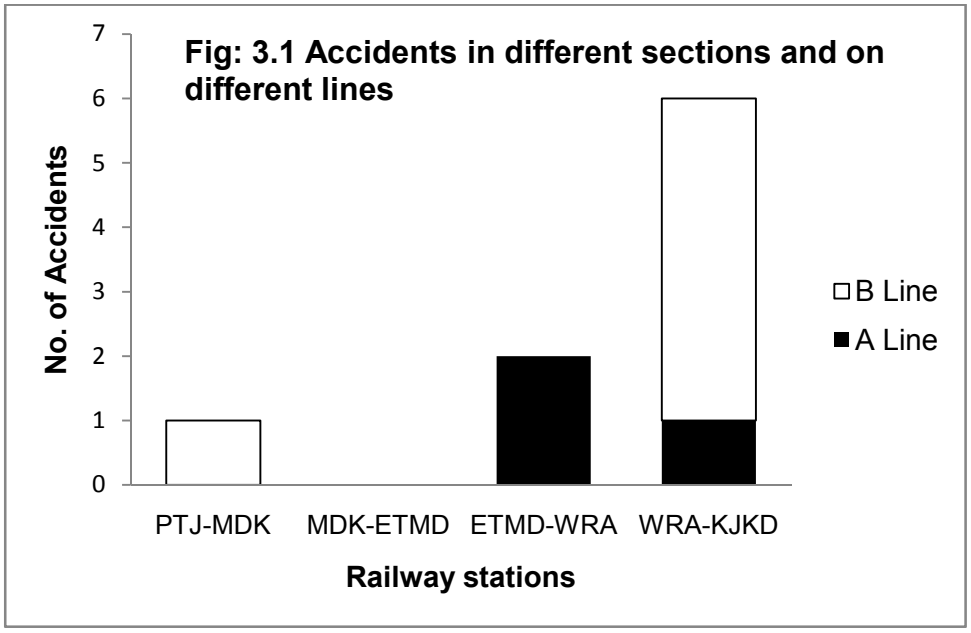


Fig. 2.4: Locations of the past accidents

3. Results

3.1 Pattern of animal mortality

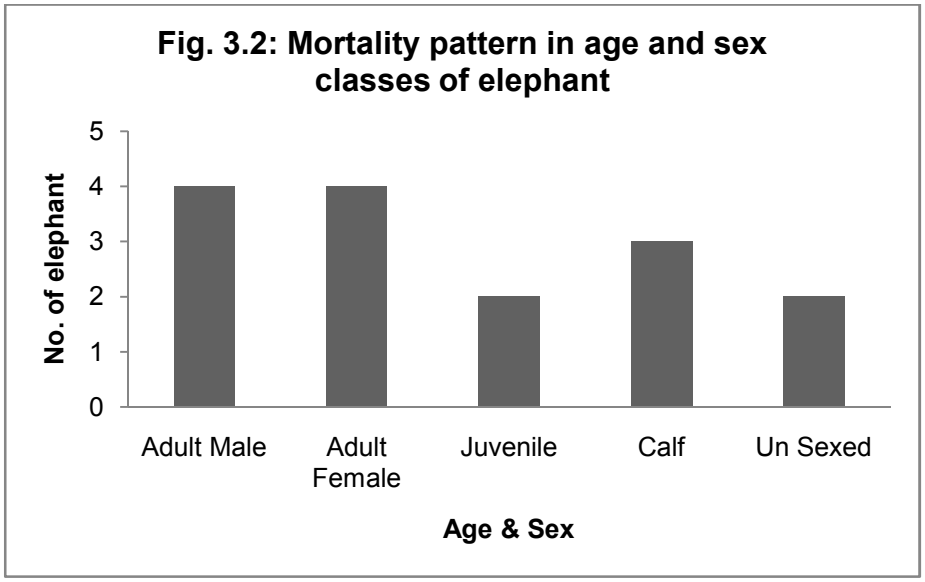
Till date 15 elephants have been killed in nine accidents on both the lines, of which eight have been killed in Kerala and seven in Tamil Nadu. On the B line, six accidents have taken place in which 11 elephants have died and on the A line, three accidents have taken place in which four elephants have died. Out of nine accidents, six have taken place between Kanjikode and Walayar railway section (Fig 3.1).



PTJ- Podnaur; MDK- Madukkarai; ETMD- Ettimadai; WRA- Walayar; KJKD- Kanjikode

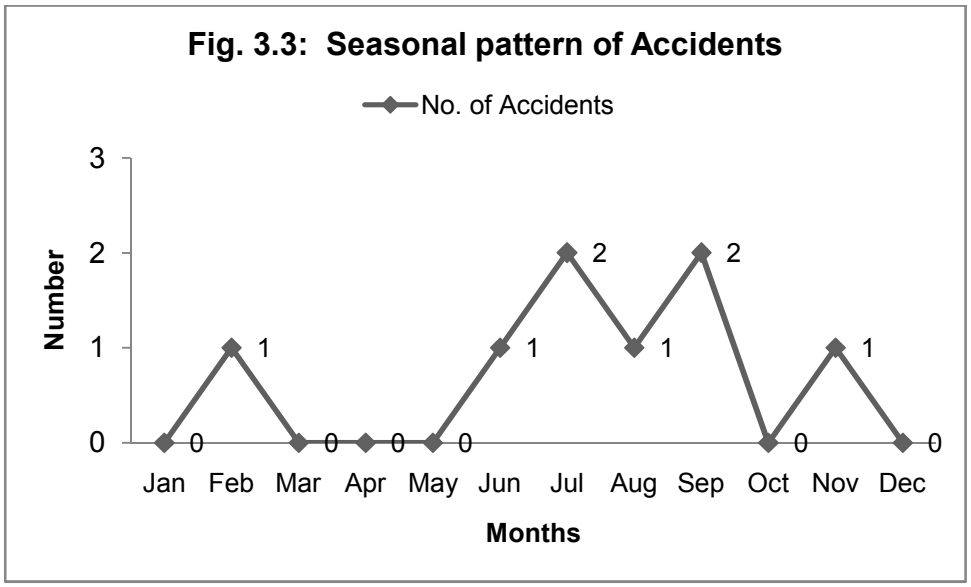
In the Walayar Range of Palakkad Forest Division 40% of the total elephant mortality has happened due to train accidents. In addition to elephant death, a few chital and wild boar have also died due to train accidents in this area.

In most of the cases animals from a herd have died. Out of 15 elephant deaths, four were adult male, four adult female, two juvenile (one male and one female), three calves and two animal are unsexed (Fig. 3.2).



3.2 Seasonality of Accidents:

Seasonal mortality data show that most of the accidents have taken place during monsoon and the agricultural season between the months of June and November (Fig 3.3).



All accidents have taken place by night bound passenger trains between 21:00 and 02:15 hours.

3.3 Elephant movement

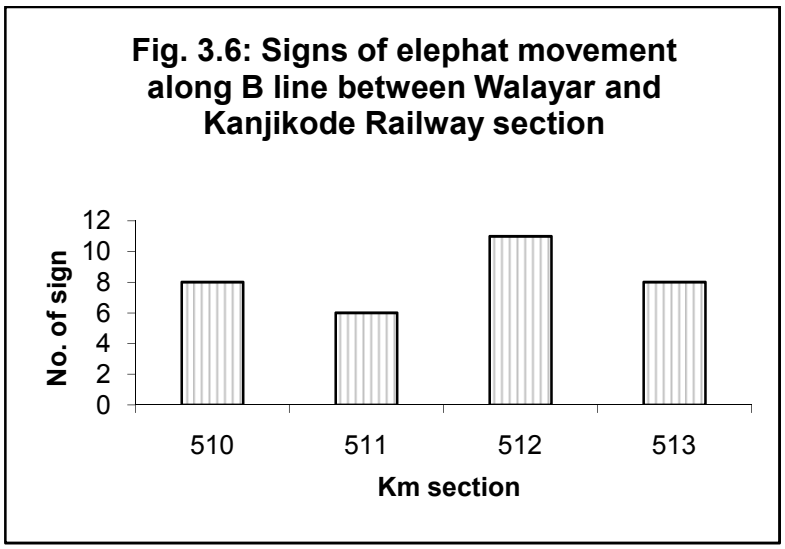
Frequent elephant movement along the railway track were recorded both on A and B line between Kanjikode-Walayar and Walayar – Etimadai stations (Fig. 3.4 & 3.5).

Fig. 3.4: Elephant signs along the railway track

Fig. 3.5: Family group crossing railway track between Walayar-Kanjikode

Between Walayar and Kanjikode, frequencies of elephant signs were recorded from Km 510 to 513 on B line and from Km 511 to 513 on A line (Fig 3.6 & 3.7). Elephant movement signs were also noticed between Km 505A-508 on B line and Km 506 – 508 on A line between Walayar and Etimadai (Fig 3.8 & 3.9). Between

Etimadai-Madukarai and Madukarai-Podnaur stations elephant movement is occasional.



During the whole study period elephant groups or loners were sighted on 15 occasions close to the railway track and in nearby areas. The largest group sighted was of 15 animals. The area between Walayar-Kanjikode stations is being used by a family herd of approximately 15-20 elephants and a few small groups and loners. The area between Walayar-Etimadai stations is mainly used by loners but at times small family groups also visit this area.

The area between Walayar and Kanjikode where elephant movement has been recorded has a good forest patch between A and B line extended between Km 510 and 513. Though this is a small patch of forest this is the only flat land available for the elephant in that area. Most of the forests of the Walayar range are hilly. Another important reason is that this is the only area where elephant can negotiate the hill range between Walayar and Kanjikode stations (Fig. 3.10).

Similarly the area between Walayar and Etimadai where elephant movement has been recorded has a good forest patch between A and B line. This is also a flat land and has a large patch of bamboo. Other areas close to it is highly fragmented and disturbed.

Fig. 3.7:Signs of elephant movement along A line between Walayar and Kanjikode Railway section

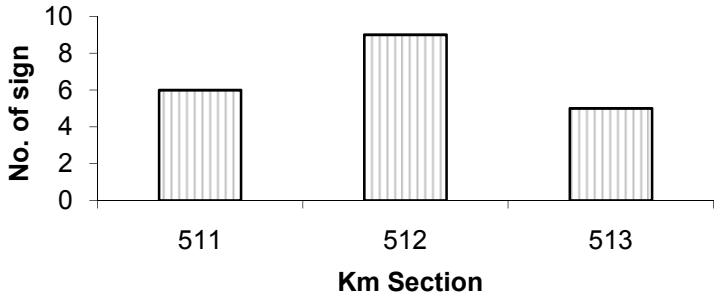


Fig. 3.8: Signs of elephant movement along B line between Walayar and Etimadai Railway section

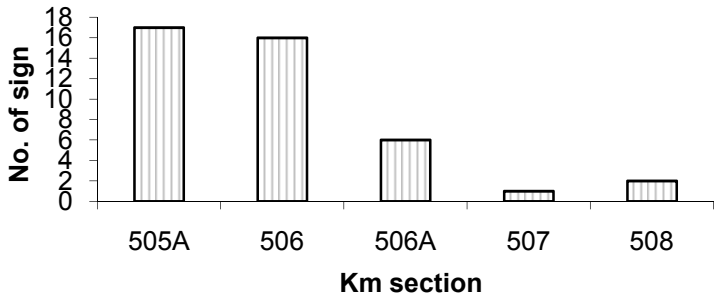
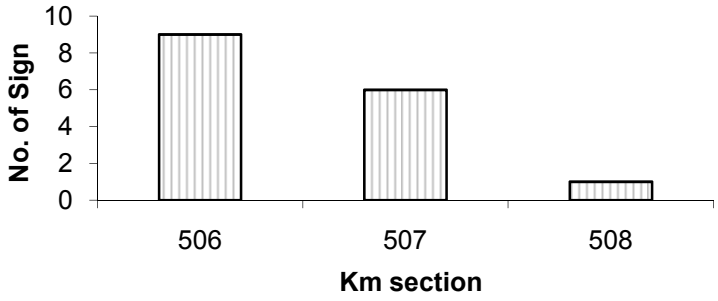


Fig.3.9: Signs of elephant movement along A line between Walayar and Etimadai Railway Section



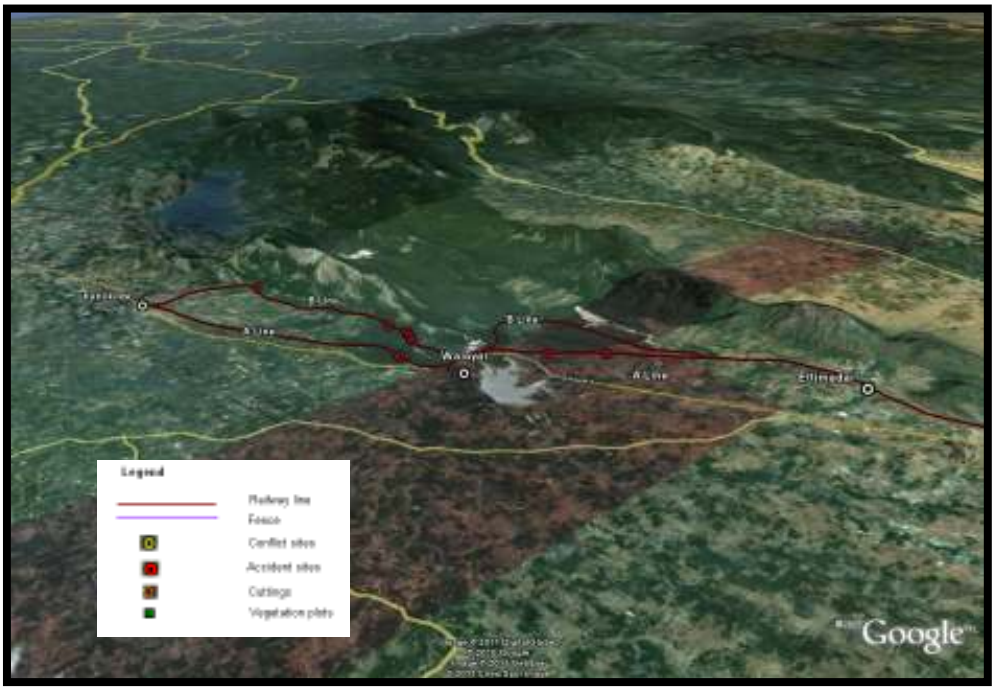


Fig. 3.10: Map showing the terrain of the area

3.4 Identification of critical sections:

Out of six accidents in the Kanjikode-Walayar section, five have taken place on the B line and one on the A line (Fig 2.4). In all accidents on the B line, members from a family unit have been killed. On the A line one solitary male was killed.

On the B line, clearly the most critical section lies between Walayar and Kanjikode (Fig 3.11). Even in this section, the area between 511 Km to 513 Km is the most crucial as four accidents have taken place in less than a two kilometer stretch. This area is very crucial for elephant movement as one accident has also taken place in the same area on A line between 511-12 Km (Fig 19). Similarly, on the A line the stretch from 505 Km to 508 Km on the Walayar-Etimadai section is critical as two accidents have taken place in this area too (Fig 3.12). This result helps in narrowing down of the problem. For implementation of mitigation measures between Walayar and Kanjikode stations attention should be given in the three Km section on both A and B line from 510 and 513 Km. Similarly between Walayar and Etimadai stations attention should be given on A and B line from 505 and 508 Km. Between Walayar and Etimadai stations although no accidents have happened on the B line in the past, the stretch is highly prone to accidents. There is another critical section on B line between Walayar and Kanjikode stations from Km 515 to 517. This is a three Km stretch and elephant movement takes place

mostly for crop raiding in the fringe villages. In the past, one accident has taken place in this section.

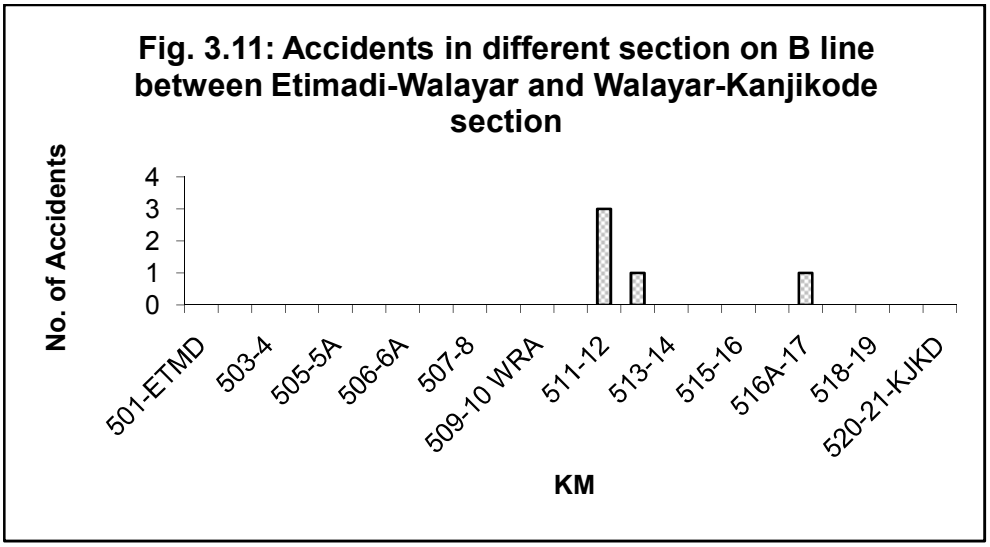


Fig. 3.11: Accidents in different section on B line between Etimadi-Walayar and Walayar-Kanjikode section

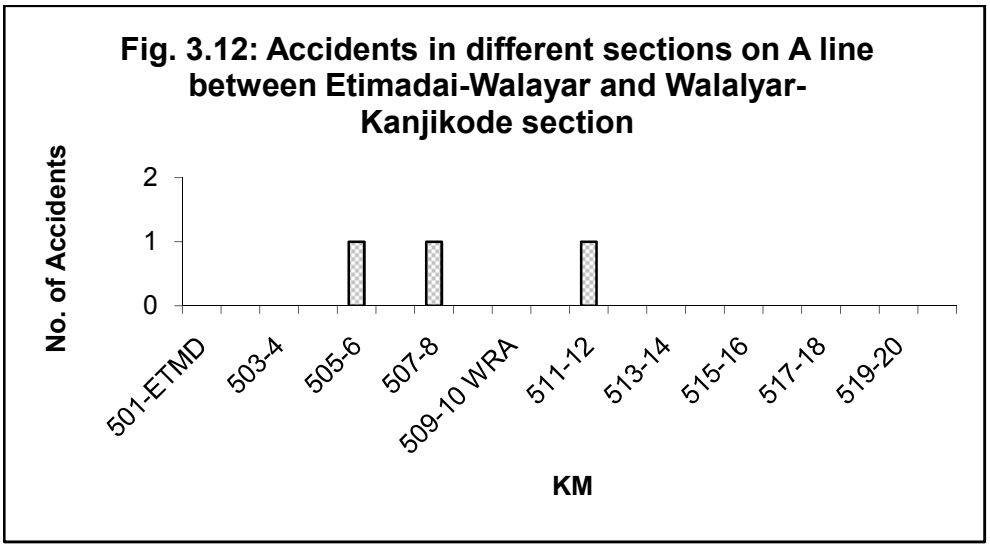


Fig. 3.12: Accidents in different sections on A line between Etimadai-Walayar and Walalyar-Kanjikode section

3.5 Factors responsible for accidents

There might be several factors which has an influence on the mortality of elephants due to train hits in this region. These might be ecological, technical or human induced factors.

A) Physical factors

(i) Curves

Curves are a very important physical feature along the track. Curves increase the probability of accidents due to low visibility (Fig. 3.13). The area between Walayar

and Kanjikode especially on the B line has a large number of critical curves (Table 1, 2, 3 & 4 in Appendix-4). The area with curves and steep cuttings become more prone for accidents. The area between Km 511 and 513 and 516A and 517 has experienced five accidents due to the presence of curves or cuttings.

Fig. 3.13: On sharp curve visibility decreases

(ii) Cuttings

Cuttings are highly sensitive sections on the track. Animals get trapped in cuttings at the time of train movement and get killed. Out of nine accidents, six accidents have happened in cutting with steep embankments on the sides of the track Fig. 3.14, 3.15 & 3.16). In such a situation the animal does not get space to escape and cannot climb up to the top. The area between Walayar and Kanjikode specially on the B line has a large number of critical cuttings (Table 5, 6, 7 & 8 in Appendix-4). There are few critical cuttings between Walayar and Etimadai and Madukarai and Podanur (Table 6 & 8 in Appendix-4).

Fig. 3.14: Elephant death in cutting between Etimadai and Walayar

Fig. 3.15: Elephant death in cutting Between Podanur and Madukkarai

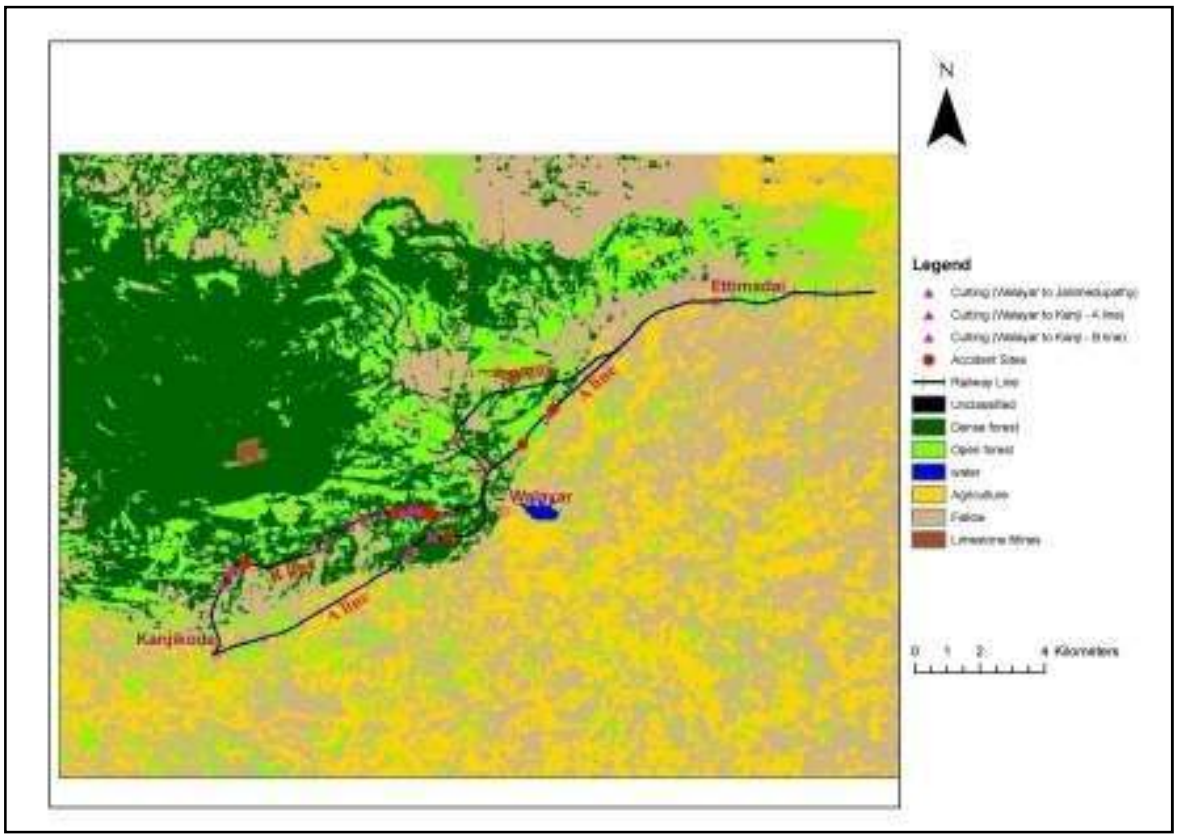


Fig. 3.16: Locations of the cuttings and accidents along the railway track

B) Technical factors

i) Speed and frequency of the trains

After establishment of B line the frequency of trains has increased several folds in this section. Each day more than 50 trains pass through this area. Similarly the speed of trains has also increased gradually. Train speed in some of the section is 80 Km / hour or above. The high frequency and speed of the train has contributed a lot to elephant casualty on this track.

C) Ecological factors

(i) Landuse changes

Unlike other regions this area has also experienced extensive changes in landuse pattern in last few decades. In addition to commissioning of B line through forest area in 1974, other development activities and landuse changes like, urban developments, industrializations, mining, growth of settlements and change in crop pattern & land tenure together has contributed to the habitat loss especially in the flat areas and foothills (Fig. 3.17, 3.18, 3.19 & 3.20).

A change detection analysis over period of only nine years between 1990 and 1999 showed decrease in dense forest category (Table 13). The increase in open forest and decrease in agriculture and fallow land actually could be due to increase in plantation like coconut and banana (Table 13).

In the last few years several buildings have come up in the foothills especially in Tamil Nadu which was previously open for elephant movement. Industrial developments like Malabar & ACC cement factories and their associated infrastructure and activities have contributed to the habitat fragmentation to a certain extent. The limestone mining activities in the prime elephant habitat both in Kerala and Tamil Nadu had created lot of disturbance and blocked the natural movement of elephants. This is also one of the reasons that elephants started using the area close to railway track.

Similarly, in past the several years, villages have also expanded. In our questionnaire survey 48% respondents revealed that they shifted to the area in the past 30 years (Table 9). Cash crop plantation has increased at the cost of fallow land (increase in open forest category shown in the Table 13 could be due to plantation). Change in cropping pattern and landuses in villages situated close to the railway track has created favorable conditions for elephant movement.

Table 9: Change in village population and landuse

Year of residing in the village	% surveyed population
0-20	31
21-30	17
31-40	14
41 – Above	38

Fig. 3.17: Urban development in the foothill, part of elephant habitat

Fig, 3.18: Malabar cement factory

Fig. 3.19: Malabar limestone mining right in the elephant habitat

Fig. 3.20: Change in crop pattern and landuse near railway track and area

(ii) Crop as an attractant

A change in cropping pattern and plantation especially in the villages situated on close vicinity of the railway track has created an environment which attracts elephant (Fig 3.21, Table 10 & Appendix-6). Paddy is the major crop in Kerala and coconut and banana is the major plantation. In Tamil Nadu major crops are paddy, gram and groundnut and major plantation is coconut and banana. These crops and plantations are preferred food for elephant. The land holding of more than 50 % people surveyed were two or less than two ha (Table 11). Only 12 % people have land holding of more than five ha (Table 11).

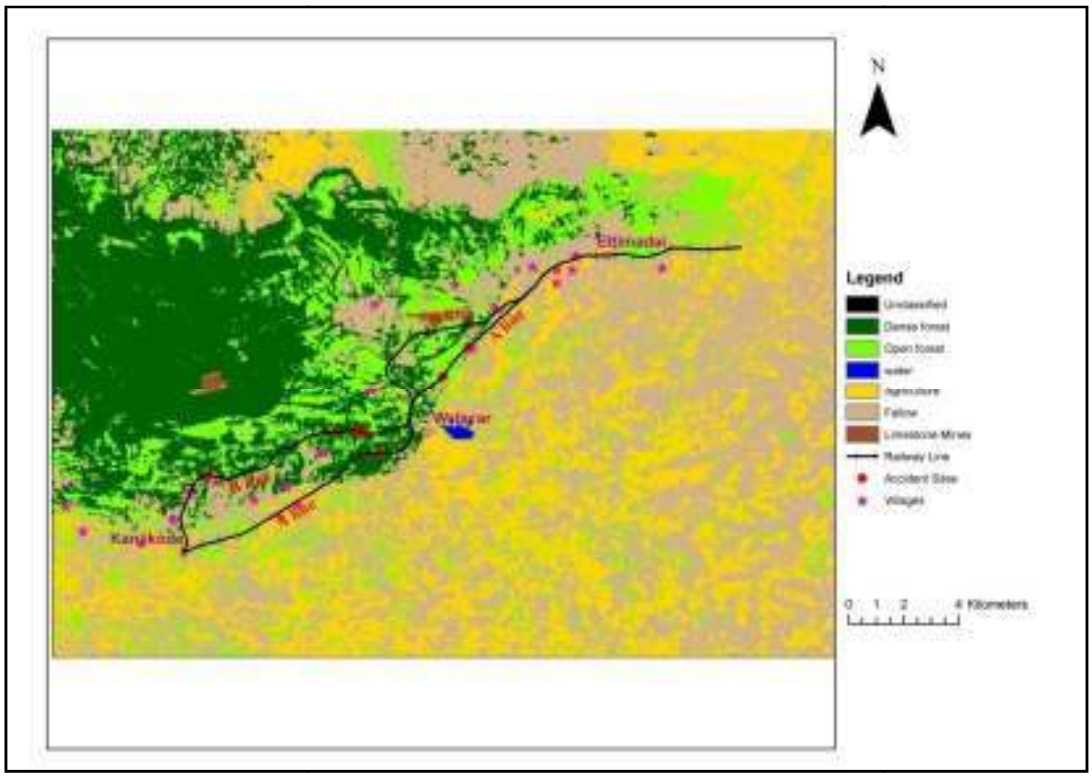


Fig. 3.21: Locations of the villages

Table 11: Land holding of the area

Area	% of surveyed population
0-2 ha	***53.60***
2.1-4 ha	25.49
4.1-6 ha	8.50
6.1-8 ha	3.92
Above 8 ha	8.50

In the questionnaire survey 65% of the respondents reported crop depredation by elephants in the last one year to the tune of 58 hectare (Table 12). People also reported about an increase in crop depredation cases in the last few years (Fig. 3.22). Elephants use forest patches close to the track as shelter during daytime and do crop raiding in nearby villages in the evening and night time. Most of the crop raiding takes place between June and December. Period of crop depredation also coincides with the elephant mortality due to train accidents in this area. Crop depredation by herd (52%) and loner (48%) are almost equal.

Table 12: Intensity of damage in the surveyed villages

Sl. No.	Damage of different crops	Area (in ha.)
1	Plantation (coconut, banana, mango and others)	29.03
2	Other cereals and pulses	4.5
3	Maize	2.63
4	Groundnut	14.38
5	Paddy	6.27
6	Vegetable	2.46
7	Peanut	1.01
8	Tomato	3.44
	Total=	57.96

Fig. 3.22: Damage to coconut plantation by

Ninety three percent of respondent reported that crop depredation management is still undertaken individually. People use combination of method to protect their crops. Out of three mitigation measures adopted widely 93% uses crackers to drive elephants. Power fence is used by only 8% people. More than 92% people who are using power fence placed it in medium (69%) or ineffective (23%) category in conflict management.

(iii) Habitat

Line B passes through elephant habitat between Etimadai-Walayar and Walayar-Kanjikode railway sections. The total habitat available for elephant in the region is less than 200 km^2 (Table 13). But most of the area is hilly, of which some are inaccessible for the elephant (Fig. 3.10). The flat lands available are under few small forest patches, agriculture land, plantations, settlements and other development activities. The two comparatively good forest patches in the flat land falls between A and B line (between Km 505A and 508 and Km 511 and 513) and this is exactly where most of the accidents are occurring. Though these are small forest patches, these are the only forests available in the flat land.

We did extensive sampling to compare the habitat (Fig. 3.23), utilization status, availability of water, preferred food species, and disturbances. It is evident from the result that habitat quality and utilization pattern is more or less same in the compared areas (Table 14 & 15). The details of tree species are provided in Annexure-5 (Table 16 to 23).

Hence habitat does not play a major role. But during the rainy season between the months of June and December the frequency of elephant movement increases due to a combination of reasons like crop raiding, inaccessibility of forest areas that have difficult terrain, disturbances due to blasting and other activities in mining area and blockage in the natural movement area due to several disturbances. Though the habitat present near railway track between Etimadai - Walayar and Walayar – Kanjikode are small patches but their utilization by the elephant is at par to larger habitat, due to the attractions near it and disturbances in the main habitat.

Table 13: Area under different landuse classes

Sl. No.	Landuse classes	Area in 1990 (Km^2)	Area in 1999 (Km^2)	Change in area (Km^2)
1.	Dense forests	124.22	122.21	- 2.01
2.	Open forests	66.69	83.86	+ 17.17
3.	Water bodies	2.5	0.5	- 2
4.	Agriculture & Fallow land	351.82	338.24	- 13.58
5.	Limestone mines	1.13	1.24	+ 0.11
	Total	546.36	546.05	

Table 14: Status of habitat available around railway track and in the region for elephant in Palkkad and Coimbatore Forest Divisions of Kerala and Tamil Nadu

Sl. No.	Area	No. of tree sp.	Tree density /ha.	Status of elephant food species		
				No. of species	Tree density/ ha.	% of total tree density
1	Habitat near A and B line between Walayar and Kanjikode, Kerela	41	349	22	241	69
2	Habitat in the foothills in Puduchery south between Walayar and Kanjikode, Kerela	27	490	14	273	57
3	Habitat in and around Kanjikode and Mallampuzha dam, Kerela	28	636	15	465	73
4	Habitat near A and B line between Walayar and Etimadai, Tamil Nadu	37	338	19	259	76
5	Habitat on the north to the ridge around Malabar mine, Kerela	36	453	21	383	84
6	Habitat in the hills near Parapatty, Tamil Nadu	26	236	14	149	63
7	Habitat near track between Etimadi and Madukari, Tamil Nadu	5	87	1	58	67
8	Habitat in foothill near Arivoli Nagar between Etimadi and Madukari, Tamil Nadu	3	42	2	26	62

Table 15: Status of habitat utilization, disturbances and water availability

Sl. No.	Area	Percentage of plots with		
		Elephant signs	disturbances	Water bodies
1	Habitat near A and B line between Walayar and Kanjikode, Kerela	36	62	46
2	Habitat in the foothills in Puduchery south between Walayar and Kanjikode, Kerela	60	40	75
3	Habitat in and around Kanjikode and Mallampuzha dam, Kerela	58	100	50
4	Habitat near A and B line between Walayar and Etimadai, Tamil Nadu	64	72	33
5	Habitat on the north to the ridge around Malabar mine, Kerela	50	16	33
6	Habitat in the hills near Parapatty, Tamil Nadu	71	88	65
7	Habitat near track between Etimadi and Madukari, Tamil Nadu	0	40	0
8	Habitat in foothill near Arivoli Nagar between Etimadi and Madukari, Tamil Nadu	67	100	33

Fig. 3.23: Elephant feeding sign *Wrightia tinctorea*

(iv) Impact of disturbances

Limestone mining activities in Walayar and Etimadai landscape is not only an obstruction in the elephant movement but also creates huge disturbances due to operation activities like, blasting, movement of heavy vehicle to carry ore and presence of operation staff (Fig. 3.24, 3.25, & 3.26). Similarly, indiscriminate building construction, industrial and urban development in the foothill between

Ettimadai and Podnaur over the year has also created hurdle in natural movement. These are also the reason now elephants are using forest patches close to the railway track which previously they might not be using so frequently. Elephant movement has been shown in figure 3.27.

Fig. 3.24: Walayar cement factory

Fig. 3.25: Mining operation in the elephant habitat

Fig. 3.26: Map showing various disturbances to elephant movement

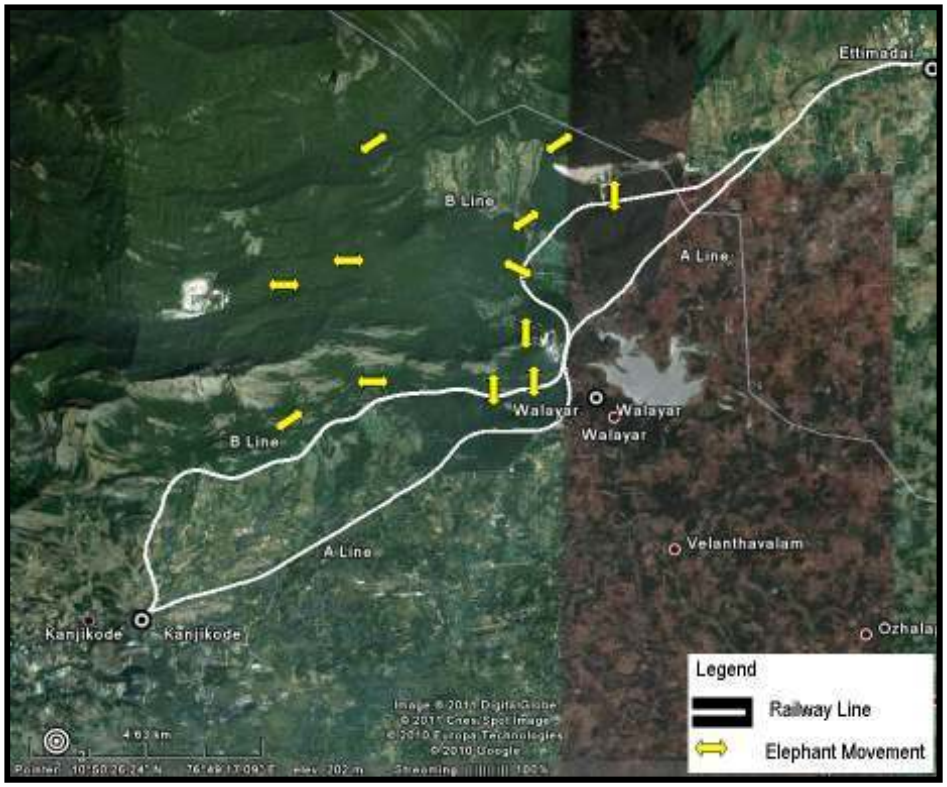


Fig. 3,27: Map showing elephant movements

4. Mitigation measures undertaken by Railway and Forest Department

The Railways has taken several initiatives to minimize the problem (Fig. 4.1 & 4.2). These include putting up elephant signage along the track to remind drivers about elephant movement, small awareness signage for the passengers on the railway stations, announcement for the train passengers at Palakkad and Coimbatore and patrolling of the track by their gang man. Other than this, the Railways has also issued a caution to their loco pilots to blow the whistle continuously in elephant movement areas and has reduced the train speed to 45 Km/ hour during night between 6 PM to 6 AM in the accident prone areas.

Fig. 4.1: Elephant signage along the railway track

Fig. 4.2: Awareness board for the passengers

The Kerala Forest Department has on its part fenced approximately 10 km of railway track between Walayar and Kanjikode in the Walayar range (Fig 4.3). Maintenance of these fences was found satisfactory except for a few sections. Similarly, Tamil Nadu Forest Department has also fenced some of the area before Podnaur to restrict the elephant movement on to the road and railway track. However, these measures fall short of a comprehensive management plan which is required to stop the accidents from happening (Fig. 4.4). The selection of barrier for elephants should be done carefully as per the terrain and its maintenance (Fig. 4.5). Power fences may not be a long term solution due to maintenance problems.

Fig. 4.3: Power fence along the track

Fig. 4.4: Elephant manages to cross the trenches

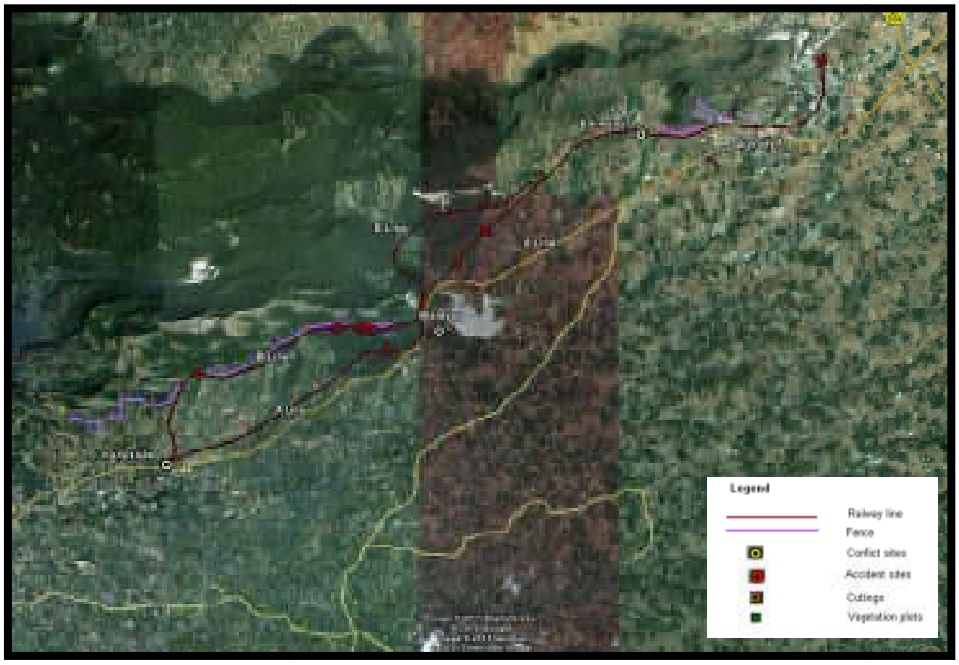


Fig. 4.5: Map showing fence and accident sites

5. Suggested mitigation measures

To mitigate this problem site specific mitigation measures needs to be implemented in different sections. There are few other conservation issues like human-elephant conflict and disturbances in the elephant habitat due to limestone mining and growth of settlements, which is directly and indirectly associated with this problem. Hence, these issues should also be considered holistically while implementing the plan.

Based on the accidents records, elephant movement and presence of various factors responsible for accidents, the following stretches are identified as highly sensitive and prone for accidents on A & B lines:

a. Km 510-513 (Walayar-Kanjikode, Kerala)
b. Km 505-508 (Etimadai-Walayar, Tamil Nadu and Kerala)
c. Km 515-517 on B line (Walayar-Kanjikode, Kerala)
d. Km 492-493 (Podnaur-Madukkari)

5.1. Long term Mitigation Measures:

Following long term mitigation measures needs to be implemented section wise

A. Podanur-Madukkari Section:

Stray movement of elephant occasionally takes place in this section. It is not a high elephant movement area. Both the A and B line run parallel in this section. On 4th February 2008 one accident took place in this section in a cutting (Km 492/1-15) in which four animals died. There are two critical cuttings (Km 492/1-15 & Km 492/17-25) which needs to be widened with gentle slope provided on the sides. The other two cuttings mentioned (49/10-14 & 495/3-9) are low and not critical.

B. Madukari-Etimadai Section:

Elephant movement along the railway track in this section is also rare. No accident has taken place in this section. Both the A and B line run parallel in this

section also. The two critical cuttings (Km 500/7-1 & Km 496/45-497/20) need to be widened with gentle slope on the sides.

C. Etimadai-Walayar Section:

Problem in this section is mostly confined between Km 505/0-508 on both A and B line. The B line is two km longer than the A line (There are additional kilometers, 505A and 506A on B line). There is regular movement of elephants (loners) in this section across the railway track to use small patch of forest between both the lines and for crop raiding in nearby villages. This forest patch extend on B line from end of the Km 505 to 506A/13 approximately 2.5 km and on A line from 506/14 to 507/14 for approximately one km. In this section the limestone mine of ACC cement factory is situated to the north to the B line at a distance ranging from 100 to 500 m.

After Km 507/14, the A line runs completely outside the forest up to the Walayar railway station but B line again goes through forest between Km 507/5 and Walayar railway station (509/15). On B line movement of elephant between Km 507/5 and 509/15 is less.

On A line there is a critical cutting between Km 505/14 and 506/4 in which one accident has taken place on 17th July 2009. Including this, total two accidents have taken place in this section on A line. Though there has not been any accident on B line in the past but, due to frequent elephant movement across the track this section is very crucial.

The B line in this section between Km 505 and 509 should be fenced using old rails from both sides (Fig. 5.1 & 5.3). Fencing should be done in such a way that it ends on bridge to prevent elephant entry inside the fenced area on railway track. The total length of fencing on one side will be around five Kilometer. Fencing on B line can be started from Km 505A/1 from the bridge and can end at suitable place near 506 A/ 15. Again fencing can be started from 507/9 from the bridge on the Walayar River and can end near 509/0. The area where the bridge is not present a girder bridge kind of structure can be constructed to prevent the elephant entry in the fenced area. There are few bridges which elephant can use after little

modifications, like replacement of iron structure with concrete on the top and providing slope in the river bed below the bridges (Fig. 5.2). Bridges in this sections are near 505A/11-13, 506/33-35, 506/7-9 (below this is road for ACC mines), 507/5-9 (On Walayar River) and 508/5-7.

Fig 5.1: Old rail fencing to prevent elephant movement in Jharkhand

Fig 5.2: Bridge which elephant can negotiate

Similarly the A line should be fenced between 506/14 and 507/14 from one side only for approximately one km (Fig. 5.3). Fencing poles should be placed three meters apart from each other. The minimum length of poles above the ground should be 180 centimeter and below the ground 70 centimeter. There should be two horizontal rails joined to each poles first at the height of 75 centimeter from the ground and another at the top.

The critical cutting between 505/14 and 506/4 can be widened with gentle slopes on the sides. The other option is to fence the cutting from the sides using old rails to prevent the animal movement inside. These options can be selected based on actual estimation of the cost and feasibility. In cuttings minimum three to five meter gap should be provided on the sides depending on the height of the cutting. Providing gentle slopes on the sides is essential.

To prevent crop depredation in nearby village a suitable barrier (power fence/trench) should be made along the entire forest fringe. Other than this there should some strategies to have regulation on mining and growth of settlements.

D. Walayar-Kanjikode Section:

The entire stretch between Km 510 and 518 on B line is critical. The critical sections are Km 510/0-513/15 and Km 515-517. On the A line the problem is between Km 510 and 513. This whole section is situated in Kerala. There is regular movement of family groups and loners as this section also has a small patch of forest between the A and B lines. Elephants use this area both as a habitat and for crop raiding in nearby villages. This is the only area between Walayar and Kanjikode where elephants can manage to cross the hills from the railway track to the northern side of the habitat. This forest patch extends on B line from Km 510 to 513/17 approximately 3.5 km and on A line from 510 to 513 approximately 3 km.

After Km 513, A line runs completely outside the forest up to the Kanjikode railway station but B line goes through forest between Km 513/25 and 518.

On B line there are several critical cuttings (Table 5 in Appendix-4) which along with blind curves (Table 1 in Appendix-4) make the area highly prone for accidents. Out of nine accidents, five have taken place on B line in this section. Some of the cuttings are difficult to widen. Even after widening of critical cuttings, the problem in this area will remain the same as there are several blind curves and frequent elephants movement.

The B line in this section should be fenced from both sides using old rails between 510/25 and 518 (Fig. 5.3). Fencing can be started from the one end of a bridge at 510/25 near the nallah and end near the edge of the first cutting (510/44). Then it can start from the other edge of the first cutting at 511/9 and can end at 512/11 near the first end of the next critical cutting. Fencing can be started again from 512/19 at the second end of the cutting and can end at 512/29 near the bridge on the nallah. The total fencing till this point will be 1.5 Km in length. Fencing can then be started from 512/31 from the other end of this nallah and can end near 518. The B line in this section is two km longer than the A line. Fencing on B line will be approximately 8.5 kilometer on one side. There are several bridges in this sections of which a few of them (between km 510/23-25, 512/29-31, 513/15-17) are crossable for elephants. Some of these bridges are being used by the

elephants. Bridges in this area should also be made animal friendly after few modifications like replacement of iron structure by concrete. Fencing of the B line from both sides is important to prevent elephant movement along the track.

Similarly the A line should also be fenced by old rail from one side between 510 and 513 for approximately 3 Kilometers (Fig 5.3). Therefore, the total old rail fencing required to be done is 8.5 Km on the B line on both sides (total 17 Km) and 3 Km on the A line.

To prevent crop depredation in nearby village a suitable barrier (power fence/trench) should be made along the entire forest fringe as well. This area also needs proper strategies to regulate mining activities.

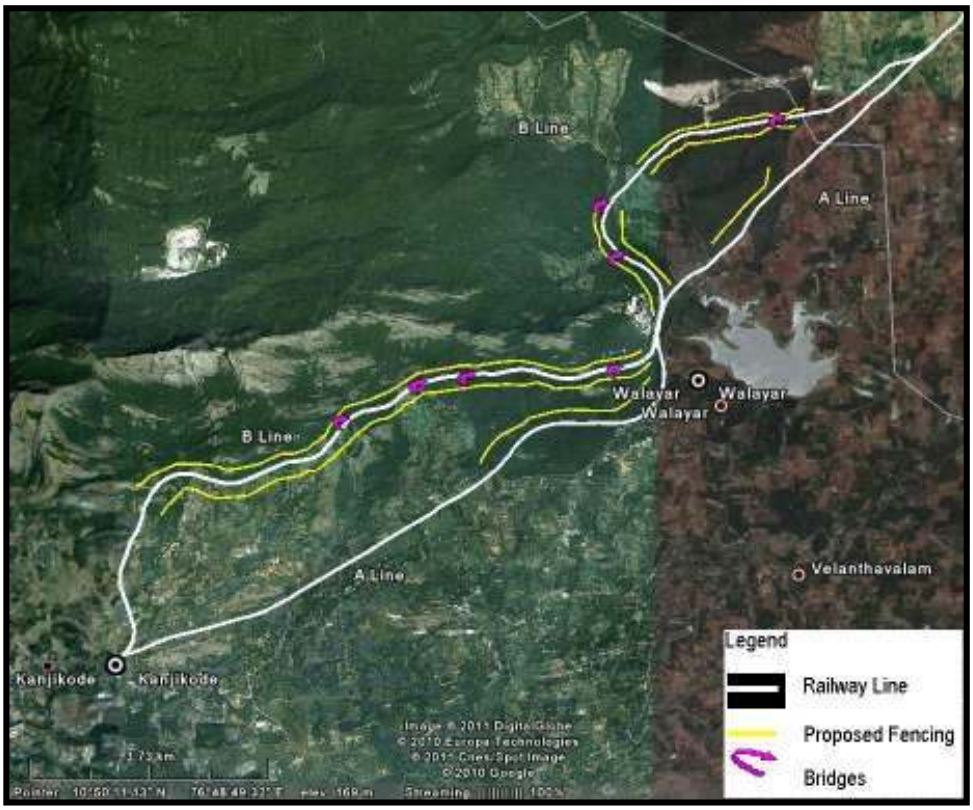


Fig. 5,3: Map showing proposed fencing

The important reason of allowing the elephants beyond the B line is the presence of habitat between the A and B lines. It is also difficult to restrict them up to the B line due to attractants like crops and plantations on the other side.

Erecting a suitable barrier only on one side of the B line (northern side) may not yield the desired result as elephants would still manage to come on to the track by moving to the other side by traveling along the barrier till they reach the ends. Last year, elephants crossed the track along areas between Kanjikode and Palakkad. Unless the other side of the B line is also fenced, thereby sandwiching the track between two closely laid out fences, there is no way one can prevent the elephants from approaching the tract. Employing old rails for fencing would be a better option than power fences or trenches as they require constant maintenance. Old rail fence installed between Posita and Manoharpur Railway section in Jharkhand has yielded a desired result in preventing elephant movement on the railway track (Fig. 5.1).

5.2. Short and Medium term Mitigation Measures:

The following short term and medium term mitigation measures should be initiated immediately until the long term solutions are implemented.

a. Initiate Joint night patrolling at five critical stretches

As it has been established that most of the accidents have taken place between the month of June to November, joint night patrolling by forest and railway staff can be undertaken in the five critical stretches (between Km 505/14-507/14 & 510-513 on A line and Km 505- 508, 510-513 & 515-517/25 on B line) between the months of June to December by five patrolling teams. Patrolling teams should be equipped with wireless or other communication systems, search lights and special signal to stop the train in emergency, raincoat and shoes. A minimum of three members should be in each patrolling teams. These patrolling groups should be trained to driving elephants off the track and rapidly communicate in case of emergency. In case of elephant movement along the railway track these patrolling teams shall inform the railway authority about the location of the elephant for cautioning the loco pilots. In such cases all trains in that particular stretch should proceed slowly with caution. Patrolling teams will stay near the site till the elephants move away from the track. Patrolling team will also try to drive the elephants from the track in case of emergency. This method has been tested on

the ground in Rajaji National Park and Deepor Beel area of Assam and has yielded good result.

b. *Clear vegetation along blind curves listed in Appendix-* 4:

Vegetations along blind curves in the elephant movement areas should be cleared up to a distance of 15 meters from the track in high priority areas (sees specific recommendations below) to increase the visibility for the loco pilots.

1. Vegetation should be cleared on either side of A & B line on Kms 510/0-513/15.
2. Vegetation should be cleared on either side of A & B line on Km 505/0-508 and Km 515-517 on the B line.

c. Raise Awareness among the Loco Pilots:

Awareness workshops for key railway staff like Loco Pilots, Loco Guards, and Stationmasters should be organized to provide them better information about this problem, elephant behaviour and precaution during time of emergency. Such activities can be organized by the Wildlife Trust of India in crew lobbies at important railway stations in this section.

d. Initiate Stakeholder coordination:

Regular meetings between railway and forest officials in the field are very important to share information, to implement mitigation measures and its monitoring. It is recommended that a Task Force comprising of representatives from Southern Railways, Kerala Forest Department, Tamil Nadu Forest Department, Wildlife Trust of India, and Elected Local Representatives of people (Village/gram level) be constituted with regular meeting immediately.

CHAPTER 4

Survey Report of Jharkhand

1. Introduction

The state of Jharkhand also has a problem of elephant mortality due to train accidents. Presence of a vast rail network through protected areas and important wildlife habitats, ferrying passengers and mineral resources has been responsible for death of several wild animals every year. Since 1994, more than 12 elephants have been killed in Jharkhand. Area like Saraikela- Kharsama, South Chaibasa and Kolhan Forest Divisions are accident prone sites (Fig 1.1).

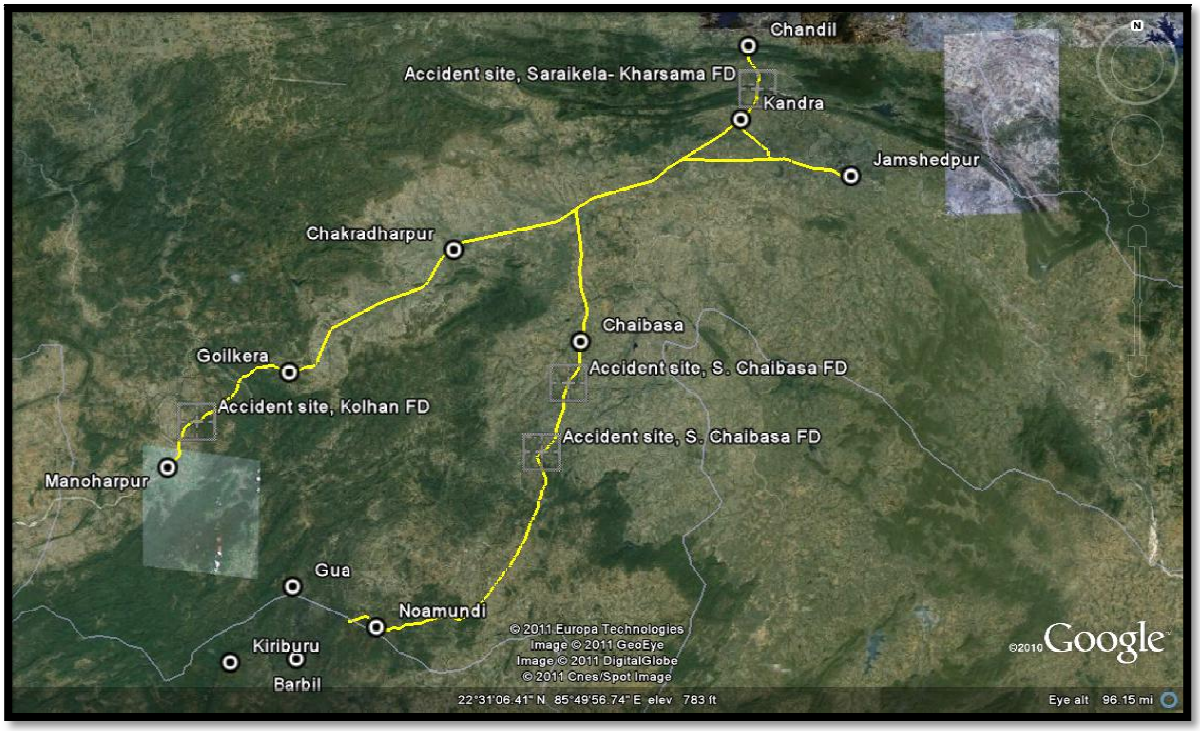


Fig. 1.1 Accident prone railway sections in Jharkhand

1.1. Critical Sections in important Forest Divisions:

Kolhan Forest Division:

Kolhan Forest Division has been the worst affected with record of nine elephant deaths since 1994. This section falls on the main Hawarah- Mumbai line between Chakrdharpur and Manoharpur (Fig 1.2). More than 40 mail/ express and several goods trains pass every day on this route. Goods trains carry raw materials and finished products of major steel and cement plants to several part of the country.

The main accident prone areas in this section fall in Goilkera range of Kolhan Forest Division between Goilkera and Manoharpur railway section. There are three small railway stations between Goilkera and Manoharpur, namely, Mahadevsal, Derawan and Posotia. One elephant death also took place (1994-95) in a tunnel between Mahadevsal and Derawan in Kolhan range and the other eight between Posotia and Manoharpur railway stations in Goilkera range.

The five kilometer track section (Km 362 to 367) between Posotia and Manoharpur is the most critical section. On 7th August 2000, four elephant died in a single accident near Km 364/30. In the year 2001 again four elephants died in two accidents on 21st September (two) and 28th October (two) in the same area.

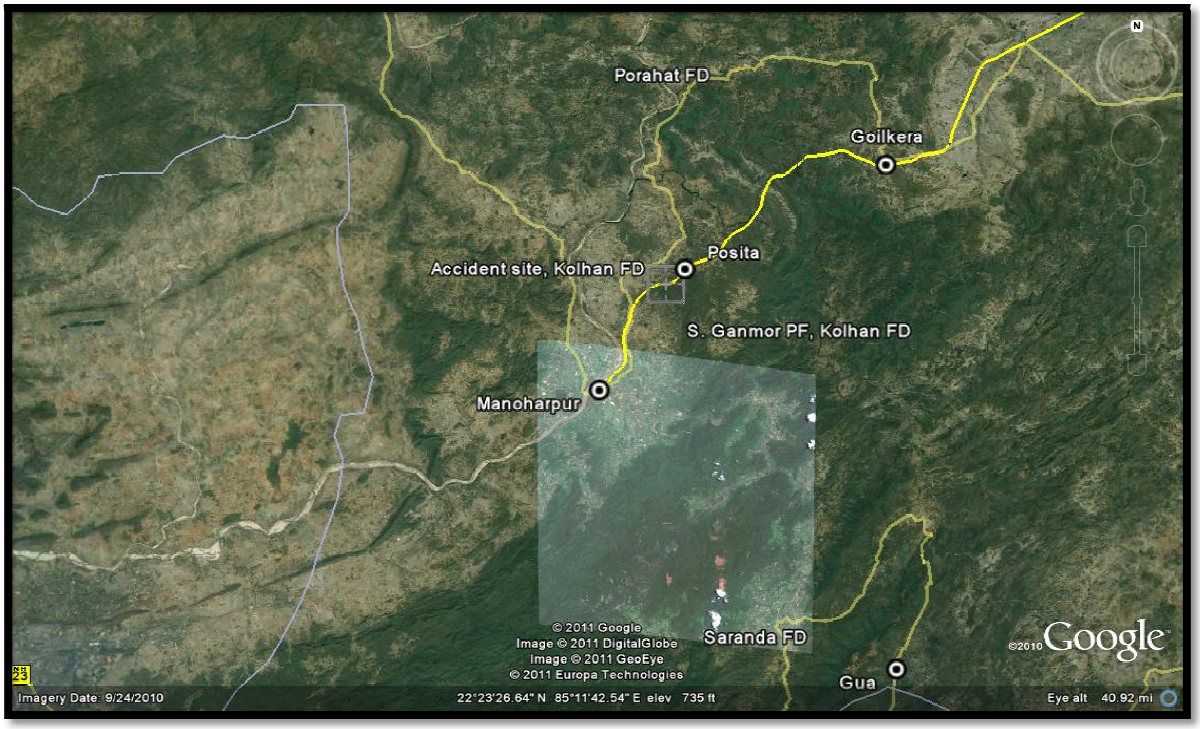


Fig. 1.2 Accident prone railway sections in Kolhan Forest Division

South Chaibasa Forest Division

In South Chaibasa Forest Division two elephant death have been recorded from Chaibasa range. The railway section between Chaibasa and Noamundi passes through the forest patches of South Chaibasa Forest Division. One accident took place between Singhookharia and Jhinkpani and another between Jhinkpani and Talaburu railway stations (Fig. 1.3). In this section mainly goods trains run to carry iron ore from Gua, Kiriburu, Meghatuburu, Jamda and mines based in Orissa.

Train traffic is very high in this area. Everyday around 40-50 goods and 10 passenger trains run on this track.

One female elephant died and three were injured in an accident which took place between Singhookharia and Jhinkpani railway stations on 19th Nov. 2002. Accident site is close to the Singhookharia railway station (Km 320/10). One male elephant was killed on 20th October 2007 in another accident which took place between Jhinkpani and Talaburu near Km 332/1 in Baralisia forest.

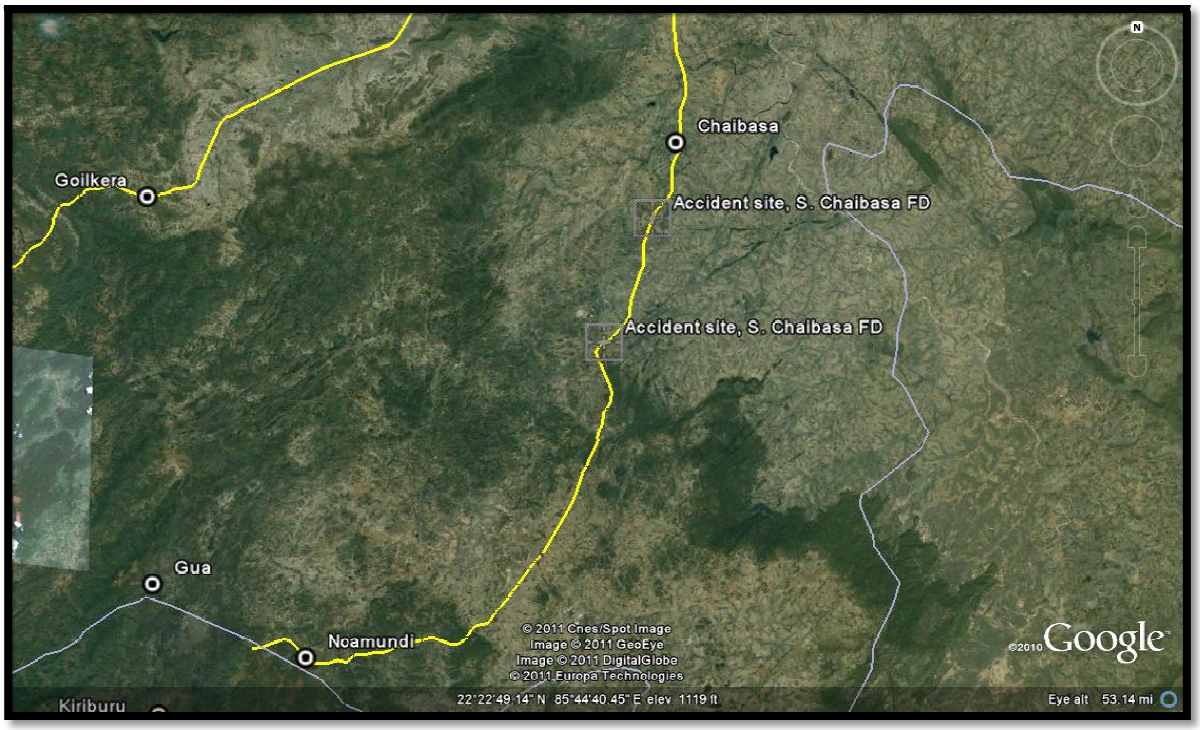


Fig. 1.3 Accident prone railway sections of South Chaibasa Forest Division

Saraikela-Kharsama Forest Division

In Saraikela-Kharsama Forest Division accident prone area falls between Manikui and Kunkai railway stations of Chandil- Kandra railway sections (Fig 1.4). One juvenile male elephant got killed in an accident on 25th December 1998 near Km 385/5-16 in Saraikela Range of Saraikela- Kharsama Forest Division. This section has high frequency of trains. Train speed in this section is also very high (80-100 Kmph).

Given the high vulnerability of these areas to elephants and the needs to reduce the possibility of accidents in the region, WTI conducted an assessment to outline

the vulnerable areas and to suggest suitable mitigation measures on the basis of our understanding of this issue.

Fig. 1.4 Accident prone railway sections of Saraikela- Kharsama Forest Division

2. Methodology

Secondary information on elephant deaths, date and time of accidents, locations and detail of trains involved in accidents, was collected from the forest records maintained with different forest divisions. Field visits were made to collect site specific details (Fig 2.1).

Information was collected on elephant movement using direct and indirect evidences present along the railway tracks. Information on habitat and corridors was also collected. Various habitat and landscape attributes like availability of water bodies along tracks, sharp curves and steep cuttings on the sides have been recorded. Data were also collected on presence of attractants like crops along the track in conflict prone areas.

Information was collected to identify critical areas prone to accidents, elephant movement zones along the railway tracks and physical features responsible for accidents. Information on mitigation measures undertaken by various stakeholders and their effectiveness in reducing elephant mortality were recorded during discussion with the officials and field visits.

GPS locations of the important landmarks were collected and transferred in a GIS domain to prepare maps. A digital satellite imagery of Landsat 5 of 1990 and 1999 was used for GIS mapping.

Fig. 2.1 Field visits and data collection along with forest and railway staff

3. Results

3.1. Animal mortality due to train hits

Since 1994, 12 elephant deaths have been recorded from different forest divisions of the state of Jharkhand. Out of these, nine elephants have died in Kolhan, two in South Chaibasa and one in Saraikela- Kharsama Forest Divisions (Fig 3.1).

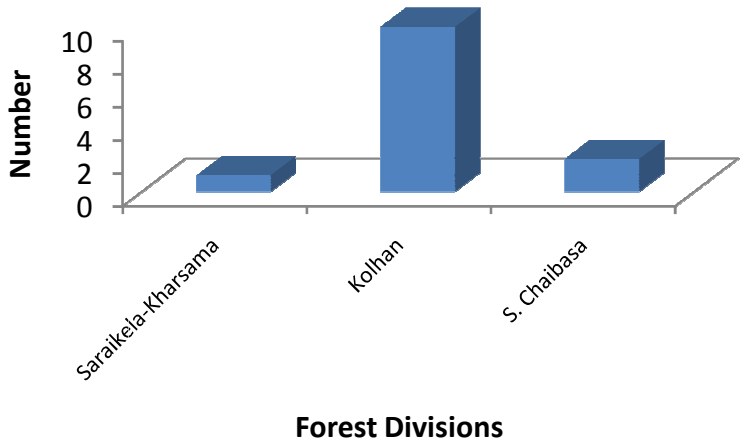


Fig. 3.1 Elephant death recorded from different divisions of Jharkhand

All elephant deaths took place during paddy crop season between months of August and December (Fig 3.2). During paddy season the frequency of elephant movement increases in the area when there are crops near railway tracks.

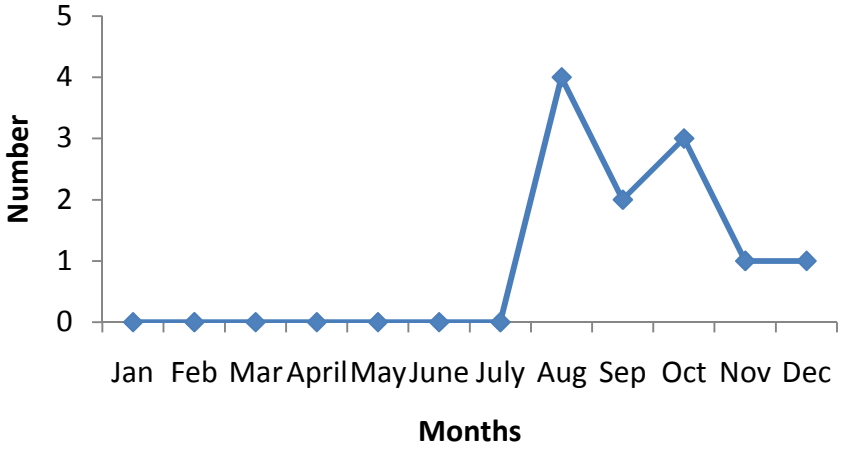


Fig. 3.2 Seasonal pattern of elephant death in Jharkhand

Accidents and elephant deaths have taken place in the year 1994-95, 1998, 2000, 2001, 2002 and 2007 (Fig. 3.3), suggesting a random nature of accidents.

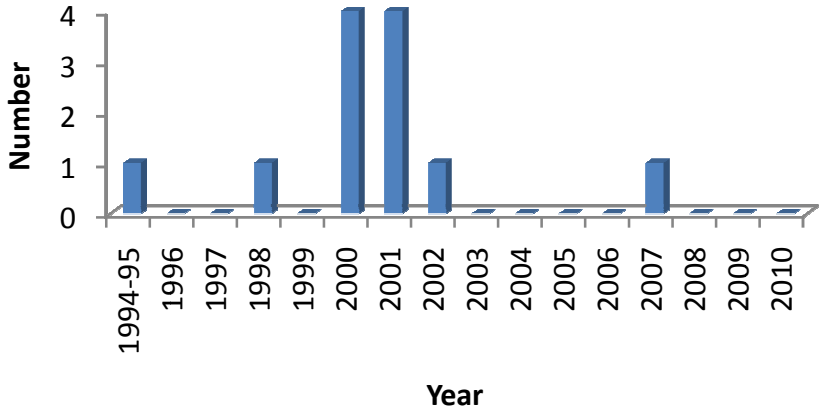


Fig. 3.3 Annual pattern of elephant death in Jharkhand

3.2 Animal movement and habitat

Kolhan FD

The railway track between Posotia and Manoharpur runs along the fringe of the forest of Kolhan FD (Fig. 1.2 & 3.4). Elephant movement in this section takes place mostly during crop season between August and February. Elephant movement from South Ganmore Protected Forest of Kolhan Forest Division, situated on south eastern side of the railway track usually takes place for crop raiding in the villages situated on the north western side of the railway track (Fig. 3.4). These villages are Sonpokhari, Barpose, Raida, Zozogutu, Ghaghera and posaita. After fencing, elephant crossing from south eastern side of the railway track has been stopped. Group size varied of elephants from 10 to 20 and on few occasion up to 35 elephants.

Forest is mostly sal dominated with several mixed associates.

Saraikela-Kharsama FD

Approximately 400 m length of railway track between Manikui and Kunkai railway stations passes through a forest patch of Saraikela range under Saraikela-Kharsama Forest Division (Fig 1.4). Elephant movement in this section mostly takes places during paddy and maize crop season between months of July and February. Group size varies from single elephant to 12. Elephant movement takes place between Km 384/26 and 387 (Fig. 3.5). During our survey, elephant signs (dung ball, foot mark and feeding signs) were recorded near km 385/14-16, 385/s-24-26 and 386/s10-11.

Forests of the Saraikela range are contiguous with Kharsama Range on one side and with the Chandi range on the other side. Elephants move from Kharsama range to Saraikela range and after crossing the railway track also goes up to Chandil range. Elephants sometimes cross the river Subernrekha and move up to the NH33 to Asanbani forest area of the Chandil Range. They occasionally cross the NH33 and goes up to Dalma Wildlife Sanctuary. Previously, this was a movement corridor but since the last several years, developmental activities like road, canals, stone crasher and urbanization have blocked their movement. Now-a-days elephant movement in the area is influenced by the availability of crops.

In Saraikela and Chandil Ranges the dominant species is sal and the forests are Protected Forests.

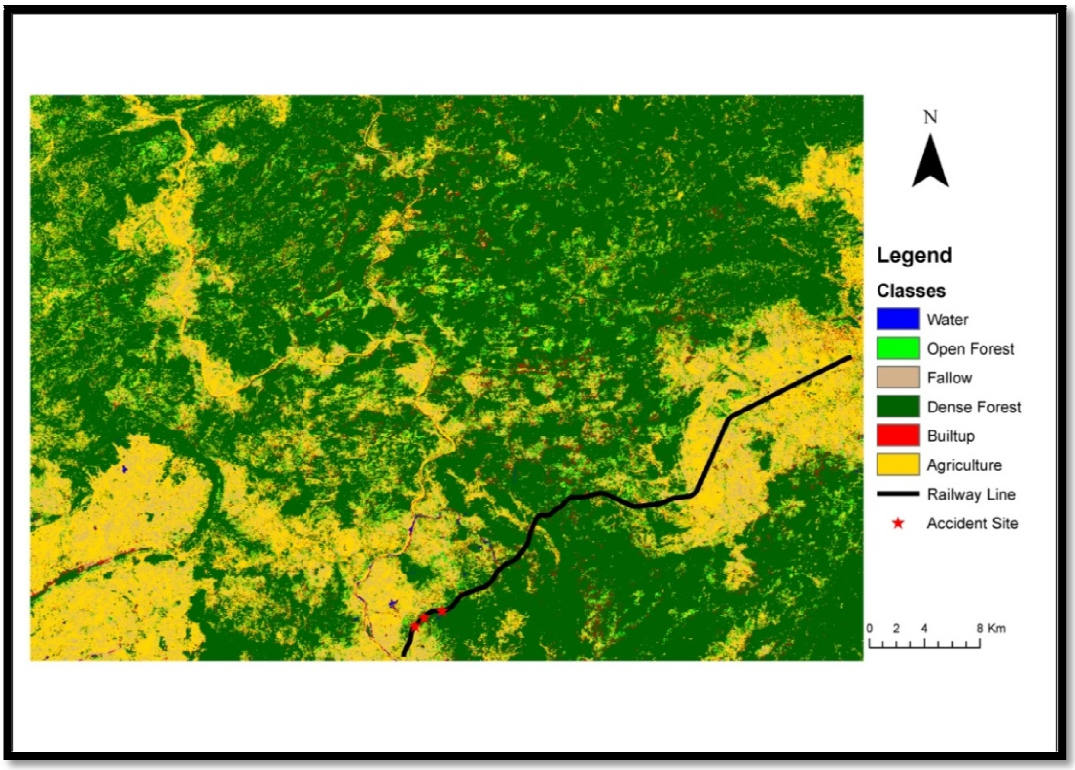


Fig. 3.4 LULC map showing accident prone areas in Kolhan FD

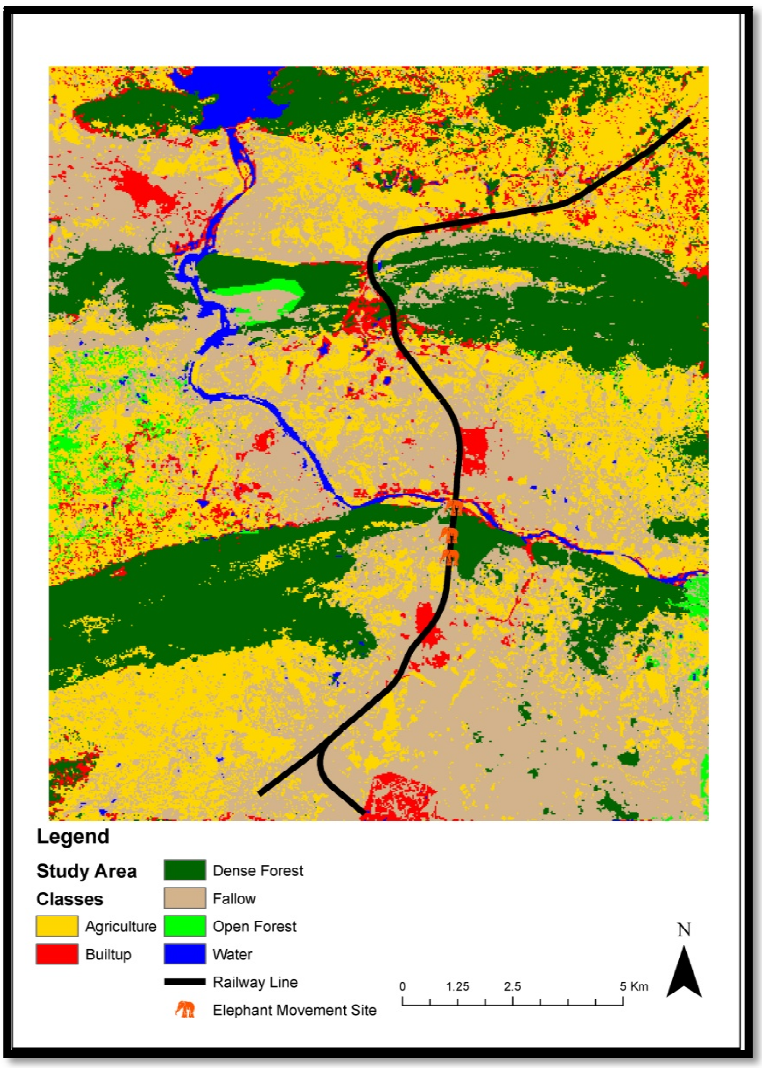


Fig. 3.5 LULC map showing elephant movement area
In accident prone areas in Saraikela- Kharsama FD

South Chaibasa FD

Elephant movement takes places mostly during the paddy season. This area is used as corridor between Bichaburu and Anjadbera Protected Forests connecting Kolhan to Chaibasa Forest Divisions. Habitat degradation and landuse changes in the area have been responsible for fragmentation of elephant habitat (Fig. 3.6). Large scale mining and industrial development has contributed to the habitat destruction.

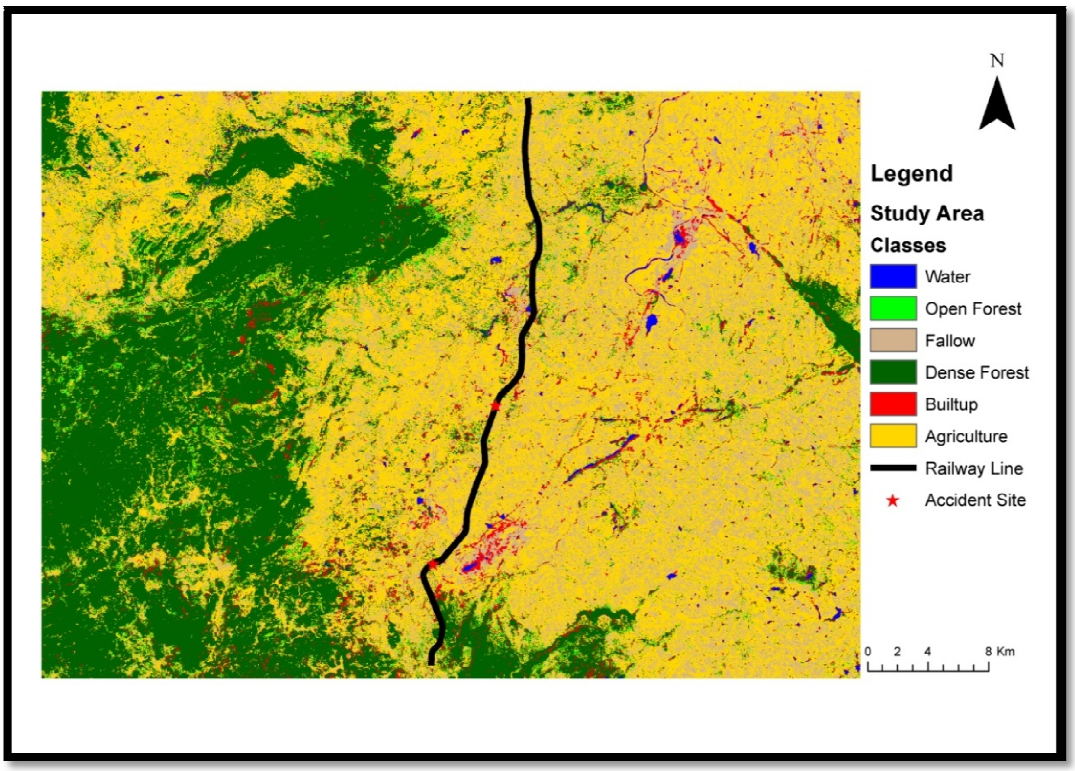


Fig. 3.6 LULC map showing accident prone areas in South Chaibasa FD

3.3. Identification of critical accident prone sections

Based on frequency of animal deaths, five different sections of the railway track were found prone to accidents. Among these one section (Km 362/20-367) in Kolhan FD was found highly critical (Table 3.1 & Fig. 3.4).

Table 3.1 Critical accident prone sections in Jharkhand

Area	KM section	Length	Railway stations	Elephant death
Kolhan FD	362/20-367	5	Posotia and Manoharpur	8
	350/18-354/14	4	Mahadevsal and Derawan	1
S. Chaibasa FD	331-333	3	Jhinkpani and Talaburu	1
	319-321	2	Singhookharia and Jhinkpani	1
Saraikela-Kharsama FD	384/27-387	2.2	Manikui and Kunkai	1

3.4 Factor Responsible for Accident

3.4.1 Physical factors

3.4.1.1 Cutting

Cuttings are highly sensitive sections on the track. Animals get trapped in cuttings at the time of train movement and get killed. Critical cuttings were noticed at accident sites in Kolhan and Saraikela- Kharsama Forest Divisions (Table 3.2). Cuttings at accident site in Saraikela- Kharsama Forest Division are rocky and very steep (8 to 25 feet high) (Fig. 3.7). In Kolhan and Saraikela- Kharsama Forest Divisions accidents have taken in such areas.

3.4.1.2 Tunnel

There is a tunnel in the accident prone section (350/18- 354/14) between Mahadevsal and Derawan railway station of Kolhan range under Kolhan Forest Division. One elephant had died in a train accident in this tunnel.

Table 3.2 Physical/ ecological attributes at critical sections in Jharkhand

Forest Divisions	Accident prone section	Attributes					
		Cutting	Curve	Water bodies	Crop	Elevated track	Corridor
Kolhan	362/20-367	3 nos. (364/22 to 30, 363/38 to 364/10 & 362/26 to 32)	Yes	No	Yes	No	No
	350/18-354/14	Yes	Yes	Yes	No	No	Yes
S. Chaibasa	331-333	No	Yes	No	Yes	Yes	Yes
	319-321	1 no. (319/8-20)	No	No	Yes	No	No
Saraikela-Kharsama	384/27-387	2 nos. (385/s-16 to 25 & 386s20 to 32)	No	Yes	Yes	No	Yes

Fig. 3.7 Critical cutting at accident site in Saraikela- Kharsama FD

3.4.1.3 Curve

In Kolhan Forest Division sharp curves are present at accident sites (Table 3.2, Fig. 3.8). Presence of curve and cutting together make the area more prone to accidents. One accident (near Km 332/1) between Jhinkpani and Talaburu railway stations in South Chaibasa FD, also took place on a sharp curve (Table 3.2).

Fig. 3.8 Presence of sharp curve and embankment make the site more prone to accident (Kolhan FD)

3.4.1.4 Elevated track

Elevated track sections have also been responsible for animal deaths because of train accidents. The railway track at accident site (near Km 332/1) between Jhinkpani and Talaburu railway stations in South Chaibasa FD is around 25 feet above the ground level (Table 3.2).

3.4.2 Ecological factors

3.4.2.1 Visibility

The growth of thick foliage and bushes along the railway track decreases the visibility especially on sharp curves. In Kolhan Forest Division and at one accident site, between Jhinkpani and Talaburu railway stations in South Chaibasa Forest Division low visibility has been one of the major factors responsible for accidents.

3.4.2.2 Crops

Agriculture activity in close vicinity of railway track has been a major attractants for the wild animals. All accidents prone sites in Jharkhand have presence of crop field in close vicinity (Fig. 3.9). In Saraikela- Kharsama Forest Division, cropland of Kandra and Raghunathpur villages are situated close to the track. Similarly in Kolhan Forest Division elephant raid crops in Posotia, Ganmore, Zozoguta, Sanpokhari, Raida, Baressa, Dhipa, Ghaghra and Tumsai villages.

3.4.2.3. Corridors

Some of the accident prone sections were previously contiguous elephant habitats (Menon *et al.,* 2005). Over the last few decades various developmental activities in the area including setting industries, habitations, canal, roads and railways has fragmented the habitat. The forest patches in accident prone section in Sraikela-Kharsama is now the only connectivity left between Saraikela-Kharsama FD and Dalma WLS (Fig. 3.5). This is also highly fragmented further due to NH 33 and a canal. Due to such situations elephants are exposed to accidents.

Fig. 3.9 Crops near railway track is one of the major attractant for elephant.

3.4.3 Frequency and Speed of trains

Higher speed and frequency of trains has been also one of the reasons behind animal deaths. In all accident prone sections of Jharkhand the train frequency and speed is high. The average train speed is 70 to 80 Kmph.

3.5. Mitigation measures undertaken

For the long term solution of this problem mitigation measures have been implemented only in accident prone section between Posotia and Manoharpur in Kolhan Forest Division. These measures have been implemented jointly by the Jharkhand Forest Department and Railway. Mitigation measures implemented in this section is as follows:

- Railway has imposed a permanent speed restriction of 40 Kmph between 363/29-366/22 in up direction and 30 Kmph between 350/18-354/14 in dn direction. Written caution order is being given to loco pilots in either direction to keep sharp look for animals and blow long whistle throughout the section between Manoharpur and Posotia.
- Between Posotia and Manoharpur section Forest Department and Railways is installing 9.72 Km long fence made of discarded rail scraps on one side of the railway track to stop the movement of elephant on the track (Fig 3.10). A total

6.89 Km railway track has been fenced already (Fig. 3.11). The cost of fence has been jointly shared by the Railways and Forest Department,

- Signage has been also installed along the railway track in elephant movement areas (Fig. 3.12).

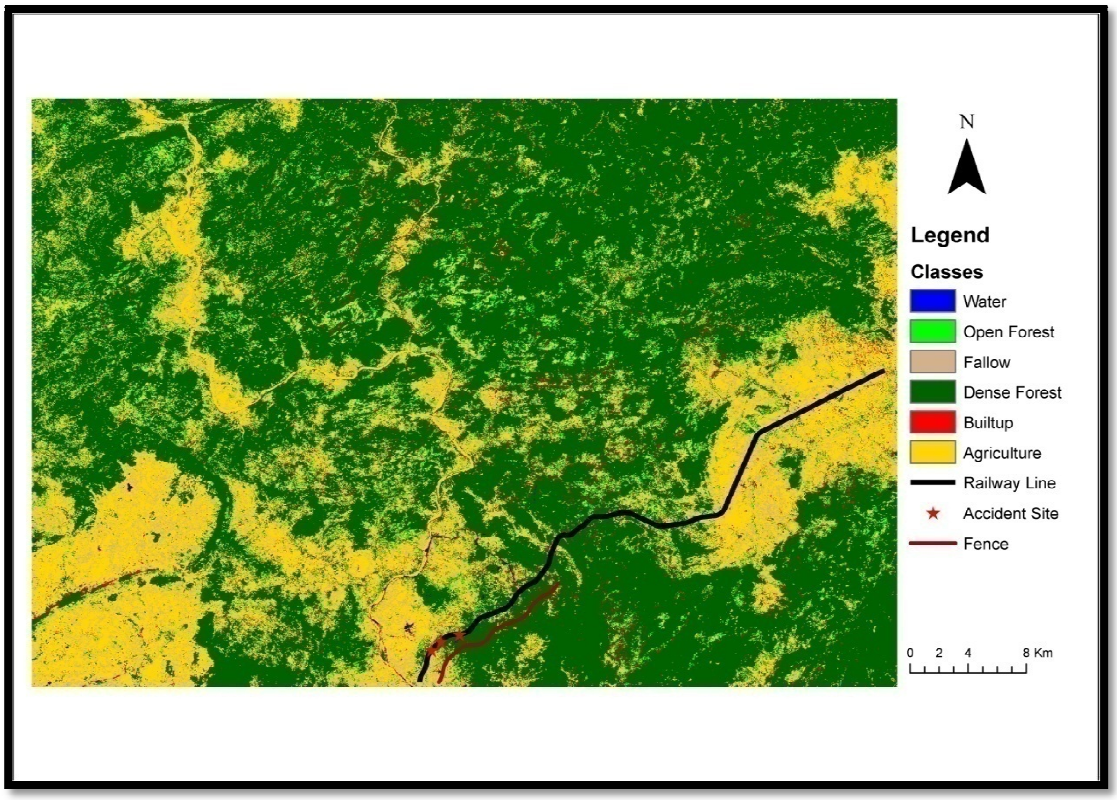


Fig. 3.10 Accident prone area between Posotia and Manoharpur section in Kolhan FD has been fenced from one side

Fig. 3.11 Old rail fencing in accident prone area between Posotia and Manoharpur section in Kolhan FD

Fig. 3.12 Caution signage along the railway track in accident prone area between Posotia and Manoharpur section in Kolhan FD

4. Inferences

Analysis of data has revealed that all the accidents have happened during paddy and maize crop season between months of August and February. Expansion of cultivation activities near or inside the forest attracts the elephants close to the railway track. During cropping season the frequency of elephant movement and crossing to railway track increases. This increases the chances of accidents. Thick fog during winter season also contributes to accidents by decreasing the visibility. In addition to crop, sharp curves, cuttings on the sides, elevated track sections, speed and frequencies of the train are other contributors to such accidents.

Sections from Km 362/20 to 367 and 350/18 to 354/14 in Kolhan Forest Division, Km 331 to 333 and 319 to 321 in South Chaibasa Forest Division and Km 384/27 to 387 in Saraikela- Kharsama Forest Division has been found critically prone to accidents. The total length of critical accident prone sections in the state is only 16 Km. For an effective management of the problem all mitigation measures should be targeted in these sections only.

Fencing of the railway track between Posotia and Manaoharpur railway section has proved effective in preventing the elephant movement on the railway track and accidents. There are a few occasions when elephant have damaged the fence but it was repaired immediately. Fence is strong enough to stop the elephant and require zero maintenance for long time. The cost sharing of the fence both by Railway and Forest Department is also important as it sets a precedent. This fence has been successful in reducing the elephant death due to train accidents in Kolhan Forest Division (Fig. 4.1).

The drawback of this fence is that it has been done from one side only. The railway track towards cropland side is open. Currently there is no elephant movement on that side but any stray movement of elephant in future can be devastating. This section should be fenced from both sides.

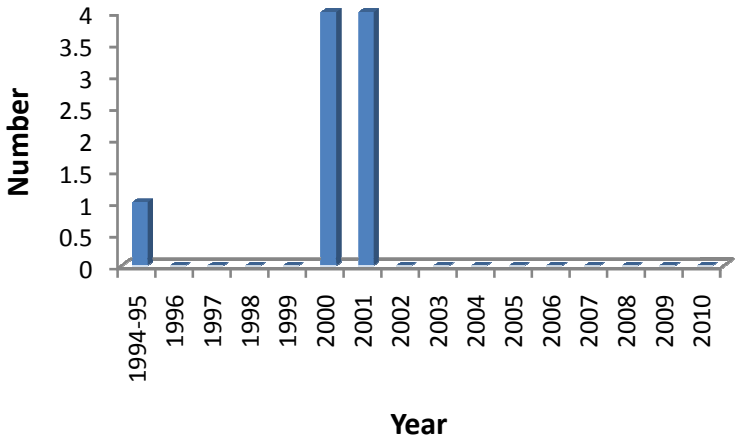


Fig. 4.1 Elephant death due to train accident in Kolhan Forest Division

5. Suggested Mitigation Measures

To mitigate this problem site specific mitigation measures need to be implemented in different sections.

5.1. Short and long term mitigation measures

Mitigation measures need to be implemented in following areas:

1. Kolhan Forest Division
   A. Between Posotia and Manoharpur railway station
      Km 362/20 to 367
   B. Between Mahadevsal and Derawan railway station
      Km 350/18 to 354/14
2. South Chaibasa Forest Division
   A. Between Jhinkpani and Talaburu railway station
      Km 331 to 333
   B. Between Singhookharia and Jhinkpani railway station
      Km 319 to 321
3. Saraikela- Kharsama Forest Division
   A. Between Manikui and Kunkai railway station
      Km 384/27 to 387

5.1.1 Imposition of speed limit in accident prone areas

Railways has imposed speed limit in the accident prone areas of Kolhan Forest Division. The accident prone area in Saraikela- Kharsama Forest Division between Manikui and Kunkai railway station is hardly three kilometer. Railway should also impose speed limit in accident prone area in Manikui and Kunkai railway stations.

5.1.2 Installation of Signage in accident prone areas

There is need to install at least 10 signage along the accident prone areas of Kolhan (four signage), South Chaibasa (four signage) and Saraikela- Kharsama (two signage) Forest Divisions to alert the loco pilots about animal movements.

5.1.3 Leveling/ widening of cutting

Though the accident prone area between Manikui and Kunkai railway station is approximately two kilometers, presence of cuttings force the elephants to use three locations to cross in a stretch of less than one kilometer. The cutting has left the terrain and steep. Last accident took place in one of these cutting. There is need to widen these cuttings.

The old rail fencing in accident prone area between Posotia and Manoharpur railway stations in Kolhan Forest Division has been done from one side only. The railway track towards cropland side is still open. Currently problem in this area has been solved to some extent. But any movement of elephant approaching from cropland side may have devastating consequences. Owing to this situation it is advisable to fence the railway track from both sides to prevent elephants being trapped on the track. This section has few cuttings. Presence of turnings along with cuttings makes the area more vulnerable. Leveling of cuttings can also help in managing the problems.

5.1.4 Joint night patrolling

Till date the long term mitigation measures like old rail fencing or leveling of embankments are put in to place, the joint night patrolling should be initiated in some of the accident prone areas. Joint patrolling should be undertaken during elephant movement period between months of August and February in Saraikel-Kharsama Forest Division in accident prone area between Manikui and Kunkai railway stations.

Patrolling teams should be equipped with wireless, mobile sets, search lights, special signal to stop the train in emergency. A minimum of four members should be in each patrolling teams. In case of elephant movement along the railway track these patrolling teams shall inform the railway authority about the location to caution the loco pilots. In such cases all trains in that particular stretch should proceed slowly with caution. This method has been tested on the ground in Rajaji National Park and Assam and has yielded good result. Joint patrolling will also help in securing track safety.

5.1.5 Raise awareness among the Loco Pilots

Awareness workshops for key railway staff like Loco Pilots, Loco Guards, and Station Masters should be organized make them aware of this problem, elephant behaviour and precaution to be taken during time of emergency. Such activities can be organized by the Wildlife Trust of India in crew lobbies at important railway stations in accident prone sections at regular intervals. Awareness activities should be also undertaken in the railway training school.

5.1.6 Initiate Stakeholder coordination

Regular meetings between railway and forest officials in the field are very important to share information, implement mitigation measures and its monitoring. It is recommended that a Task Force comprising of representatives from Railways and Jharkhand Forest Department should be constituted to improve the stakeholder coordination.

CHAPTER 5

Survey Report of West Bengal

1. Introduction

The West Bengal has been one of the most affected states after Assam where large number of wildlife deaths has been recorded due to train accidents. Since 1974, 57 wild animals have died in several train accidents which include elephant, tiger, leopard, leopard cat, guar and civet. Elephant are the worst sufferers. The death of elephants due to train accidents has been a major concern, as 49 elephants have died in train accidents since 1974.

The accidents have taken place on the railway track which connects Siliguri to Alipurduar passing through several protected areas and forests (Fig 1.1). This is situated in the northern part of the state of West Bengal, commonly known as North Bengal. The total length of this track is 168 Km, of which approximately 74 Km (44%) passes through the forests. There are 21 railway stations across the entire stretch (Table 1.1). The track was a Meter Gauge (MG) line established during 1950s. During 1999 to 2003 it was converted in to Broad Gauge (BG) by the North Eastern Frontier Railway (NF Railway). Problem aggravated after conversion of this track in to broad gauge. This led to increase in frequency and speed of the trains and consequently increased in number of accidents.

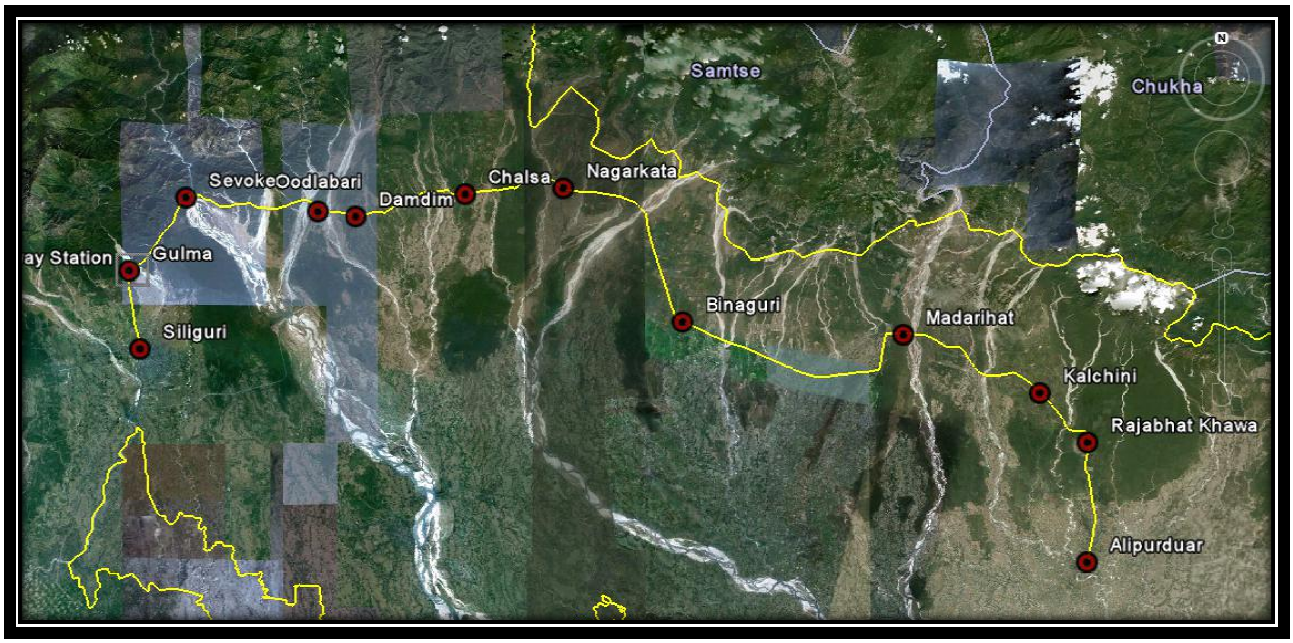


Fig. 1.1 Accident prone railway sections in North Bengal.

Table 1.1: Railway stations distributed entire accident prone sections in North Bengal

Sl. No	Station Name	Km Pole No	Distance in Km
1	Siliguri	0	0
2	Gulma	16.5	16.5
3	Slvok	27.74	12.29
4	Bagrakote	40.03	13.81
5	Oodlabari	44.32	4.29
6	Damdim	49.4	5.08
7	New Mal Jn.	54.97	5.57
8	Chalsa	62.7	7.73
9	Nagrakata	75.79	13.09
10	Carron	81.08	5.29
11	Banarhat	93.92	12.84
12	Binaguri	99.35	5.43
13	Dalgaon	108.42	9.07
14	Mujnai	114.1	5.68
15	Madarihat	122.72	8.62
16	Hasimara	133.48	10.76
17	Hamiltonganj	142.65	9.17
18	Kalchini	145.46	2.81
19	Garopara	150.9	5.44
20	Rajabhatkhawa	157.27	6.37
21	Alipurduar	168.21	10.94

The railway track passes through three Sanctuaries, viz, Mahananda, Chapramai and Jaldapara and buffer areas of Buxa Tiger Reserve (Fig. 1.2). The entire length is inside the “Eastern Duars Elephant Reserve”. The track cuts across innumerable rivers and streams and also stretched across lush green tea estates at places.

The railway track between Gulma and Slvok passes through Mahananda Wildlife Sanctuary, between Slvok and Bagrakote through Mongpong RF, between Chalsa and Nagrakata through Chapramari Wildlife Sanctuary, between Madarihat and Hasimara through Jaldapara Wildlife Sanctuary and between Garopara and Rajabhatkhwa through buffer areas of Buxa Tiger Reserve (BTR) (Fig. 1.1 & 1.2).

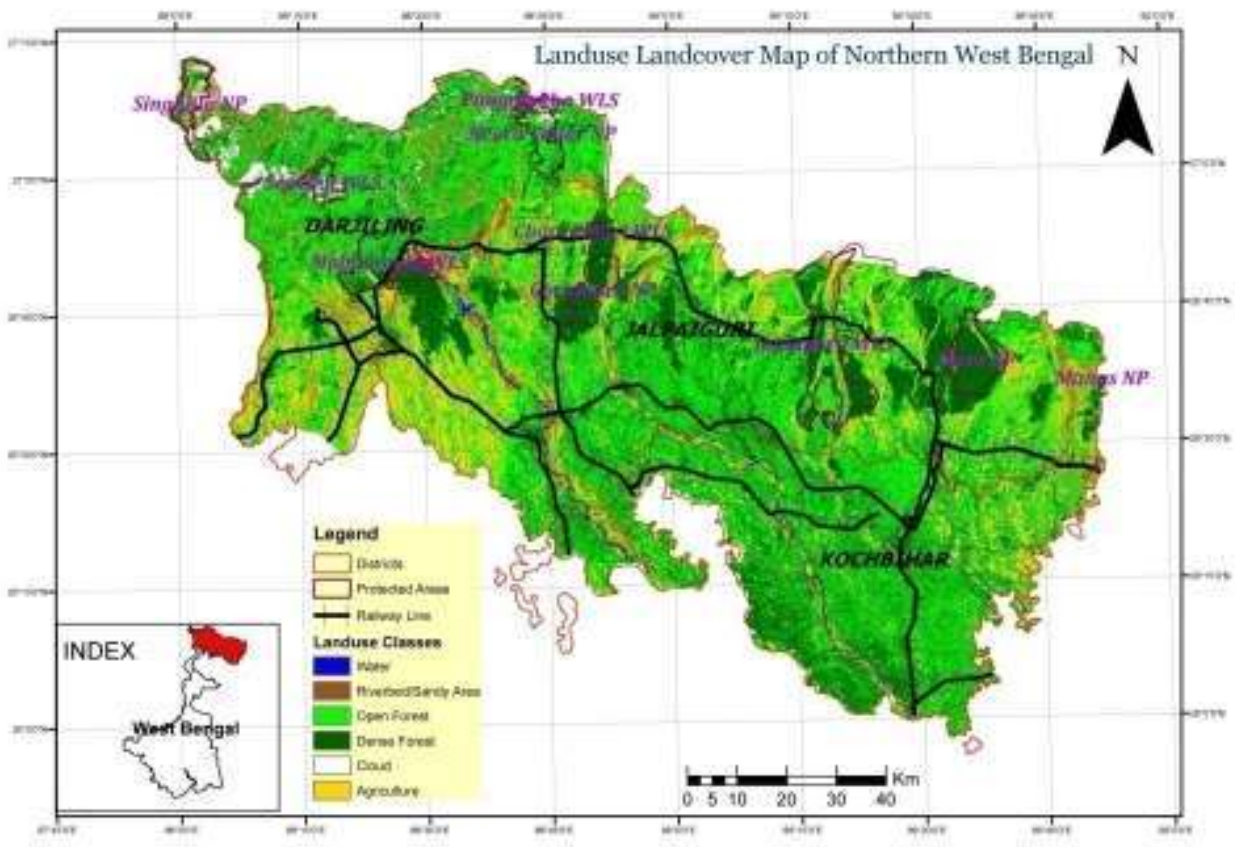


Fig. 1.2 LULC map of North Bengal with the accident prone railway track

In South West Bengal also one accident took place between Midnapore and Chandrakona Road in the year 1996 on the railway track which connects Midnapore to Purulia. In this accident one adult tusker got injured seriously.

2. Methodology

Secondary information on elephant deaths, date and time of accidents, locations and detail of trains involved in accidents was collected from the forest records maintained at different forest divisions. Field visits were made to collect site specific details.

Information was collected on elephant movement using direct and indirect evidences present along the railway tracks. Information on habitat and corridors were also collected. Various habitat and landscape attributes like availability of water bodies along the track, sharp curves, and steep cuttings on the sides have been recorded. Data were also collected on presence of attractants like crops along the track in conflict prone areas.

Information was collected to identify critical areas prone to accidents, elephant movement zones along the railway tracks and physical features responsible for accidents. Information on mitigation measures undertaken by various stakeholders and their effectiveness in reducing elephant mortality were recorded during discussion with the officials and field visits.

GPS locations of the important landmarks were collected and transferred in a GIS domain to prepare maps.

3. Results

3.1. Animal mortality due to train hits

Since 1974, 57 wild animal deaths have been recorded from the state of West Bengal. Endanger animal like elephant, tiger, leopard, leopard cat, civet and gaur have died on this railway track (Fig 3.1). The worst sufferers are elephants which contributed to 86% of the total animal mortalities.

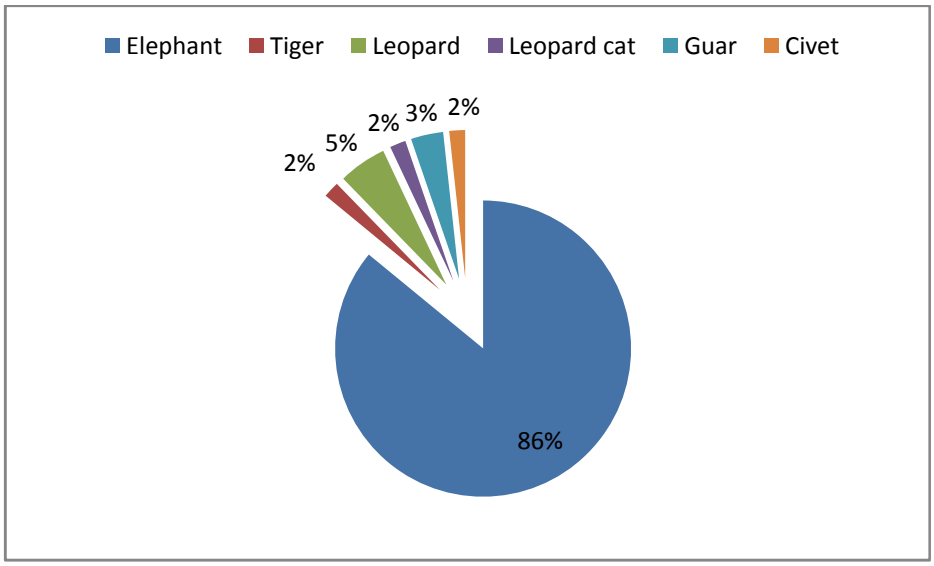


Fig. 3.1 Death of various endangered wild animal recorded from North Bengal

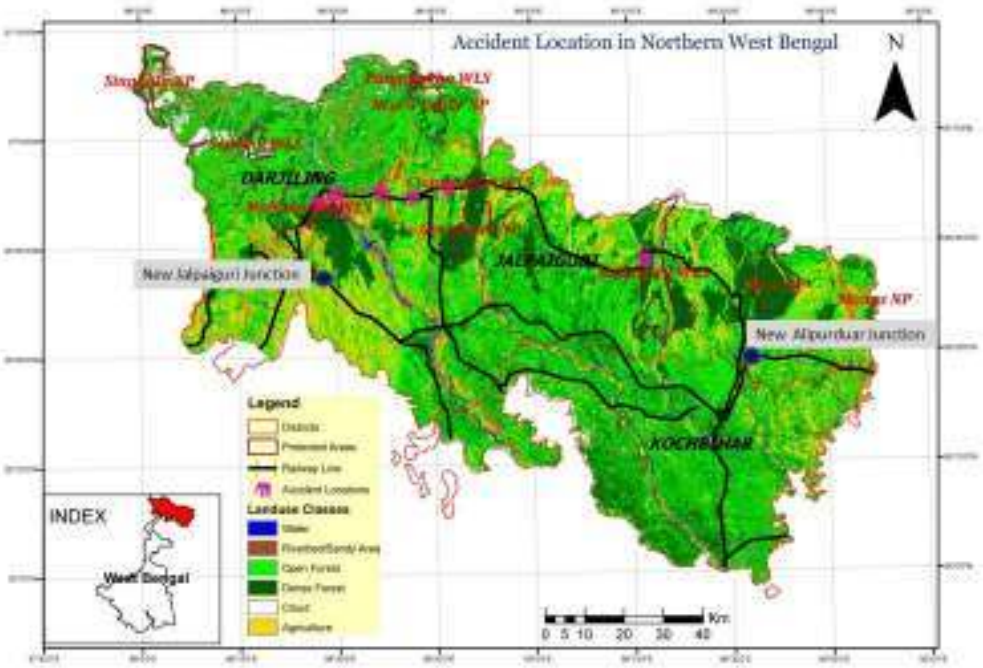


Fig. 3.2 Locations of the elephant deaths on the railway track in North Bengal

Till date 49 elephants have been killed in different sections of this railway track (Fig 3.2). Most of the elephant deaths have happened in Mahananda WLS (12), Chapramari WLS (9), Jalpaiguri Wildlife Division (9), Buxa Tiger Reserve (7), Kalingpong Forest Division (5) and Jaldapara WLS (4) contributing to 94% of the elephant deaths due to train accidents in the state (Fig 3.3).

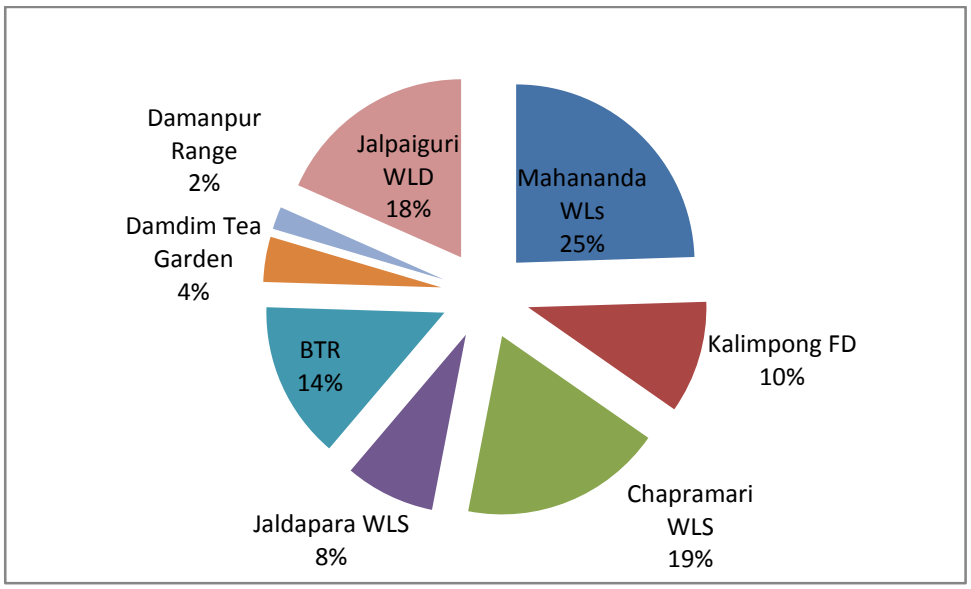


Fig. 3.3 Elephant deaths recorded from different divisions in North Bengal

In North Bengal three seasonal peaks have been recorded in elephant deaths due to train accidents (Fig. 3.4). The highest peak is during months of September and October. The other two are during months of May-June and February. These periods coincide with the paddy and maize crops seasons. During crop season frequency of elephant movement increases which make them vulnerable to being hit by trains due to their frequent movement across track.

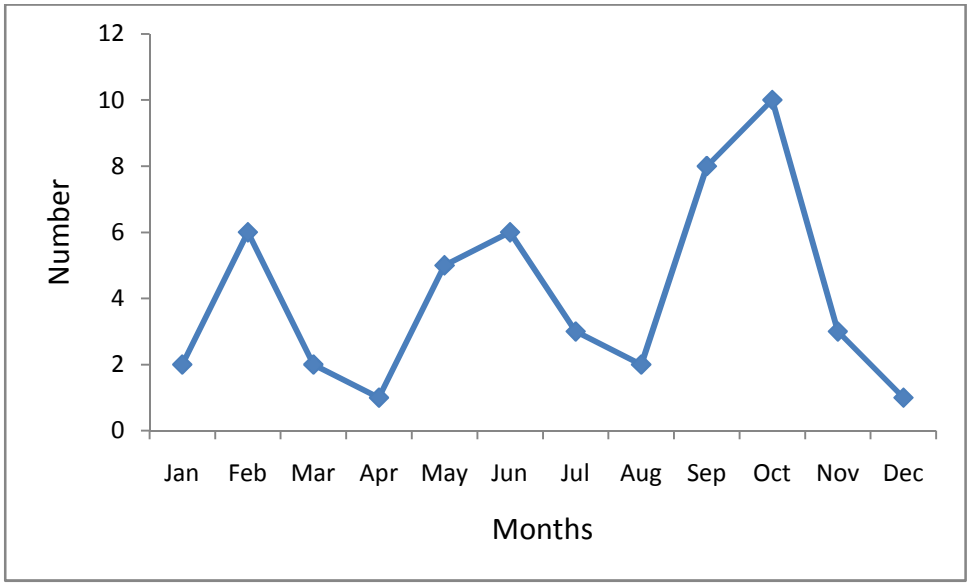


Fig. 3.4 Seasonal pattern of elephant deaths due to train accidents in North Bengal

Annual pattern of elephant deaths due to train accidents in North Bengal shows an increase in the number of elephant deaths after year 2000 (Fig. 3.5). This is due to the conversion of Meter Gauge Railway track in to the Broad Gauge between year 1999 and 2003. After conversion of this track both frequency and speed of trains has increased. Now trains moves at a much faster speed of 110 Km/hr compared to 60 Km/hr earlier. The number of trains moving during night time has also increased substantially.

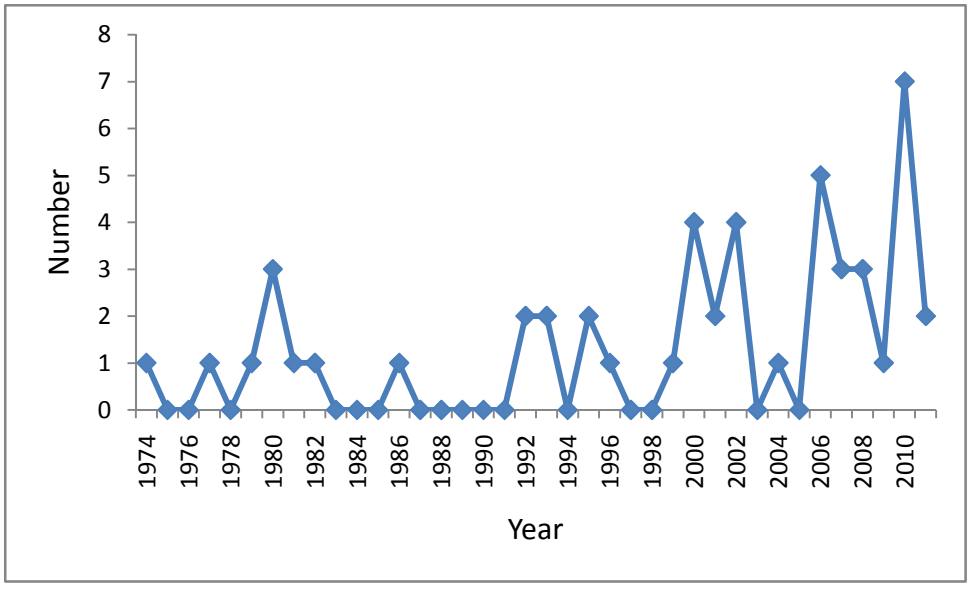


Fig. 3.5 Annual pattern of elephant death due to train accidents in North Bengal

Information on temporal pattern of accidents is only available in 34 cases. Forty one percent accidents took place during night between 18:00 hr to 24:00 hr followed by 35% between 24:00 hr to 04:00 hr and 12% each between 04:00 hr to 12:00 hr and between 12:00 hr to 18:00 hr (Fig. 3.6).

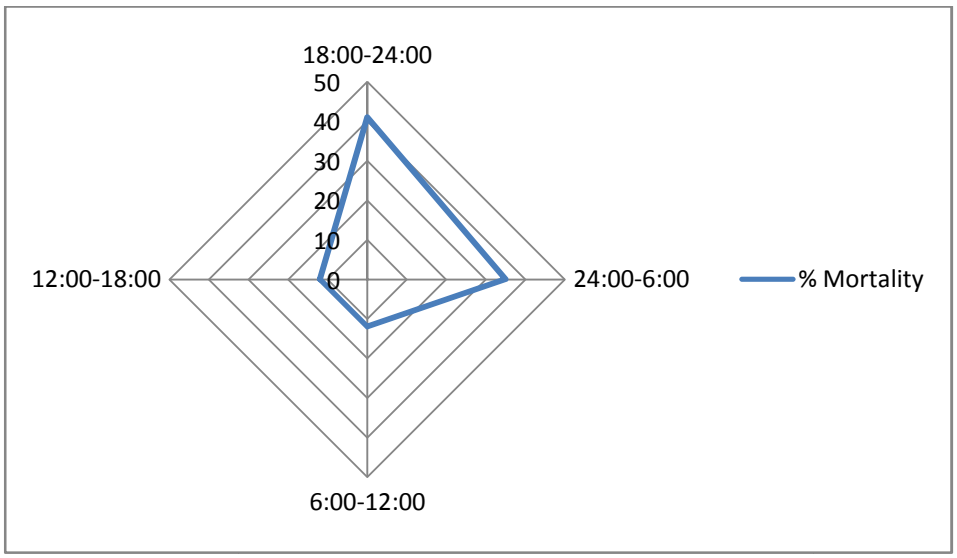


Fig. 3.6 Diurnal distribution of elephant deaths due to train accidents in North Bengal

The conversion work of the railway track was completed in the year 2003. The data of elephant mortality before and after conversion of the track was compared and presented in the figure 3.6. The average annual elephant mortality due to train accidents before conversion of the railway track was below one. But after conversion the average annual elephant mortality increased to 2.75 (Fig. 3.7).

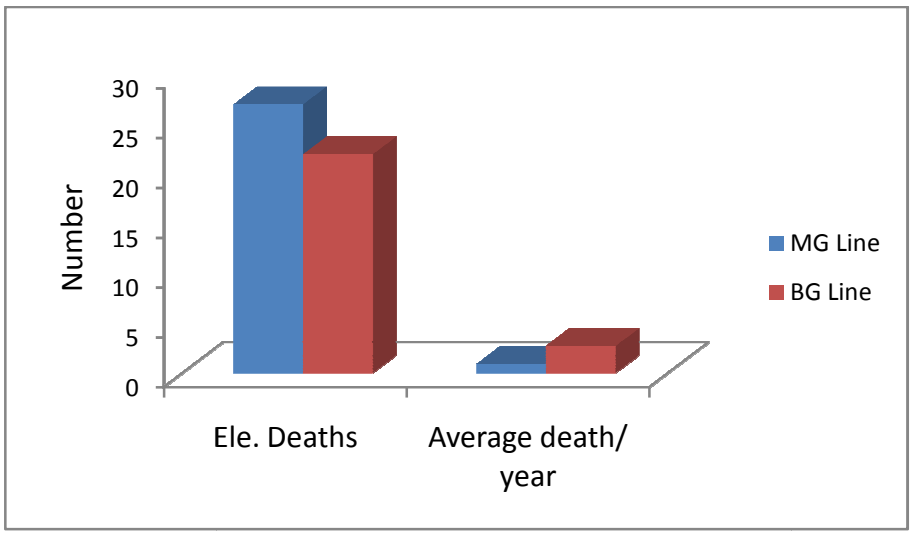


Fig. 3.7 Elephant death before and after conversion of the railway track

Out of 49 elephant deaths, data on age and sex classes were only available for 35 cases. Out of these total recorded cases, 57% were male and 43% female (Fig. 3.8). The adult contributed to 48%, followed by 28% and 23 % by sub-adult and Juvenile & Calf respectively.

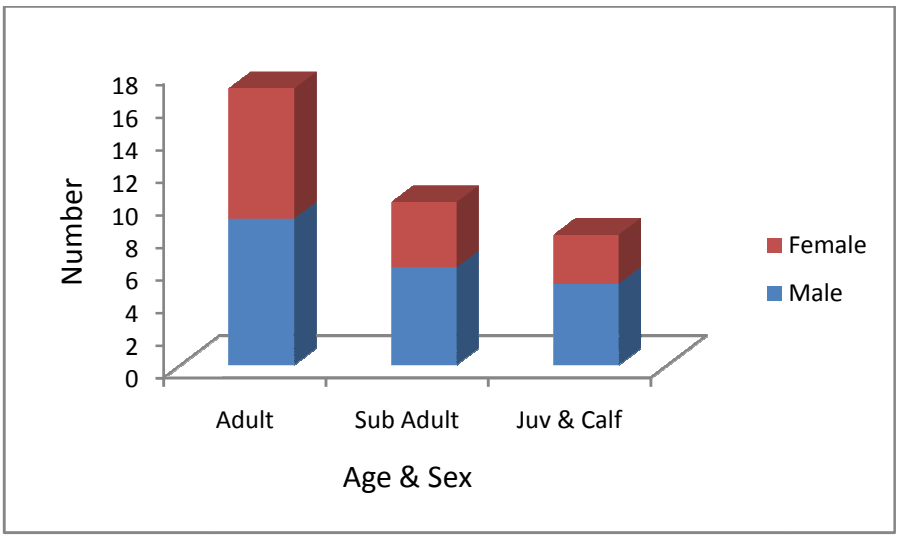


Fig. 3.8 Age and sex of elephants died due to train accidents in North Bengal

3.2. Identification of critical trains responsible in accidents

Out of 41 accident cases, data on trains responsible for accidents were only available for 20 cases. The highest number of accident took place by passenger trains (13) followed by goods trains (6) and engine (1) (Fig. 3.9). Among the passenger trains, Intercity Express and Guwahati-Jhajha Express have been observed to be repeatedly involved in accidents.

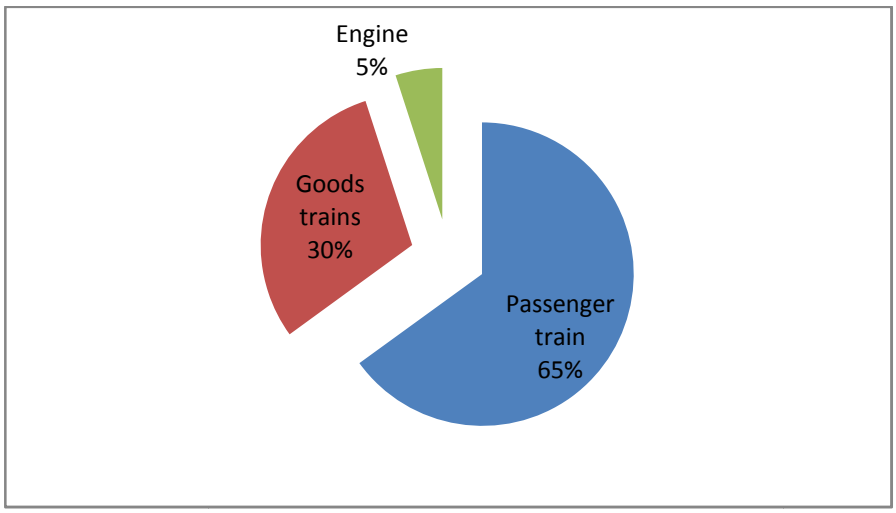


Fig. 3.9 Train involved in accidents in North Bengal

3.3. Identification of critical accident prone sections

Data on elephant deaths in different sections were available in 38 cases. Based on frequency of elephant death, nine sections of the railway track were found prone to accidents. Out of these, five sections between, Km 21-25, Km 30-33, Km 66-70, Km 127-131 and Km 151-163 were highly critical (Table 3.1). These sections fall in Mahananda Wildlife Sanctuary (Km 21-25), Mongpong RF (Km 30-33), Chapramari Wildlife Sanctuary (Km 66-70) and Jaldapara Wildlife Sanctuary (Km 127-131). After conversion of the track in to Meter Gauge, accidents took place in two new sections between Km 51- 52 and Km 123-124.

Table 3.1 Critical accident prone sections in North Bengal

Sl. No.	Accident prone sections	Length of track (in Km)	Elephant deaths		
			1974-2004	2004-2011	Total
1.	21-25	4 Km	9	3	12
2.	30-33	3 Km	2	1	3
3.	41-42	1 Km	1	0	1
4.	51-52	1 Km	0	2	2
5.	66-70	4 Km	8	0	8
6.	123-124	1 Km	0	1	1
7.	127-131	4 Km	3	1	4
8.	138-139	1 Km	1	0	1
9.	151-163	12 Km	1	5	6
	Total	**31 Km**	**25**	**13**	**38**

3.4 Factor Responsible for Accident

3.4.1 Physical factors

Similar to other accident prone areas in the country, cuttings/ embankments and blind curves have been responsible for elephant deaths in North Bengal also. Cuttings were noticed to be highly responsible for accidents in Mahananda WLS (Km 16/5 to 27) and Chapramari WLS (Km 65/8 to 68/9). Similarly blind curves are also present at several locations in the section. Limited visibility on the curve is one of the main reasons for accidents. Areas with cutting and curve are most vulnerable. Elevated track in this section especially in Jaldapara WLS (Km 128/3 to 130/7) has been also responsible for animal deaths in train accidents.

3.4.2 Ecological factors

The railway track in this section passes through at least four elephant corridors, viz. Apalchand-Kalimpong at Mal block (via sylee), Apalchand-Kalimpong at Mal block (via Meenglass), Rethi-Central Diana and Rethi-Moraghat. Frequent movements through corridor make the elephants vulnerable for accidents. One of the devastating accidents which killed seven elephants in September 2010 took place in Rethi-Moraghat elephant corridor.

Similarly agriculture activities in close vicinity also attract the wild animals and their frequent movements make them vulnerable for accidents. The seasonal mortality peaks during crop seasons clearly shows a positive correlation between crops and accidents.

3.4.3 Frequency and Speed of trains

After conversion of this railway track in to Broad Gauge line both frequency and speed of trains has increased. Now trains moves at a much faster speed of 110 Km/hr compared to 60 Km/hr earlier. The number of trains moving during night time has also increased substantially. The data of elephant mortality before and after conversion of the track shows a drastic increase in annual mortality of elephants (Fig. 3.7).

4. Inferences

Elephant death due to train accidents in North Bengal become a major challenge for conservationists. The railway track that passes through several protected areas and elephant habitats between Siliguri and Alipurduar is mainly responsible for these accidents. The problem further aggravated after conversion of this old meter gauge line in to broad gauge between 1999 and 2003. The annual elephant mortality rate due to train accidents registered a threefold increase after conversion. This was largely due to the increase in frequency and speed of the train in this section.

Elephant populations in the state are already under threat due to habitat degradation, fragmentation and intense conflicts with humans. This is an additional threat to the conservation of elephants in this region. Development of road and rail network has contributed to irreparable damage of the habitats. Due to degradation and fragmentation of the habitats elephants are forced to involve in conflict situation. Growing cases of human elephant conflict in the state has changed the public attitude towards elephant conservation. In this situation elephant deaths due to train accidents and railway track passing through corridor or prime elephant habitat become a challenge for conservation.

Presence of sharp curves, steep cuttings on the sides, elevated track and low visibility due to dense foliage on the sides are major reasons of accidents in this section. Analysis of data has revealed that most of the accidents have happened during night hour in paddy and maize crop seasons. During cropping season the frequency of elephant movement and crossing to railway track increases. This increases the chances of accidents. Thick fog during winter season also contributes to accidents by decreasing the visibility.

Identification of critical sections will help in an effective implementation of mitigation measures. The total length of accident prone sections are 30-35 Km, of which five between, Km 21-25, Km 30-33, Km 66-70, Km 127-131 and Km 151-163 are highly critical.

5. Suggested Mitigation Measures

Presence of several cuttings/embankments, blind curve, elevated track section and thick foliage at places along the railway track make the task difficult. In this situation it is important to implement both long and short term mitigation measures simultaneously. To mitigate this problem site specific mitigation measures need to be implemented in different sections.

5.1 Long term mitigation measures

Following are the long term mitigation measures:

5.1.1 Addressing the cuttings/ Embankments:

There are several steep cuttings especially between Km 21 and 27 and Km 65 and 70. Presence of retaining wall at few sites makes the section more dangerous for the animal. Some of the cuttings are virtual death trap for the animal. Some of the cuttings can be leveled or space can be provided on the sides for the animals. Some of the cuttings are difficult to level. In such cuttings animal movement can be barred by construction of girder bridges on each sides or blocking the movement by fencing by old rails on the both end which can end to an existing bridges.

5.1.2 Construction of underpass:

There are certain areas where track is elevated from the ground level. Such sections exits between Km 128 and 131. Few underpasses needs be constructed to provide passage to the animal.

5.1.3 Speed limit in accident prone areas

A permanent speed limit of maximum 25-30 Km/hr should be imposed between five highly critical sections (Km 21-25, Km 30-33, Km 66-70, Km 127-131 and Km 151-163).

5.2 Short term mitigation measures

5.2.1 Installation of Signage in accident prone areas

There is need to install signage in elephant movement areas along the accident prone sections.

5.2.2 Joint night patrolling

Till date the long term mitigation measures are put in to place, the joint night patrolling should be initiated in some of the accident prone areas. Joint patrolling should be undertaken during elephant movement period.

Patrolling teams should be equipped with wireless, mobile sets, search lights, special signal to stop the train in emergency. A minimum of four members should be in each patrolling teams. In case of elephant movement along the railway track these patrolling teams shall inform the railway authority about the location to caution the loco pilots. In such cases all trains in that particular stretch should proceed slowly with caution. This method has been tested on the ground in Rajaji National Park and Assam and has yielded good result. Joint patrolling will also help in securing track safety.

5.2.3 Improving visibility

Vegetation growth on 30m width on both sides should be done at regular intervals especially on curves.

5.2.4 Raise awareness among the Loco Pilots

Awareness workshops for key railway staff like Loco Pilots, Loco Guards, and Stationmasters should be organized to provide them better information about this problem, elephant behavior and precaution during time of emergency. Such activities can be organized by the Wildlife Trust of India in crew lobbies at Siliguri and Alipuduar railway stations at regular intervals. Awareness activities should be also undertaken in the railway training school at Alipurduar.

5.2.5 Initiate Stakeholder coordination

Regular meetings between railway and forest officials in the field are very important to share information, implement mitigation measures and its monitoring. It is recommended that a Task Force comprising of representatives from NF Railways and West Bengal Forest Department should be constituted to improve the stakeholder coordination.

CHAPTER 6

Recommendations

In a developing country like India, developmental projects like construction of roads, canals, hydel projects, urbanizations and rail expansions are inevitable. The worst sufferers of such developments are the ecosystems in general and wildlife especially threaten species. Whereas eco-sensitive developments come at a price, very often user agencies are not willing to invest that extra amount. Thus, development has been at loggerheads with the need to be eco-sensitive. There is need for a significantly different approach to transportation planning, one that recognizes the long-term ecological costs of roads, highways and railways, and takes seriously the need to mitigate these impacts.

In the process of expansion or construction of new railway tracks authorities often face problems in acquiring private lands. As a result there is a tremendous pressure to acquire forest land instead of revenue land. Railways do not need to go through the Environmental Impact Assessment (EIA) process for forest clearance. Such drawbacks in the policy framework have been responsible for large scale devastation of habitat in the country. Several railway tracks were constructed through forests and there have now become serious threats for wildlife. Construction of Railway track between Siliguri and Alipurduar in West Bengal and B-line between Etimadai and Kanjikode in Kerala and Tamil Nadu are cases in point.

Elephant death due to accident caused by trains is a country wide problem spread throughout the elephant country. Lack of coordination and cooperation among main stakeholders i.e., between Indian Railway and Forest Departments has been a major issue in tackling this problem. Such accidents on rail tracks can also cause heavy loss of human lives in case of derailment or train accident of train. Sharing of responsibility will help in solving the problem.

There is need to develop and implement site specific mitigation plans for each accident prone site. All conservation issues in the area, directly or indirectly associated with this problem, must be addressed holistically. It is also important

that these mitigation measures should be made part of the routine activities of the Railway and Forest Department. Some of these activities, like leveling of critical embankments or fencing require large investments. The Railway Board and Ministry of Environment and Forests should allocate adequate fund on time to address these issues.

Factors that cause accidents can be clubbed in to one those are generic in nature while some are localized, often depending on local environmental conditions. While the site specific factors have been alluded to in the individual chapter the generic factors and recommendation to address those factors are provided below:

1. Declaration of accident prone areas as caution zones and speed limit

All accident prone elephant movement areas should be declared as caution zones. There should be speed limits imposed in each caution zone to allow loco pilots avoid accidents and wildlife mortalities.

2. Installation of Signage in accident prone areas

Signboards should be erected along the railway track in all accident-prone elephant movement areas to warn the loco pilots. These should be in accordance with norms laid out by the Indian Railways.

3. Raise Awareness among the Loco Pilots

Awareness activities for the key railway staff like Loco Pilots, Loco Guards, and Stationmasters are essential for tackling this problem. Awareness workshops should be organized to provide them better information about this problem, elephant movement, presence of signage and patrolling teams, elephant behavior and precaution during time of emergency etc. Railway staff should also be given proper opportunity to interact so that they may provide inputs. Forest staff should also be involved in such workshop to improve coordination for implementation of mitigation measures.

4. **Awareness activities for the train passengers**

Unmanaged disposal of food waste and garbage by train caterers and passengers is one of the major attractant for the wild animals (Singh *et al.,* 2001). Elephants and other animals have been noticed to feed these items near the track, which may then cause accidents.

For reducing disposal of food waste and non-biodegradable garbage inside the forest areas, public should be made aware about hazards of unmanaged garbage disposal by placing hoardings and announcements at important railway stations in accident prone areas. Posters should also be placed inside the train bogies with a message to avoid garbage disposal outside the train.

5. Improving visibility

Low visibility is one of the major problems for loco pilots and contributes to the accidents. It is important to improve the visibility especially on curves/turnings and in accident prone areas by clearing bushes/ grasses in at least 10 -15 meter width on both sides of the track. Bushes should be cleared at least twice in a year and must before the winter season.

6. Joint night patrolling

Joint night patrolling should be initiated in each accident prone areas to avert accidents. Patrolling teams should be equipped with wireless, mobile sets, search lights and other devices to drive elephants and special signal to stop the train in case of emergency. In case of elephant movement along the railway track these patrolling teams shall inform the railway authority about the location to caution the loco pilots. In such cases all trains in that particular stretch should proceed slowly with caution. Patrolling parties will also help in keeping away the elephants from the track and will maintain elephant movement records. This method has been tested on the ground in Rajaji National Park and Assam and has yielded good result.

A minimum of three members should be in each patrolling teams from forest department and railways. The patrolling teams should be trained to driving elephants off the track and rapidly communicate in case of emergency.

Presence of patrolling teams on the track helps in several ways to railway and forest department. In addition to providing information on elephant movement they will be also useful for track safety and will help in reducing forest and wildlife crime in the areas.

7. Initiate Stakeholder coordination

Bringing the two departments of railway and forest together for implementation of mitigation measures is one of the major challenges. Regular meetings between railway and forest officials at various levels should be organized to share information, to strategize and implement joint short and long term mitigation measures and its monitoring. Meetings should also be organized at the field level involving range and division level forest officials and railway staff from local railway stations to have a proper coordination in the field.

It is recommended that a Task Force comprising representatives from Railways, Forest Department, NGO and Elected Local Representatives of people (Village/gram level) be constituted to monitor the implementation of mitigation measures on regular basis.

8. Leveling/ widening of cutting

It has been seen that most of the accidents takes place in critical track sections with steep cuttings/ embankments and blind curves. It is important to level all critical cuttings falling in accident prone areas to provide space to the wild animals. In some of the areas cuttings can be fenced using old rails to restrict the animal movement inside the cuttings.

9. Fencing of railway track

In some of the areas where elephants cross the railway track only for crop raiding and there is no other biological need, the routes may be fenced using old rail to

restrict their movement on the track. In certain critical sections railway bridges, can be used as underpass and the track can be fenced to restrict the elephant movement.

10. Improving water facility

In several areas it has been noticed that animal only cross the railway track for water. In such area, facilities affording water should be provided or improved to reduce the regular crossing of the railway track.

11. Developing and field testing of an appropriate animal detection system (based on sensor or radar technology) to alerting train drivers.

Animal detection system has been used by scientists for resolving the problems of animal mortality due to road hits (Huijser *et al.,* 2006). These systems use high tech equipment to detect large animals when they approach the road or rail track. Once a large animal is detected, warning signs are activated urging drivers to reduce the speed of their vehicles, be more alert, or both.

There is need to develop such system in accordance to the Indian situation. WTI is in touch with several organizations/ Institutions to develop an animal detection device. It requires large amount of fund investment in the beginning. Indian Railway and MoEF should work together to develop such system for the long term solution of this problem.

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Appendix-1

Wild animal deaths due to train accidents recorded in Dudhwa National Park

SL No.	Date	Range	Place	Time	Species	Sex
1	07.08.93	- -	- -	Night	Chital	Female
2	17.09.93	- -	- -	-	Chital	Male
3	29.11.93	- -	- -	-	Chital	Female
4	03.10.94	- -	- -	Night	Crocodile	Unidentified
5	18.10.94	- -	- -	Night	Chital	Female
6	08.11.94	- -	- -	Night	Chital	Female
7	21.12.94	- -	- -	-	Chital	Male
8	11.12.95	- -	- -	-	Sloth Bear	Unidentified
9	18.07.96	- -	- -	-	Fishing cat	Unidentified
10	25.07.96	- -	- -	Night	Chital	Female
11	05.06.97	- -	- -	Around 10.00 am	Tiger	Female
12	12.02.97	- -	- -	Forenoon	Fishing cat	Unidentified
13	11.12.97	- -	- -	Night	Fishing cat	Female
14	05.01.98	Dudhwa RS	Nakowa River Pole No.88	Around 1.30 am	Elephant	Male
15	07.04.99	Dudhwa RS	Nakowa River Pole No.88	Night	Chital	Male
16	05.01.00	Bilreyan area	Curve No. 23 Godnia crossing	-	Chital	Male
17	21.03.00	S. and N. Sonaripur	Curve No. 22 Kila crossing	Around 1.30 am	Sloth Bear	Unidentified
18	27.12.02	Dudhwa RS	Nakowa River Pole No.88	-	Fishing cat	Unidentified
19	31.05.03	Dudhwa RS	Nakowa River Pole No.88	Night	Elephant	Male
20	31.05.03	Dudhwa RS	Nakowa River Pole No.88	Night	Elephant	Male
21	31.05.03	Dudhwa RS	Nakowa River Pole No.88	Night	Elephant	Female
22	12.11.03	S. and N. Sonaripur	Curve No. 22 Kila crossing	Around 1.30 am	Hog deer	Female
23	12.11.03	S. and N. Sonaripur	Curve No. 22 Kila crossing	Around 1.30 am	Hog deer	Calf
24	25.12.03	S. and N. Sonaripur	Curve No. 22 Kila crossing	Night	Hog deer	Female

25	19.08.04	S. and N. Sonaripur	Curve No. 22 Kila crossing	Night	Chital	Male
26	20.08.04	S. and N. Sonaripur	Curve No. 22 Kila crossing	Night	Hog deer	Female
27	03.01.05	Bilreyan area	Curve No. 23 Godnia crossing	Around 1.30 am	Chital	Unidentified
28	10.01.05	S. and N. Sonaripur	Curve No. 22 Kila crossing	Around 1.30 am	Chital	Male
29	18.01.05	S. and N. Sonaripur	Curve No. 22 Kila crossing	Around 1.30 am	Chital	Female
30	18.01.05	S. and N. Sonaripur	Curve No. 22 Kila crossing	Around 1.30 am	Chital	Calf
31	27.05.05	S. and N. Sonaripur	Curve No. 22 Kila crossing	Around 1.30 am	Tiger	Female
32	11.03.06	Bilreyan area	Curve No. 23 Godnia crossing	Night	Chital	Female
33	11.03.06	Bilreyan area	Curve No. 23 Godnia crossing	Night	Chital	Female
34	14.03.06	S. and N. Sonaripur	Curve No. 22 Kila crossing	Night	Barking deer	Male
35	17.03.06	S. and N. Sonaripur	Curve No. 22 Kila crossing	Around 9.30 am	Chital	Unidentified
36	20.03.06	S. and N. Sonaripur	Curve No. 22 Kila crossing	Night	Barking deer	Unidentified
37	15.04.06	Dudhwa RS	Nakowa River Pole No.88 -	Night	Tiger	Female
38	24.05.06	Bilreyan area	Curve No. 23 Godnia crossing	Forenoon	Chital	Male
39	15.08.06	Bilreyan area	Curve No. 23 Godnia crossing	-	Chital	Male
40	28.12.06	S. and N. Sonaripur	Curve No. 22 Kila crossing	Night	Chital	Male
41	29.12.06	S. and N. Sonaripur	Curve No. 22 Kila crossing	Around 12.30 pm	Chital	Male
42	20.02.07	S. and N. Sonaripur	Curve No. 22 Kila crossing	Night	Chital	Female
43	03.03.10	Dudhwa	225/5 – 226	Night	Hog deer	
44	07.03.10	Dudhwa	225/5 – 226	Night	Chital	

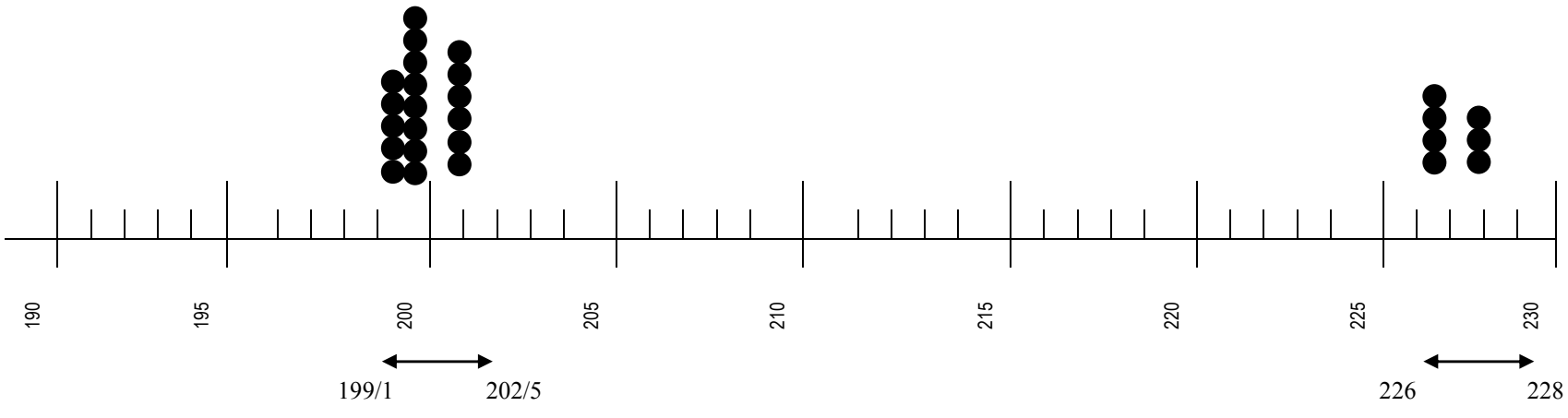
Wild animal deaths due to train accidents recorded in Kishanpur WLS

SL No.	Date	Time	Species	Sex
1	10.10.04	12.30 pm around	Crocodile	Unidentified
2	31.01.05	Night	Chital	Unidentified
3	13.08.06	Night	Wild boar	Male

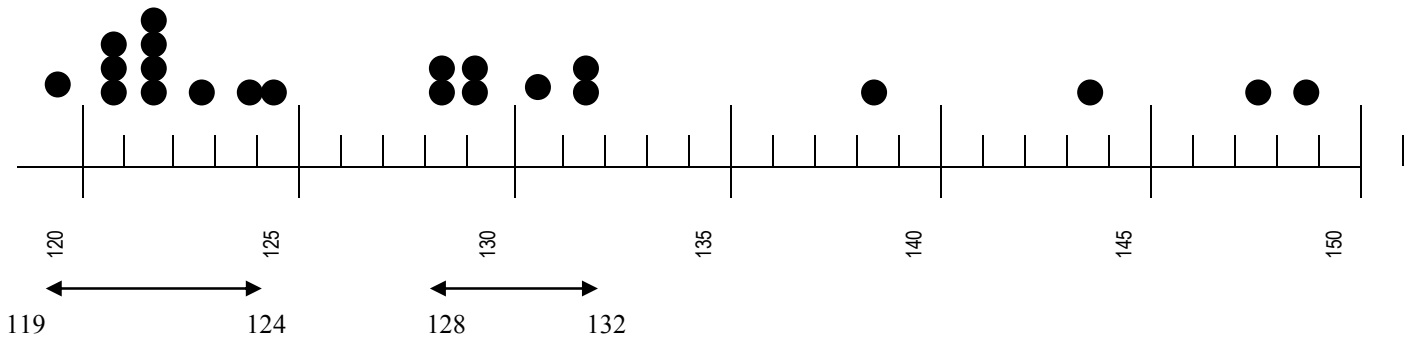
Wild animal death recorded due to train accidents in Katerniaghat WLS

SL No.	Date	Range	Location (Pillar No.)	Time	Species
1	07.11.98	Kakraha	29/4	Night	Chital
2	01.05.01	Katerniaghat	161-162	-	Tiger cub
3	26.08.01	Motipur	123/5	-	Tiger cub
4	27.12.01	Katerniaghat	156-157	-	Chital
5	29.01.05	Murteeha	137/10	-	Chital
6	15.02.05	Motipur	119/19	-	Python
7	22.03.05	Katerniaghat	174/9	-	Tiger
8	17.04.05	Dharmapur	132/7-132/8	-	Nilgai
9	11.07.05	Nishangara	148/4- 5	-	Chital
10	08.08.05	Katerniaghat	157/2	-	Chital
11	30.09.05	Kakraha	129/5	4.00 am	Wild boar
12	08.10.05	Katerniaghat	157/12	9.30 am	Chital
13	22.10.05	Katerniaghat	164-165	2.00 am	Chital
14	10.05.06	Kakraha	129/7	12.00 am	Nilgai
15	23.05.06	Murteeha	132/9	8.00 am	Nilgai
16	4/5.06.06	Motipur	123/9	Night	Nilgai
17	02.10.06	Motipur	122/5- 122/6	-	Wild boar
18	27.11.06	Katerniaghat	161/1- 161/2	4.00 am	Chital
19	08.12.06	Kakraha	126/3	6.00 am	Sambar
20	30.12.06	Katerniaghat	164- 165	5.00 pm	Chital
21	02.01.07	Katerniaghat	161- 162	-	Chital
22	18.02.07	Katerniaghat	162/9- 162/10	2.00 am	Chital
23	24/25.07.07	Motipur	122/8- 122/9	-	Wild boar

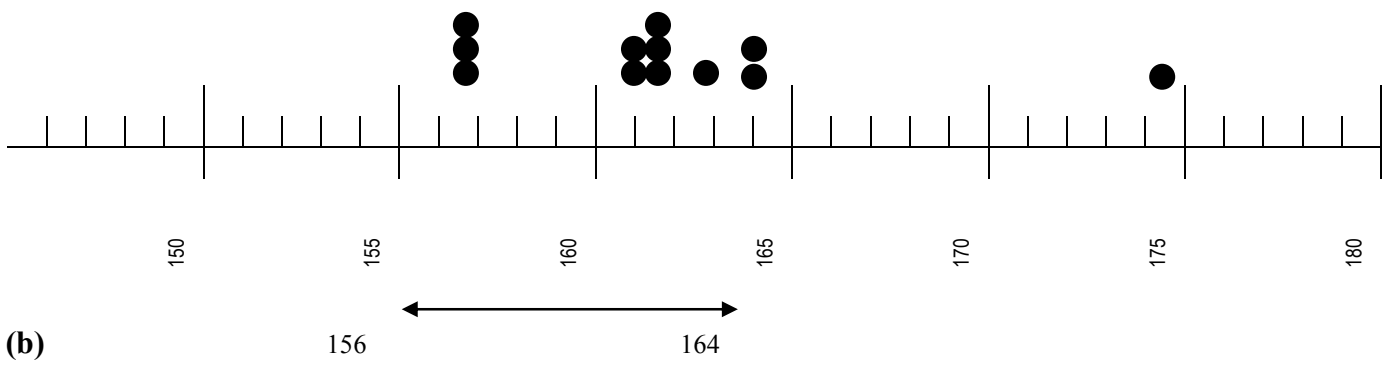
24	09/10.09.07	Motipur	121/2- 3	-	Wild boar
25	11.12.07	Murteeha	131/8- 5	-	Sambar
26	09.12.07	Motipur	121/9-10	10:00 AM	Wild boar
27	13/14.01.08	Katerniaghat	161/13	-	Chital
28	14.01.08	Motipur	122/8- 9	12.30 am	Wild boar
29	21/22.01.08	Katerniaghat	162/3	7.00 am	Wild boar
30	07.02.08	Motipur	128/4	-	Chital
31	12/13.02.08	Katerniaghat	163/15- 164	10.30 pm	Chital
32	18.02.08	Katerniaghat	158/07- 159	7.00 pm	Chital
33	14.02.08	Motipur	122/8	-	Wild boar
34	01.04.08	Dharmapur	143/2	5.00 am	Nilgai
35	06.04.08	Dharmapur	147/9	-	Chital
36	04.07.08	Motipur	121/8- 9	-	Wild boar
37	05.09.08	Katerniaghat	174/3	9.00 pm	Tiger
38	13.11.08	Motipur	123 – 124		Nilgai
39	15.02.09	Motipur	122/1 – 5		Wild boar
40	09.05.10	Motipur	121/5		Wild boar
41	25.06.10	Motipur	121/5		Wild boar
42	24.10.10	Katerniaghat	160/10 - 16		Chital
43	24.10.10	Katerniaghat	160/10 - 16		Chital
44	24.10.10	Katerniaghat	160/10 - 16		Chital
45	24.10.10	Katerniaghat	160/10 - 16		Chital
46	24.10.10	Katerniaghat	160/10 - 16		Chital



Dots showing animal death due to train accident in Dudhwa National Park



(a)



(b)

Dots showing animal death due to train accident in Katerniaghat WLS

Appendix-3

List of critical curve in Dudhwa National Park and Katerniaghat Wildlife Sanctuary

Area	Sl. No.	Curve No.	Start Km	End Km	Length (meter)	Start GPS Location		End GPS Location		Types
						Latitude	Longitude	Latitude	Longitude	
Katerniaghat WLS	1	14	138/0	138/6	510	28 10 10.0	81 17 03.4	28 10 23.8	81 16 53.3	C- type
	2	15	144/2	144/9	-	28 12 42.2	81 14 33.0	28 12 58.5	81 14 21.7	C- type
	3	1	148/2	148/8	710	28 14 41.2	81 13 36.0	28 15 00.1	81 13 21.5	C -type
	4	2	155/6	155/8	150	28 17 28.2	81 10 21.3	28 17 32.4	81 10 17.1	S- type
	5	3	155/8	155/9	146	28 17 32.4	81 10 17.1	28 17 36.1	81 10 13.4	S- type
	6	4	155/9	156/0	146	28 17 37.8	81 10 11.4	28 17 38.8	81 10 10.2	S- type
	7	5	156/2	156/4	147	28 17 42.1	81 10 05.3	28 17 45.6	81 10 00.2	S- type
	8	6	159/2	161/1	1015	28 18 46.0	81 08 47.0	28 18 27.1	81 08 00.9	U- type
	9	7	165/2	165/10	565	28 16 34.5	81 06 21.2	28 16 26.7	81 06 08.2	S- type
	10	14	177/3	178/3	1000	28 19 26.2	81 03 19.8	28 19 55.7	81 03 08.1	C- type
Dudhwa NP	11	22	199/03	199/7	340	28 23 42.8	80 51 55.1	28 23 45.9	80 51 50.8	C- type
	12	23	202/01	202/5	420	28 24 44.9	80 50 42.9	28 24 51.1	80 50 31.9	C- type
	13	24	210/06	211/0	430	28 26 29.1	80 46 07.9	28 26 38.4	80 45 46.4	C- type
	14	25	221/06	222/6	1000	28 30 40.4	80 41 04.0	28 30 42.8	80 40 35.0	U- type
	15	26	226/01	226/3	135	28 29 15.9	80 39 06.0	28 29 12.9	80 39 02.6	C- type
	16	27	226/03	226/4	135	28 29 12.2	80 39 01.5	28 29 09.2	80 38 58.1	C- type

Appendix-4

Table 1: Critical curves between Walayar and Kanjikode Railway sections

Sl No.	B line		A line	
	From Km to Km	Length	From Km to Km	Length
1.	509/35 – 510/7	400 m	509/4-48 ½	800 m
2.	510/33-45	230 m	510/2-511/20	670 m
3.	511/1 – 21	440 m	512/8 -513/8	940 m
4.	511/37-512/15	370 m	513/8-514/6	1020 m
5.	512/15-21	180 m		
6.	513/1-11	220 m		
7.	513/19-37	380 m		
8.	514/1- 23	470 m		
9.	514/31-49	380 m		
10.	515/11-39	500 m		
11.	515/41- 516/13	290 m		
12.	516/29-516 A/11	590 m		
13.	516A/21-517/11	720 m		
14.	517/15-29	270 m		
15.	517/37-518/5	220 m		
16.	518/3-11	190 m		

Table 2: Critical curves between Walayar and Etimadai Railway sections

Sl No.	B line		A line	
	From Km to Km	Length	From Km to Km	Length
1.	509/0-19	370 m	506/22-507/8	406 m
2.	508/1-507/3	1 km	508/30-507/4	260 m
3.	506/37-15 ½	450 m		

Table 3: Critical curves between Etimadai and Madukarai Railway sections

Sl. No.	From Km to Km	Length
1.	500/21-13	190 m
2.	499/5 ½ - 21 ½	390 m
3.	498/7 ½ - 33 ½	690 m
4.	497/7 ½ - 25 ½	460 m
5.	496/27 ½ - 45	330 m
6.	496/15- 27 ½	260 m

Table 4: Critical curves between Madukarai and Potnore Railway sections

Sl. No.	From Km to Km	Length
1.	495/4 ½ - 492/32 ½	2.22 Km
2.	492/29-491/29 ½	1.04 Km

Table 5 Critical cuttings between Walayar and Kanjikode Railway sections

Sl No.	B line		A line	
	From Km to Km	Status	From Km to Km	Status
1.	510/42-511/9	High	512/10-16	High
2.	511/35-37	Medium	513/6-12	Medium
3.	512/0-7	High		
4.	512/11-19	High		
5.	513/0- 5	Medium		
6.	513/25-514/5	Medium		
7.	514/47-515/5	Medium		
8.	517/7-13	High		
9.	517/17-35	Medium		

Table 6 Critical cuttings between Walayar and Etimadai Railway sections

Sl No.	B line		A line	
	From Km to Km	Status	From Km to Km	Status
1.	509/10-508/25	High	505/14-506/4	High
2.	507/29-25	Medium		

Table 7 Critical cuttings between Etimadai and Madukarai Railway sections

Sl. No.	From Km to Km	Status
1.	500/7-1	Medium
2.	497/20-496/45	Medium

Table 8 Critical cuttings between Madukarai and Potnore Railway sections

Sl. No.	From Km to Km	Status
1.	495/9- 3	Medium
2.	494/14-10	Medium
3.	492/25-17	High
4.	492/15-1	High

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Table 16: Density of tree species near A and B line between Walayar to Kanjikode, Kerela

Sl. No.	Tree species	Density/ha
1	*Allophylus cobbe*	0.55
2	*Aporusa lorideliyana*	0.55
3	*Cassia tora*	0.55
4	*Emblica officinalis*	0.55
5	*Eucalyptus hybrid*	0.55
6	*Ficus racemosa*	0.55
7	*Prosopis juliflora*	0.55
8	*Randia brandisii*	0.55
9	*Terminalia tomentosa*	0.55
10	*Vitex altissima*	0.55
11	*Bridelia crenulata*	1.10
12	*Bridelia retusa*	1.10
13	*Lannea coromandelica*	1.10
14	*Pterocarpus marsupium*	1.10
15	*Zizyphus microphylla*	1.10
16	*Zysigium cummini*	1.10
17	*Beutia monosperma*	2.20
18	*Citrus medica*	2.20
19	*Grewia tiliiaefolia*	2.20
20	*Pavata indica*	2.20
21	*Prosopus spicigera*	2.20
22	*Acacia ferruginea*	2.75
23	*Bauhinia purpurea*	2.75
24	*Holoptelia integrifolia*	2.75
25	*Azadarachta indaca*	3.30
26	*Ficus hispida*	3.30
27	*Tamarindus indicus*	3.85
28	*Dalbergia latifolia*	4.40
29	*Taberuaementana heyneana*	4.95
30	*Helectres isora*	5.49
31	*Lagerstroemia lanceaata*	7.69
32	*Marinda tinctoria*	7.69
33	*Scliechera ollesa*	9.89
34	*Mallotus philippensis*	12.64
35	*Alangium salvifolium*	14.29
36	*Bombax ceiba*	16.48
37	*Holarhena antidysentrica*	18.13
38	*Terminalia paniculata*	20.33
39	*Anogeissis latifolia*	20.88
40	*Xylia xylocarpa*	52.75
41	*Tectona grandis*	112.09
	Total=	349.45

Table 17: Density of tree species in the foothills in Puduchery south between Walayar and Kanjikode, Kerela

Sl. No.	Tree species	Density/ ha
1	*Acacia mylotica*	1.59
2	*Bridelia crenulata*	1.59
3	*Bridelia retusa*	1.59
4	*Dalbergia latifolia*	1.59
5	*Ficus hispida*	1.59
6	*Holarhena antidysentrica*	1.59
7	*Albizia odoratisima*	3.17
8	*Chloroxylon monogynum*	3.17
9	*Erythryna varigata*	3.17
10	*Milia dubia*	4.76
11	*Pavata indica*	4.76
12	*Dalbrgia sisso*	7.94
13	*Grewia tiliiaefolia*	7.94
14	*Hopea parviflora*	7.94
15	*Lagerstroemia lanceaata*	7.94
16	*Taberuaementana heyneana*	9.52
17	*Ficus racemosa*	11.11
18	*Tectona grandis*	11.11
19	*Lannea coromandelica*	12.70
20	*Terminalia tomentosa*	12.70
21	*Mallotus philippensis*	33.33
22	*Tetramelos nudiflora*	39.68
23	*Terminalia paniculata*	44.44
24	*Scliechera ollesa*	46.03
25	*Anogeissus latifolia*	63.49
26	*Pterocarpus marsupium*	65.08
27	*Xylia xylocarpa*	80.95
	Total=	490.48

Table 18: Density of tree species in and around Kanjikode and Mallampuzha Dam, Kerela

Sl. No.	Tree species	Density/ha
1	*Bridelia retusa*	2.63
2	*Cassia tora*	2.63
3	*Dalbergia latifolia*	2.63
4	*Ficus racemosa*	2.63
5	*Grewia tilliaefolia*	2.63
6	*Madhuca neriifolia*	2.63
7	*Milia dubia*	2.63
8	*Morinda tinctoria*	2.63
9	*Terminalia bellerica*	2.63
10	*Terminalia tomentosa*	2.63
11	*Albizia oborattissima*	5.26
12	*Pterocarpus marsupium*	5.26
13	*Emblica officinalis*	7.89
14	*Holarhena antidysentrica*	7.89
15	*Taberuaementana heyneana*	7.89
16	*Chloroxylon monogynum*	13.16
17	*Anogeissus latifolia*	15.79
18	*Lannea coromandelica*	18.42
19	*Accasia sp*	21.05
20	*Alangium salvifolium*	21.05
21	*Bombax ceiba*	23.68
22	*Ficus hispida*	26.32
23	*Tectona grandis*	26.32
24	*Scliechera ollesa*	31.58
25	*Unknown*	31.58
26	*Marinda tinctoria*	55.26
27	*Terminalia paniculata*	63.16
28	*Xylia xylocarpa*	228.95
	Total=	636.84

Table 19: Density of tree species near A and B line between Walayar to Etimadai, Tamil Nadu

Sl. No.	Tree Species	Density/ha
1	*Acacia catechu*	0.81
2	*Beutia monosperma*	0.81
3	*Bridelia crenulata*	0.81
4	*Citrus medica*	0.81
5	*Dalbergia paniculata*	0.81
6	*Ficus benghalensis*	0.81
7	*Grewia tilliaefolia*	0.81
8	*Macaranga peltata*	0.81
9	*Prosopus spicigera*	0.81
10	*Pterocarpus marsupium*	0.81
11	*Bambusa bamboo*	1.63
12	*Chloroxylon monogynum*	1.63
13	*Gmelina arborea*	1.63
14	*Milia dubia*	1.63
15	*Prosopis juliflora*	1.63
16	*Holoptelia integrifolia*	2.44
17	*Dalbergia latifolia*	3.25
18	*Ficus racemosa*	3.25
19	*Lagerstroemia lanceaata*	3.25
20	*Xylia xylocarpa*	3.25
21	*Anogeissus latifolia*	4.07
22	*Lannea coromandelica*	4.07
23	*Albizia oborattissima*	4.88
24	*Ficus hispida*	4.88
25	*Taberuaementana heyneana*	4.88
26	*Terminalia paniculata*	4.88
27	*Holarhena antidysentrica*	5.69
28	*Azadarachta indaca*	6.50
29	*Pavata indica*	8.94
30	*Scliechera ollesa*	10.57
31	*Acacia ferruginea*	15.45
32	*Alangium salvifolium*	17.07
33	*Marinda tinctoria*	18.70
34	*Acacia mylotica*	20.33
35	*Tamarindus indicus*	52.85
36	*Tectona grandis*	60.98
37	*Bombax ceiba*	61.79
	Total	338.21

Table 20: Density of tree species north to the ridge around Malabar mining, Kerela

S. No.	Tree species	Density/ha
1	*Albizia lebbeck*	1.33
2	*Anogeissis latifolia*	1.33
3	*Bridelia retusa*	1.33
4	*Ficus racemosa*	1.33
5	*Gmelina arborea*	1.33
6	*Helicteres isora*	1.33
7	*Hopea parviflora*	1.33
8	*Kingiodendron pinnatum*	1.33
9	*Mallotus philippensis*	1.33
10	*Morinda tinctoria*	1.33
11	*Prosopis juliflora*	1.33
12	*Pterocarpus marsupium*	1.33
13	*Terminalia bellerica*	1.33
14	*Tetramelos nudiflora*	1.33
15	*Wrightia tinctoria*	1.33
16	*Bauhinia purpurea*	2.67
17	*Aporusa lindeliyana*	4.00
18	*Dalbergia lanceolaria*	4.00
19	*Delonix regia*	4.00
20	*Lagerstroemia lanceaata*	4.00
21	*Beutia monosperma*	5.33
22	*Holarhena antidysentrica*	5.33
23	*Pithecelobium dulce*	5.33
24	*Bombax ceiba*	8.00
25	*Alangium salvifolium*	9.33
26	*Albizia oborattissima*	9.33
27	*Cassia fistula*	10.67
28	*Dalbergia latifolia*	12.00
29	*Emblica officinalis*	12.00
30	*Bambusa bamboo*	14.67
31	*Macaranga peltata*	17.33
32	*Terminalia paniculata*	25.33
33	*Schlechira oliosa*	38.67
34	*Grewia tiliiaefolia*	45.33
35	*Xylia xylocarpa*	73.33
36	*Tectona grandis*	122.67
	Total=	453.33

Table 21: Density of tree species in the hills near Parapatty, Tamil Nadu

Sl. No.	Tree species	Density/ha
1	Scliechera ollesa	1.89
2	Albizia oborattissima	3.77
3	Beutia monosperma	3.77
4	Bombax ceiba	3.77
5	Ficus benghalensis	3.77
6	Lannea coromandelica	3.77
7	Mangifera indica	3.77
8	Pavata indica	3.77
9	Peltaphorum pterocarpum	3.77
10	Xylia xylocarpa	3.77
11	Anogeissus latifolia	5.66
12	Pterocarpus marsupium	5.66
13	Tetramelos nudiflora	5.66
14	Dalbergia latifolia	7.55
15	Dalbergia paniculata	9.43
16	Lagerstroemia lanceaata	9.43
17	Terminalia bellerica	9.43
18	Terminalia paniculata	9.43
19	Taberuaementana heyneana	11.32
20	Acacia ferruginea	15.09
21	Grewia tiliiaefolia	15.09
22	Holarhena antidysentrica	15.09
23	Unknown	15.09
24	Bambusa bamboo	18.87
25	Prosopis juliflora	22.64
26	Tectona grandis	24.53
	Total=	235.85

Table 22: Density of tree species near track between Etimadai and Madukarai, Tamil Nadu

Sl. No.	Tree species	Density/ha
1	*Acacia mylotica*	58.06
2	*Anogeissus latifolia*	6.45
3	*Borassus flabellifer*	6.45
4	*Holarhena antidysentrica*	9.68
5	*Melia dubia*	6.45
	Total	87.10

Table 23: Density of tree species in the foothill near Arivoli Nagar between Etimadi and Madukari, Tamil Nadu

Sl. No.	Tree species	Density/ha
1	*Acacia ferruginea*	21.05
2	*Anogeissus latifolia*	15.79
3	*Emblica officinalis*	5.26
	Total=	42.11

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Table 10: Lists villages surveyed in Tamil Nadu and Kerala

Sl. No.	Village name	State	Distance from track	Between station/place
1	Athupathi	Kerala	200m	B line-Walayar to Kanjikode
2	Kottampatti	Kerala	500m	A line-Walayar to Kanjikode
3	Kunjappachalla	Kerala	50m	A line-Walayar to Kanjikode
4	Mucroni	Kerala	50m	A line- Near to Kanjikode
5	Nadupathi	Kerala	2km	Behind Walayar Cement Factory
6	Payittukad	Kerala	200m	Between A&B line near kanjikode Rly sta.
7	Vaadhyaarchalla	Kerala	1km	B line-Walayar to Kanjikode
8	Valladi	Kerala	1.5km	Near Kanjikode RLY station
9	Velanchery	Kerala	2km	Near Kanjikode RLY station
10	Ayyampathi	Tamil Nadu	500m	Walayar to Etimadai
11	Chinnampathi	Tamil Nadu	3kms	Foothhill west to ACC mines
12	Etimadai	Tamil Nadu	100m	Walayar to Etimadai
13	Kuppamkaradu	Tamil Nadu	2km	Walayar to Etimadai
14	Maanthuruthi	Tamil Nadu	1km	B-line Walayar to Etimadai
15	Modamathithottam	Tamil Nadu	3kms	B-line Walayar to Etimadai
16	Murugampathi	Tamil Nadu	10m	B line-Walayar to Kanjikode
17	Poonga kowdam pudur	Tamil Nadu	2km	Walayar to Etimadai
18	Solakkarai	Tamil Nadu	1km	Walayar to Etimadai
19	Pudupathy	Tamil Nadu	500m	B-line Walayar to Etimadai
20	Jallimadupathy	Tamil Nadu	500m	B-line Walayar to Etimadai