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Review Paper

Forest and Wildlife Scenarios of Northern West Bengal, India: A Review

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Abstract

Study on forest, wildlife and their interaction with humans has become critical area of research in recent decades. New insights in recent years present some serious dimensions in interactions between them which include issues like depletion of forested areas, loss of habitat of wildlife, human-wildlife conflicts (HWC) etc. National Forest Policy of India states 33% of its total geographical area should be under forest cover, which under current scenario stands well short at 23.38%. West Bengal, situated on the eastern side of India, lags far behind of the national forest area and only 13.38% of its total geographical area comes under recorded forest category. Although there are reports about the conditions of forest, wildlife habitats and HWC in West Bengal, these are haphazardly arranged. This paper attempts to arrange these reports in a review form to make them more accessible and easily readable. Since, most of the reports of HWC occur from northern West Bengal, this part of the state has been made subject of this review article. Current status of forest and wildlife, emphasising on gaur, leopard and elephant, in three northern districts of West Bengal namely Jalpaiguri, Darjeeling and Cooch Behar has been reviewed along with assessing some recent reports on HWC in the region. Some of the methods employed along with recommendations and suggestions to minimise HWC have also been reviewed. The study shows that, although situation of forest area looks disappointing there is an increase in the number of gaur, leopard and elephant in recent years. Increase in population of wild animals, depletion of green cover, encroachment of forest land, decline in fodder for wild herbivores and developmental activities in protected areas emerged to be the principal causes of HWC in the region. The study further shows that since all HWC are reactions to the actions of human beings, these conflicts can effectively be brought down if proper measures are implemented.

Keywords: Dooars, human-wildlife coexistence, national parks, sanctuaries, West Bengal forests, wildlife conservation

Introduction

West Bengal is the fourth most populous state of India and is situated towards its eastern region. Out of its total geographical area, 13.38% comes under the recorded forest category compared to the national figure of 23.38%. Of the total forest area of West Bengal, 59.38%, 31.75% and 8.87% are categorised under reserved, protected and un-classed forests respectively. Furthermore, protected areas comprise 3.26% of its geographical area consisting of 15 Wildlife Sanctuaries and 5 National Parks. The state has two tiger reserves viz. Sundarbans and Buxa. Sundarbans (of Indian side) border the neighbouring country Bangladesh towards southeast while Buxa borders the mountainous country Bhutan in the north. Sundarbans has been declared a biosphere reserve which includes Sundarbans Tiger Reserve and Sundarbans National Park. In addition, two elephant reserves are also found in the state towards its northern and southern sides namely Eastern Dooars and Mayur Jharna respectively[1]. Encroachment of forests, loss of habitats, habitat degradation, and developmental activities like construction of roads and railway lines and increasing number of both human beings and wild animals, especially wild herbivores, are bringing human and wildlife in close proximity resulting in many human-wildlife conflicts (HWC) in the state. For example, the state forest report of West Bengal details that during the years 2010-2011, 96 persons, 3 persons and 4 persons were killed by the wild elephants, leopards and gaurs respectively. In addition, 2 persons and 12 persons were also injured by the leopards and gaurs respectively. In the same period 2 elephants died to retaliatory killings and 19 met accidental death. One leopard and 4 gaurs were also reported to die due to accidents during 2010-2011 assessment years[2]. Since most of the conflicts are reported from the northern side of the state a review of the current scenario of forests and HWC is needed to find some better solutions for the conservation of wildlife and forests both. The objectives of this study are: to assess the current status of forests in three northern districts of the state namely Jalpaiguri, Darjeeling and Cooch Behar; to present some recent reports on HWC in the region emphasising on gaurs, leopards and elephants; and to review some of the methods, recommendations and suggestions to minimise HWC in the region.

Forests and protected areas

The northern part of West Bengal includes three districts viz. Jalpaiguri, Darjeeling and Cooch Behar as shown in figure-1. Current status of the forest areas in these three districts is

presented in table-1. Jalpaiguri has the largest geographical area of 6,227 sq. km followed by Cooch Behar (3,387 sq. km) and Darjeeling (3,149 sq. km). Recorded forest areas, however, do not follow this trend as Cooch Behar has the least area under forest, being just 57 sq. km, which in percentage comes out to be miniscule 1.68% of the geographical area of the district. Moreover, although Jalpaiguri has more recorded forest area (1,790 sq. km) than Darjeeling (1,204 sq. km) in terms of their respective geographical areas, district Darjeeling is more forested (38.23%) as compared to Jalpaiguri (28.75%). More distinctively the data show that although Jalpaiguri is almost double the size of Darjeeling it lags behind the former by about 10 percentage points in terms of recorded forests. More disturbing scenario is observed for the Cooch Behar district, which is almost similar in size to Darjeeling but lags way behind in terms of the area under forest.

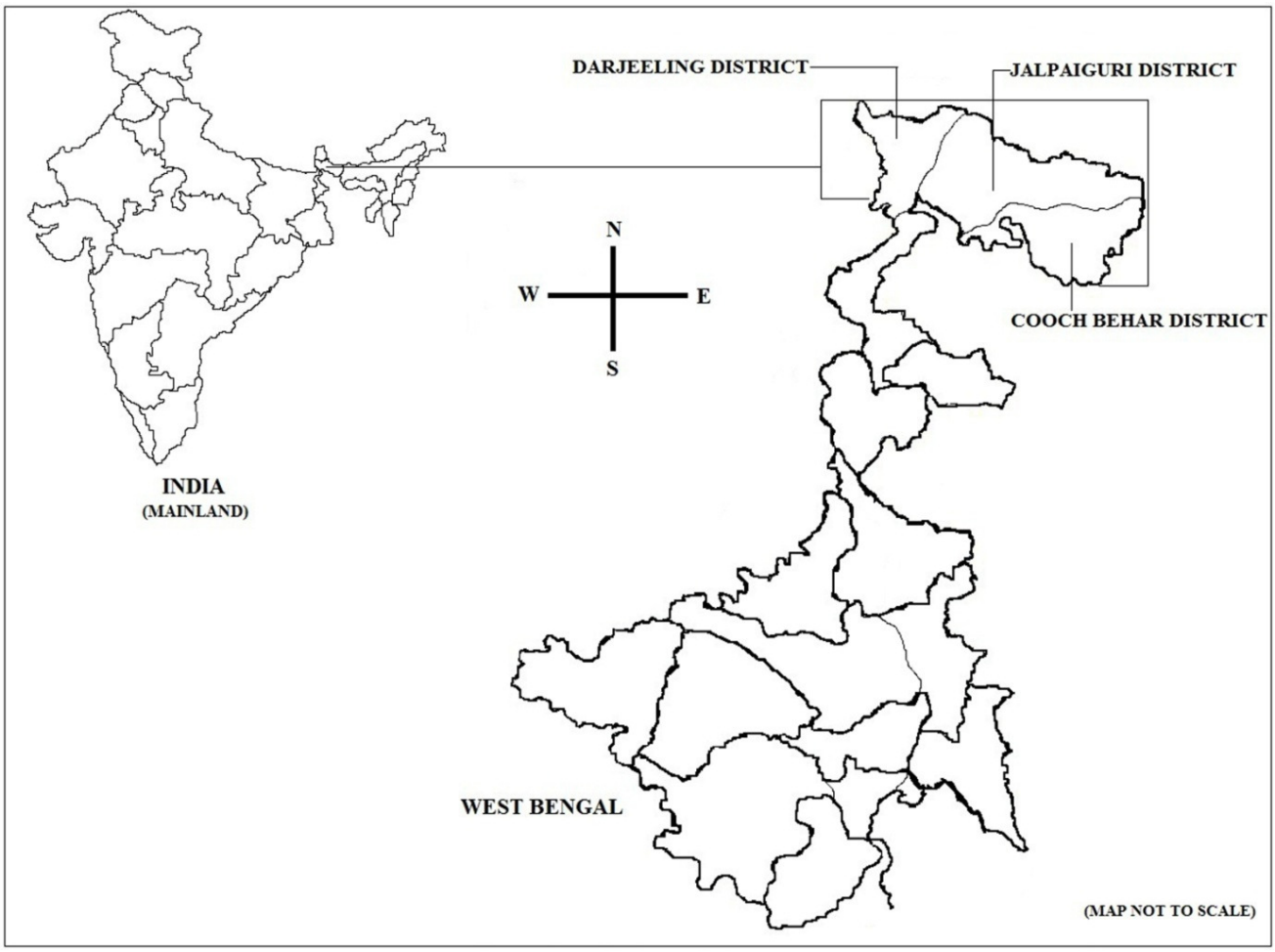

Figure-1
Three northern districts (study area) of West Bengal

Table-1
Current status of forest areas in three districts of northern West Bengal (2011)[2]

Forest Areas	Districts			All West Bengal	All India
	Jalpaiguri	Darjeeling	Cooch Behar		
Geographical area	6,227	3,149	3,387	88,752	3,287,240
Reserved forests	1,483	1,115	-	7,054	423,311
Protected forests	217	-	42	3,772	217,245
Un-classed state forests and others	90	89	15	1,053	127,881
Total recorded forest area	1,790	1,204	57	11,879	768,437
Recorded forest area in %	28.75	38.23	1.68	13.38	23.38

All areas in km^2, otherwise mentioned

The Buxa forest region is situated around 180 km from the Siliguri town and is known for tiger, leopard, elephant, clouded leopard, Himalayan black bear, gaur, pangolin and python. The forest can be further categorised into Buxa National Park, Buxa Wildlife Sanctuary and the Buxa Tiger Reserve. It shares the boundary with the Phipsu Wildlife Sanctuary of the neighbouring country Bhutan and thus serves as an international migratory tract and corridor for the elephants between Manas National Park (India) and the forests of Bhutan. Chapramari forest, in Kalimpong subdivision of the Jalpaiguri district, is located on the banks of river Murti and close to the National Highway 31, which connects the northeast region with the rest of India. Chapramari Wildlife Sanctuary is distinctively known for its elephant population. Jaldapara Wildlife Sanctuary, in Alipurdwar subdivision of Jalpaiguri district, is situated about 121 km for Siliguri and is home to a great diversity of flora and fauna. It is home to the great Indian on horned rhinos. Chilapata forest, which forms an important elephant corridor between Buxa Tiger Reserve and Jaldapara Wildlife Sanctuary, is spread near Jaldapara in the Dooars. Located about 72 km from Siliguri and further to the north of Jaldapara is Gorumara National Park. It has similar fauna to Jaldapara Wildlife Sanctuary with leopards and elephants too. Towards western parts of the Dooars in the Tarai region and between the Teesta river to the east and the Mahayana river to the west is spread Baikunthapur forest. The forest area is spread over both the Jalpaiguri and Darjeeling districts. Mahananda Wildlife Sanctuary also comes under Darjeeling Wildlife Division[2,6]. A brief description of National Parks and Wildlife Sanctuaries is given in table-2.

Status of Gaurs, Leopards and Elephants

Wild species of gaur is considered *Bos gaurus*, while the domesticated form is known scientifically as *Bos frontalis*. IUCN (International Union for Conservation of Nature and Natural Resources) has provisionally accepted two subspecies of gaur namely *Bos gaurus gaurus* and *Bos gaurus laosiensis*. *Bos gaurus gaurus* is native to India (where it is also called Indian bison) and Bhutan; whereas *Bos gaurus laosiensis* is chiefly found in some Southeast Asian countries. IUCN categorises gaur as 'Vulnerable' species, displayed in figure-2, and the Indian Wildlife Protection Act of 1972 includes it under Schedule-I giving highest priority to its conservation. The population decline of the species is considerably lower in India as compared to other Southeast Asian countries. According to IUCN report, in India, gaur conservation areas can be divided into major and minor categories. Under major areas come Western Ghats, Central India and North-east, whereas West Bengal and Bihar are regarded as minor areas for gaur population. Waynad-Nagarhole-Mudumalai-Bandipur complex has one of the most extensive surviving gaur populations in the world. The gaur population in India occurs in fragmented areas. The estimated population of gaur in India was between 12,000 and 22,000 according to the 2008 IUCN report[7]. As per West Bengal forest department the numbers of gaurs, census 2002 report, present in different forested areas of northern West Bengal are: Mahananda WLS-21, Gorumara NP-350, Neora Valley NP-81, Jaldapara WLS-440, Buxa Tiger Reserve-306, Kuresong division-14 and Jalpaiguri division-55. More details about the distribution of gaurs[8] are presented in table-3. The forest department puts number of gaurs to be 1,261 in northern West Bengal as per 2002 census. The census data quoted by The Telegraph shows gaur population to be around 2,000 in the year 2010 which in 2012 further rose to around 4,000 in all reserves of northern West Bengal[9].

Table-2
Protected areas of northern West Bengal[2,6]

Protected areas	Area (km^2)	Bio-geographic zone	District
Wildlife sanctuaries (WLS)			
Buxa WLS	267.92	7B	Jalpaiguri
Chapramari WLS	9.60	7B	Jalpaiguri
Jaldapara WLS	216.51	7B	Jalpaiguri and Cooch Behar
Jorepokhri Salamander WLS	0.04	2C	Darjeeling
Mahananda WLS	158.04	7B	Darjeeling
Senchal WLS	38.88	2C	Darjeeling
National parks (NP)			
Buxa NP	117.10	7B	Jalpaiguri
Gorumara NP	79.45	7B	Jalpaiguri
Neora Valley NP	88.00	2C	Darjeeling
Singalia NP	78.60	2C	Darjeeling
Reserves			
Buxa Tiger Reserve	Buffer area: 370.29	7B	Jalpaiguri
Eastern Dooars Elephant Reserve	977.51 Core area: 484 Buffer area: 493.51	7B	Jalpaiguri

(WLS = Wildlife Sanctuary, NP = National Park)

The leopard species, *Panthera pardus fusca*, of the Indian sub-continent, is classified as 'Near Threatened', displayed in Figure-2, under the Red List category and criteria of the IUCN. Habitat loss/ fragmentation and hunting in large parts are primarily responsible for its reduction in numbers. Leopard is still found widely in the forests of India with 9,844 leopards being estimated in 2001 census[10]. However, according to a recent report, currently they are over 11,000 in numbers[11]. Leopard is a highly protected species in India as it is included in schedule I of the Wildlife Protection Act of 1972. Leopard is often found in the tiger reserves in India, but no reliable count is available to ascertain its exact numbers. Poaching and human-leopard conflict scenarios are affecting its numbers putting a hindrance to its conservation measures. Leopard's natural traits like high level of adaptability and the ability to live in wide range of habitats bring it closure to the human settlements, often in search of prey, resulting in human-animal conflicts[11]. Going by the census (2002) data of the West Bengal forest department, presented in table-3, maximum leopards are present in the forests of Buxa Tiger Reserve (149) followed by Jalpaiguri division (49), Gorumara National Park and Jaldapara Wildlife Sanctuary (28 each), Mahananda Wildlife Sanctuary (26), Baikunthapur division (17), Kuresong division (11) and kalimpong division having 7 leopards.

The status of the Indian elephant, *Elephas maximus indicus*, on the Red List category and criteria is 'Endangered' as displayed in figure-2. Loss of habitat/ habitat degradation/ habitat fragmentation and poaching are the principal threats to its existence. The developmental activities and pressure of expanding populations of the human beings on the forest fringes and forest areas have made the species living in isolated populations. In India, the species is now confined to four regions viz. north-eastern India (which includes the portion of northern West Bengal), Central India (which includes the portion of southern West Bengal), north-western India and southern India[12]. All the regions are characterised as having highly fragmented populations of the species putting severe hindrances to their conservation planning and management under the Project Elephant. The seasonal migrations of the elephants between Bhutan and India have become seriously restricted because of habitat fragmentation on the Bhutan side and habitat loss on the India side[12]. The number of elephants in India is estimated to be about 25,000-27,000. Habitat loss has emerged to be one of the biggest threats to their survival and presently they are just confined to about 110,000 km^2 of fragmented forests in India. Moreover, these isolated populations are also threatened due to further fragmentation on account of developmental pressures. Obstruction of their natural migratory path has resulted in many conflicts with humans in recent years[11]. The elephant is a schedule I species in India and so highly protected under the Wildlife Protection Act of 1972. Census (2001) data of West Bengal forest department, presented in table-3, shows presence of 292 elephants in the forests of northern West Bengal. The article 'Elephant Conservation Scenario' of 2009 states presence of 370-400 elephants in Jalpaiguri and Darjeeling districts[13]. However, as reported in the Times of India, currently there are over 550 elephants in northern West Bengal pointing to increasing trend in their population[14].

Table-3
Census data of Gaur, Leopard and Elephant in the forests of northern West Bengal

Forest division/ protected area	Gaur*	Leopard*	Elephant# (Total)
	-	-	292
1. Wildlife-I division	15	-	-
a. Singalia NP	-	-	-
b. Senchal WLS	-	-	-
c. Mahananda WLS	21	26	-
2. Wildlife-II division	-	-	-
a. Gorumara NP	350	28	-
b. Chapramari WLS	-	-	-
c. Neora Valley NP	81	-	-
3. Cooch Behar division	-	-	-
a. Jaldapara WLS	440	28	-
4. Buxa Tiger Reserve	306	149	-
5. Baikunthapur division	-	17	-
6. Kalimpong division	-	7	-
7. Kuresong division	14	11	-
8. Jalpaiguri division	55	49	-

*Data of 2002 census, # Data of 2001 census

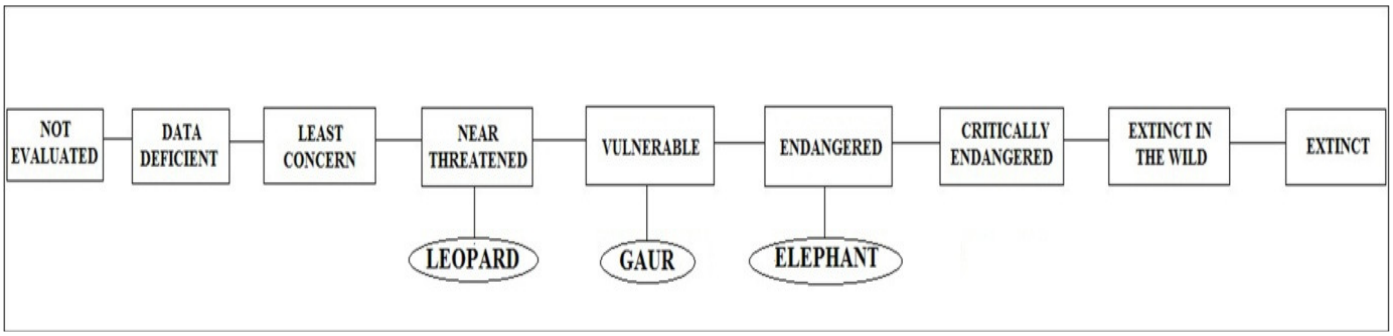

Figure-2
Status of leopard, gaur and elephant on RED LIST of IUCN

Human-Wildlife conflicts (HWC)

Background to HWC: Conflict arises from a series of both direct and indirect negative interactions between humans and wildlife[15]. Human-wildlife conflict can be defined as "any interaction between humans and wildlife that results in negative impacts on human social, economic or cultural life, on the conservation of wildlife populations, or on the environment"[16]. The conflicts result in harming both the wild animals and humans which ultimately hamper the wildlife conservation measures. Apart from economic losses suffered by the human population like destruction of agricultural crops, loss of cattle through predation by carnivores, damage to immovable properties etc. death on both sides take the extreme form of conflicts. The retaliatory killings and accidental death of wild animals due to developmental activities in forest areas (roadways, railway tracks) severely hamper the conservation measures of the threatened species. In the review work reported earlier nine factors have been described as driving forces responsible for causing HWC worldwide. These include human population growth; land use transformations, species habitat loss, degradation and fragmentation; growing interest in eco-tourism and increasing access to nature reserves; increasing livestock population and competitive exclusion of wild herbivores; abundance and distribution of wild prey; increasing wildlife population as a result of conservation programmes, climatic factors and stochastic events like fire[17]. The frequency and severity of HWC are increasing worldwide and the recent trends indicate further escalation in the conflicts. The competition for space, resources and places to call home are increasingly bringing wild animals and humans in close proximity in violent manner. Protected areas continue to become islands of habitat encircled by increasing growth of cultivation and development[18]. HWC is not simply about loss of property or life; it has serious dimensions for bringing change in human behaviour. Decrease in appreciation and increase in negative attitude towards wildlife has serious detrimental potential to impact the natural fabric of coexistence.

Human-gaur conflicts: Food chain imbalance has led to an increase in the number of gaurs in the forests of northern West Bengal. The number which was nearly 2,000 in all the reserves of northern West Bengal in year 2010 rose to 4,000 in 2012. According to a recent report, the food chain imbalance has happened due to presence of not enough tigers in the region, which are the prime predators of gaurs, escalating the population of gaurs in the forests. Though Buxa Tiger Reserve and Jaldapara forest have some presence of tigers, they are absent in Gorumara National Park and Chapramari Wildlife Sanctuary in the Dooars where the population of gaurs is mostly concentrated. The fodder is not enough to sustain this increased number, forcing the gaurs to venture into the human habitats close to forests. The conflict between villagers and gaurs has led to damages on both sides. While there are instances of people being injured and killed by gaurs, they have suffered death and injuries too. In the past two years from 2010 to 2012 the data shows that out of 11 gaurs which sneaked into human settlements close to forests, 7 of them were killed by people. Very recently two such incidents happened in Alipurduar and Dhupguri in December, 2012. In January, 2013 a gaur strayed out of Chilapata forest and injured three persons in a village in Alipurduar-I block. There are also instances of gaurs being mowed down by the trains. In 2012 two such incidents were reported to occur[9]. For example, on December 16, 2012 a gaur died at Chapramari Wildlife Sanctuary after being hit by a speeding train[19].

Three important scenarios can be observed in the forests of northern West Bengal viz. increase in the number of wild herbivores (due to conservation practices and decrease in the number of predators), depletion and shrinkage of forests and failure of the forest department to increase forest cover due to presence of sporadic habitats in the region. These events have led to an increase in the instances of human-wildlife conflicts. Moreover, the numbers of wild herbivores like gaurs in the forests are further set to increase due to presence of few predators in the forests. Cattles reared by the human population graze inside the forest causing depletion of the fodder for the wild herbivores. The scarcity of food forces these animals to sneak out of their wild habitations into the human settlements damaging the resources apart from posing serious threat to human life and themselves. Table-4 presents some recent instances of gaurs straying out of the forests[14].

Human-leopard conflicts: Land use pattern change like encroachment of forest land is bringing closer the existence of humans and wildlife. The forest land of northern West Bengal is being greatly encroached for enhanced tea plantation causing harms to both leopards and human beings. Between April 2001 and March 2008 most of the leopard attacks have taken place in tea gardens in western Dooars (90% of the 243 leopard attacks). Tea gardens act as hotspots for conflicts as leopards can prey upon cattle kept by tea garden workers[20]. Presence of cattle in villages, located at the fringes of forest, also attracts leopards. A study was conducted in the Akole valley in the Indian state of Maharashtra by wildlife and social scientists to find out the diet of the leopards in the absence of wild prey. The examination of excreta revealed leopards to be living mostly off dogs, feral pigs and livestock[21]. A recent analysis of human-leopard conflict scenario in western Dooars also reveal keeping domestic animals like cattle, goats and dogs among others can attract leopards to human settlement as these are easy prey in comparison to wild herbivores[22]. Moreover, leopards also use tea bushes to give birth. They have high maternal instincts and thus a strong urge to protect their cubs. This makes them attack anyone who they perceive coming in the way of the cubs. In western Dooars many deaths of leopards have happened trying to protect their cubs. On an average 6 leopards and 2 human beings are reported to get killed in conflicts every year in northern West Bengal[20]. Recently published study reports 65% increase in depredation levels on humans by leopards in western Dooars from the years 2001 to 2008. A steep increase in human

attacks from an average of 1.08 attacks per year in 2004-05 to 5.08 attacks per year in 2007-08 has been reported. The study further identifies tea estates adjoining the forested areas as conflict hotspots, as shown from the fact that tea estates adjoining the Gorumara National Park have seen significant increase in human depredation levels from the years 2005 to 2007. Moreover, 90% of the cases of human depredation by leopards have been recorded from tea estates and only 10% of the cases are from villages located at the periphery of the forested tracts[22]. Of the 15 human induced death of leopards recorded between 2001-2008 period, 40% were due to poisoning and 13% were killed by angry mobs of local communities. In addition, 7 leopard cubs also succumbed to injuries rescued from various tea estates[22]. In December, 2012 an adult female leopard was beaten to death by the villagers near Jalpaiguri town in northern West Bengal. The animal sneaked out of the Bodaganj forest and entered Premganj village under Paharpur gram Panchayat where it attacked several people of the locality before it was killed in retaliation. In January, 2013 an adult leopard which strayed out of the Baikunthapur forest attacked and injured four persons in Siliguri's Hakimpara locality. The animal was, however, rescued and released into the Mahananda Wildlife Sanctuary[23]. Table-4 depicts the instances of leopards straying out of the forest in recent times[14].

Table-4
Some recent incidents of human-animal conflicts

Date	Animal	Strayed into
February 4, 2013	Gaur	Premganj Char, Jalpaiguri
January 28, 2013	Leopard	Hakimpara, Siliguri
January 14, 2013	Leopard	Nagrakata, Dooars
December 22, 2012	Leopard	Premganj, Jalpaiguri
December 7, 2012	Gaur	Banerhat, Jalpaiguri
October 25, 2012	Gaur	Banerhat, Jalpaiguri

Human-elephant conflicts: Since, elephants have wide home ranges, typically between 100 and 1000 km^2, a fragmented habitat or obstruction to traditional migration path is bound to bring many human-elephant conflicts resulting in damage to agricultural crops, property, household and injury and mortality to both humans and elephants[24]. Cultivated crops are easy source of forage for elephants which is nutritious and healthy too. Foraging theory also states "animals tend to feed in a manner that maximises their nutrient intake in the minimum possible time" [24]. In India, on an average, nearly 400 people are killed per year by elephants; while annually about 100 elephants are killed in retaliation. Furthermore, on an average, they annually affect crops over an area of 0.8 to 1 million hectares which in turn affect the livelihoods of at least 500, 000 cultivators[24]. Conflict levels are especially high in intensity in West Bengal. In the areas of northern West Bengal human-elephant conflicts are widely documented. In fact the region experiences one of the highest levels of human-elephant conflicts in Asia. They not only damage large areas of agricultural crops but also kill on an average 50 people each year[25]. Over the past decade more than 230 people have been trampled by the elephants[14]. Elephants have also suffered mortality and injury in many retaliatory actions in the region. In these parts conflicts particularly occur during dhaan or harvest season coinciding with the period after monsoons[26]. Conflict between human and elephant can take a different behavioural pattern as elephant has a strong memory and can identify its tormentors. In 2002 a pachyderm was stoned to death by the villagers in Kalabari area; in retaliation an elephant herd trampled 13 villagers to death in the same Kalabari area. Death of elephants due to electrocution is another disastrous affair in the region. For example, a few years back an elephant died due to electrocution at Jalpaiguri's Malbazar when it entered a tea garden and came in contact with a livewire[26]. According to a wildlife biologist, quoted in a published literature, of 229 elephant deaths reported in 2000-2008 period, 28% were due to conflict related incidents and 9% were killed in train collisions. Furthermore, there exists a difference in intensity of conflicts between western and eastern part of the region. While the western part has more fragmented landscape and hence high intensity of conflicts, the more intact eastern part which includes Buxa Tiger Reserve and Jaldapara Wildlife Sanctuary the conflict scenarios are lower[24].

Most of the deaths of elephants have taken place in the Alipurdwar junction-Siliguri railway section. The section is also known as killer track which claims on an average at least five elephants every year. In the past thirteen years, 51 elephants have died on railway tracks in the section[27]. In September, 2010 seven elephants were killed at Moraghat by a speeding goods train lying in the section[19, 28]. In January, 2013 three elephants were killed and two injured at panjipara between Alipurdwar junction and Rajabhatkhaowa under the Buxa Tiger reserve[28]. The threat to the elephants may be further increased due to the proposed extension of broad gauge rail line New Jalpaiguri-Sevoke (which passes through a critical wildlife corridor) from Sevoke to Rangpo in the Indian state of Sikkim[29]. The existing track from New Jalpaiguri to Sevoke passes through part of the Mahananda Wildlife Sanctuary where about 40 deaths of elelpahnts of them 10 were calves have occurred between 2004 and 2012. In addition, deaths of 6 bisons and 1 leopard have also been reported on this route in the same period[30]. The extension of the existing track is going to increase the traffic on the rail route putting in danger the lives of elephants and other threatened animals like leopards and gaurs. The proposed rail line from Sevoke to Ranagpo will also pass through the Mahananda Wildlife Sanctuary including important and traditionally inhabited areas of the elephants like Gola, Chawa, Andera and Ryuem[29, 30].

Review of methods, recommendations and suggestions to minimise HWC: There are a number of management tools available that are used to tackle and reduce HWC. Most common of these approaches involve *preventive measures* like fencing, guarding, use of deterrents, resettlement, scaring of the animals involved and integrated land use planning etc.; *reactive measures* which comprise lethal removal or relocation of

problem animals; and *financial mitigation measures* like compensation package and insurance scheme. In addition new financial mechanisms like conservation incentive payments and bundled coexistence payments can also be used to address the challenges of HWC[31]. Some of the measures that are generally employed or can be used to minimise HWC in the forested tracts of northern West Bengal are discussed here.

Increasing fodder for wild herbivores in reserve forests: Increase in numbers and shortage of fodder are forcing the wild animals to venture into the human settlements in search of food. A steady supply of fodder needs to be maintained inside the forests to stop animals from straying out of forests[14]. There are two ways to deal with maintaining stable supply of fodder; first being planting grasses and plants as food. According to a forest official quoted by The Telegraph recently, lack of funds is primarily responsible for failure to plant grasses and plants in the stretches of grasslands within the reserve forests of northern West Bengal[9]. This shows that although there is enough space for increasing the food for wild herbivores, lack of fund is the principal hindrance. Both the State Government and the Central Government provide funds for planting grasses but the major amount is contributed by the Centre. It is not that the governments lack funds, but the delay in releasing funds to the forest department is the main problem. Keeping in view the requirement for steady and sustainable supply of fodder to the wild herbivores a proactive approach is needed for timely release of funds for planting grasses and plants as food. Secondly, cattle grazing inside the forests should not be allowed as food scarcity to wild herbivores and attack by the carnivores on the cattle population all compound the problem[14]. Population of wild herbivores is further set to rise in near future which will demand a constant supply of food proportional to the number of animals.

Translocation: Translocation is employed as one of the methods to deal with HWC in forests of northern West Bengal[22]. In translocation the problem animal is captured and relocated to a nearby forest area of interest or in other words translocation simply is transferring a certain number of animals from a problematic zone to a new site[17]. However, such continued relocation of animals from a wider area to a smaller area can lead to restocking of animals, causing growth of their population in new territory which can give rise to new conflicts. A recently published paper in its introductory note gives some details about change in behaviour of translocated animal like increase in stress level and aggressive tendencies. For example, there are many instances of non-problem leopards becoming engaged in conflict scenarios with humans after being captured and relocated to new sites[22]. The same authors also in their study find that rescued or captured leopard, in northern West Bengal, are mainly released into Gorumara National Park or Chapramari Wildlife Sanctuary, with most of them being released into Gorumara. The authors in their study state that until 2005 there were no recorded reports of human depredation by leopards from the tea estates adjoining the Gorumara National Park. However, after 11 leopards were released into the Gorumara over the two years period of 2005-2006 significant increase in human-leopard conflicts from the area was noted[22]. This case study indicates that translocation may not be a long term and viable solution to the ongoing HWC scenario. Also, according to the report on analysis of management strategies and good practices to minimise HWC, translocation has many drawbacks and does not seem to be an immediate and straightforward solution. In fact, it can cause many problems in case of carnivores[17].

Habitat restoration: Two phenomena i.e. depleting forest cover and increase in number of animals are bringing many HWC in the region. Encroachment and conversion of forest land for tea, sal, teak and other plantations and agricultural land is causing fragmentation of forest and natural habitats of wild animals. The efforts to increase green cover have failed due to the presence of sporadic habitats in the region[14]. There is need to prevent further degradation of their habitats and establishment of corridors for migration of animals (especially of elephants) from one habitat to another. Moreover, the existing corridors need to be improved expeditiously. To prevent forest fragmentation/degradation more emphasis should be put on 'conservation agriculture'. Afforestation should be carried out on massive scale on degraded habitats. However, some innovative solutions are to be found to procure funds for afforestation apart from the central and state governments. For example, in the article 'elephants, people and the battle for peaceful coexistence' the authors speak of innovative funding using carbon credits under climate change obligations by converting a part of the tea plantations linking Buxa and Jaldapara into mixed forest plantations for use by elephants as unhindered corridors [24].

Environmental impact assessments of developmental projects: Wildlife corridors are also being severely impacted due to developmental projects inside forest land. For every project environmental impact assessment must be carried out by an external independent agency. Based on this report and consultation with the State Wildlife Board, the National Board of Wildlife should recommend the project along with its own expertise.

Physical barriers, guarding and precautionary approaches: Barriers demarcate territories of humans and wildlife. In other words they prevent spatial overlapping among wild animals and local communities[17]. Fencing human settlements and agricultural crops can help reduce depredation by wild animals. Apart from usual methods like walls of mud and stone; brushwood and barbed wire fences new sophisticated techniques such as electric or power fences have been suggested. Though some limitations have been listed in a published literature and reference within, like higher cost of installation and maintenance, electric fences are effective deterrent against wide range of species and are more durable compared to conventional fences[17]. It is better to keep livestock within enclosures,

especially at night when most of the attacks by carnivores occur. For better protection of livestock economical approaches like covering pens with chain-link fences is highly innovative and effective. Guarding involves active monitoring of wild animals, homestead areas, agricultural crops, livestock etc. It is definitely an important preventive measure and part of good animal husbandry practice which can save depredations due to wild animals. Since, conflicts with leopards are higher when they give birth (March-June) and during pruning season around the tea gardens, by taking proper precautions during these periods depredations on both sides can be minimised.

Financial mechanisms like compensation package and insurance scheme: Economic loss to humans is one of the most important products of HWC and financial measures like compensation package and insurance can help alleviate these conflicts. In compensation system money is reimbursed to the people for their losses[17]. However, compensation system suffers from many drawbacks which need to be rectified and properly addressed. Delay in reimbursement of money, irregular payments, undervaluing of losses are some of the limitations that make the system ineffective. Any ineffective mechanism cannot be seen as a measure that will bring down HWC. In a recent study some other problems with compensation in northern West Bengal has been shown. For example, only villagers are reimbursed money for depredation to livestock by leopards and no compensation for livestock depredation to tea estate labourers are paid. Such disparity is not a healthy sign to mitigate HWC as discrimination among the local stakeholders between villagers and tea estate labourers with respect to compensation package would only generate increased intolerance, bitterness and resentment among the tea estate labourers towards leopards[22]. Tea estate labourers should also be entitled to compensation package for betterment of dealing with HWC scenarios. Thus, there is need to modernise the compensation system and make it more rational, expeditious and proportional to the loss in order to gain confidence of the local stakeholders. However, compensation is a reactive measure which is done after the depredation has happened and so cannot be regarded as suitable solution to HWC. Moreover, it also does not encourage people to protect their holdings and to coexist with wildlife[17]. Many authors have advocated insurance scheme for agricultural crop and livestock to be more innovative and practical approach[32, 33, 17]. Though, still not experimented on large scale; it can be an effective mechanism in northern West Bengal to mitigate HWC as indicated by its success in the state of Himachal Pradesh (India) with respect to livestock. Although the scheme varies according to the total number of livestock killed and total amount of the insurance fund during the year, it offers more realistic rate of compensation for livestock's losses, up to 100% of livestock's value, and also checks false compensation claims[33]. Insurance involves paying premium and claiming the insured amount in the event of livestock or crop depredation. This brings change in attitude of people towards wildlife and makes them more proactive and responsible towards their conservation.

Alternative approaches: Settlement of rights, incentive programmes and relocation of people are other strategies to mitigate HWC. Settlement of rights legitimise the rights of local villagers to access certain demarcated reserve zones of forests and use the resources like fuel wood, timber etc. For example, settlement of rights given to the local people living around the Sariska Tiger Reserve in the Indian state of Rajasthan has positive bearings towards wildlife in spite of damage to crops and livestock[34]. The positive perceptions of local communities towards wild animals and their conservation is welcome outcome of settlement of rights scheme. Incentive programmes are based on exchange of benefits phenomenon where locals are rewarded for being a part of conservation initiatives by adopting conservation friendly practices[17, 22]. For example, an incentive programme was employed in Spiti Valley in the Indian state of Himachal Pradesh to increase wild prey population for the carnivores. An area of 500 hectares was leased and forbidden for livestock grazing and other human use. The village council in turn received monetary benefit (for lost grazing) which was used for collective work and other village development schemes. In subsequent years numbers of wild prey for predators increased which in turn reduced the stress of carnivores on local livestock population[33]. This programme helped in increasing the sense of wildlife conservation in local people as the conservation itself proved beneficial to them. The success of these programmes can be repeated elsewhere including the regions of northern West Bengal. Relocation or resettlement of forest villages is provided another solution to tackle HWC. The case study of Khunia village in Jalpaiguri district is cited as one of the examples. Here people were relocated from old site to new site, which is now part of the Gorumara National Park, and provided all the basic amenities like jobs, access to hospitals, electricity etc. Not only HWC was avoided, the old site has also developed into an excellent wildlife habitat. On similar lines authorities are also considering to relocate several villages under Buxa Tiger Reserve[13].

Preventing deaths on railway tracks: A joint committee, comprising members of both the Union ministry of environment and forests and the railways, which, in 2009, had inspected the railway tracks between 168 km Siliguri-Alipurduar section recommended some measures to reduce animal deaths especially of elephants in the killer section. Some of the recommendations of the committee and other reported suggestions are: i. There should be proper, strong and effective coordination between forest and railway officials. If elephants are noticed nearby railway tracks the information must immediately be relayed to the railway officials who in turn should inform the drivers of trains to regulate the speed. ii. The suggestions of the villagers residing nearby forests should also be looked into. In fact the government officials and villagers should work in harmony for the welfare of animals in Joint Wildlife Management. For example, forest department officials together with local people can take steps to steer the elephant herds away from the tracks to prevent any untoward incident. iii. The passing trains, both passenger and goods train, must

follow the speed restrictions which is imposed from 7 pm onwards. However, recent elephant casualties at Panjipara happened before 7 pm, which shows that there is need to impose speed restrictions much earlier. The maximum speed limit on the Siliguri-Alipurduar section is 40 km/hr. iv. There is an urgent need to construct all watchtowers in forest corridors and there should not be any delay in releasing funds for this purpose. v. The residents of forest areas should refrain from cultivating paddy and corn within 1 km on both sides of the tracks as the lure of these favourite fodders bring elephants closer to the railway tracks. vi. Clear visibility through 500 metres must be ensured to the drivers on both sides of the tracks[19,27,28]. One of the major recommendations of the committee was to build underpasses in areas where elephant movement is frequent. The committee had also identified and designated some areas as high risk and elephant crossing zones[27]. However, almost four years have passed and construction of underpasses is still lagging behind the schedule. Though, forest officials have identified some more high risk and elephant crossing zones like Moraghat, Jaldhaka and Diana rail bridges, Madarihat and Lataguri, the building of underpasses in these areas sooner seems unlikely[27]. Thus, we can expect more accidental death of wild animals in the killer section. There is an urgent need to build these underpasses and funds should be immediately released for the purpose. Recently a joint team of experts, headed by elephant expert R. Sukumar, has been formed to review how far the recommendations of the earlier committee have been implemented. The expert committee must enforce a timeline for implementation of all earlier recommendations; and if the committee itself sites recommendations, a mechanism should be put to complete all projects in time.

The possibilities of the elephants' deaths can be minimised if the railway track that passes through Falakata, in Jalpaiguri district, is doubled. The trains can be shifted to run on this track at night decreasing the traffic on the existing railway track (New Jalpaiguri-Alipurduar) and consequently minimising the damage to the animals. According to a recent report, Railways ministry had announced the doubling up of the railway tracks from Ambari-Falakata to New Maynaguri to prevent the elephants being mowed down by the speeding trains in the forestlands of the Dooars and Tarai regions. The proposed track, which lies parallel to the existing track, was to be part of the project of doubling up of the railway tracks from Ambari-Falakata to Bongaigaon (Assam). However, the project is pending for over two years and there is serious delay in lining up of the tracks because of lack of funds[35]. There is an urgent need to start the Ambari-Falakata-Bongaigaon doubling of track project especially the track from Ambari-Falakata to New Maynaguri with further extension from New Maynaguri to New Alipurdwar. Electronically tagging elephants in high traffic areas could be another option. Their movements can be tracked and railway officials can be warned in advance to prevent any collision. In the railway control room one forest official should be present so that exchange of information could become easier.

Conclusion

The three districts, mentioned in this study, though, occupy 14.38% land of the state, hold forest area covering one fourth (25.68%) of the state; and out of 5 National Parks and 15 Wildlife Sanctuaries of the state, 4 National Parks and 6 Wildlife Sanctuaries are located in northern West Bengal. These observable facts definitely present the importance of this region with respect to forests and wildlife and also show why people here should be more proactive and encouraging in wildlife conservation. Many HWC from the region have been reported in recent years. There is a need to change negative perceptions about wildlife regarding animosity and hostility and good awareness and education programmes should be carried out by forest department officials in conjunction with the non government organisations. However, when the matter comes to economic loss and mortality awareness and education campaigns become unsuccessful. Some new management tools highlighted in this study can be implemented to minimise HWC scenarios. An integrated approach comprising both short term preventive measures, including good animal husbandry practices, in concurrence with long term mitigating measures is crucial to address HWC problems. Innovative mechanisms such as livestock and crop insurance; settlement of rights and incentive programmes have proved successful in managing HWC scenarios including changing perceptions about wildlife conservation and hence, should be used extensively. Many recommendations and suggestions to make railway tracks safe should be completed expeditiously. Moreover, community based forest, wildlife and other resource management is also required for peaceful coexistence between human beings and nature of which wildlife is an inherent part.

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