Annual Report (2020-21)

Mitigation of Human-Elephant Conflict in and Around Rajaji Tiger Reserve with Emphasis on Mitigation Strategies for *Kumbh* 2021

[A Collaborative Initiative Between Uttarakhand Forest Department and Wildlife Institute of India]

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भारतीय वन्यजीव संस्थान
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Executive summary

Human–Elephant Conflict (HEC) is a major threat facing elephant conservation in the Asian countries. It has increased in numerous areas culminating into economic, social and political challenges. Addressing HEC would require a multifaceted approach that focuses on understanding human livelihood and resource needs, as well as elephant ecology and behavior. As a way forward, collating baseline information on HEC at different spatial and temporal scales to decipher broad-scale trends and patterns would be critical. Additionally, the spatial and behavioral ecology of elephants would be invaluable to design specific strategies to deal with HEC. With this background, Wildlife Institute of India in collaboration with Uttarakhand Forest Department initiated a study aimed at understanding elephant home range and movement, and aspects of HEC in Rajaji landscape comprising of Rajaji Tiger Reserve and adjoining forest divisions of Haridwar, Dehardun, Lansdowne, Narendra Nagar and Mussoorie. Additionally, in view of *Kumbh* 2021, the study envisaged advancing mitigation strategies as it was envisioned that there could be overlap between sites demarcated for the event where pilgrims would congregate and elephant use areas.

The field work for the study began during the month of February 2020. During the initial months of the study, reconnaissance surveys were carried out in Rajaji NP, Haridwar FD, and Dehradun FD. These surveys were aimed at collating baseline information on HEC through field visits and discussions with the FD staff. Alongside, efforts were made to identify elephants individually using standard, morphometric-based elephant identification. During the initial months, notwithstanding the Covid-pandemic related restrictions, plans were made to collar elephants. During field surveys, locations suitable for safe collaring of elephants were identified and deliberated with the Forest Department. In this report, activities that were carried out as part of the project for the period March 2020 to March 2021 are deliberated, preliminary findings discussed and the way forward is indicated. The summary of activities carried out objective wise is provided below

1. **Spatio-temporal ranging patterns of elephants assessed through intensive individual-based monitoring of elephants and satellite telemetry:**

- A repository of elephant photos and videos has been maintained since the inception of the field work for the project. From this repository, individual elephants have been identified based on their unique morphological characteristics. A total of 21 elephants have been identified individually. Re-sighting data (location information, group composition and association patterns constitute the re-sighting data) of identified individuals is providing interesting insights. A total of 1843 hours were invested to locate and observe elephants during the period. A manual comprising of identified elephants that use the proposed *Kumbh* 2021 sites had been prepared and provided to FD staff for ease of daily monitoring of elephants.
- Twenty-one identified bull elephants were observed to regularly cross river Ganga. In that 17 of these bulls were observed to use Dassowalla, 14 of them Anjani Chaur, 13 East Ganga canal (Shyampur) and 9 islets.
- A total of 4 elephants that were identified and monitored for many months were collared in Haridwar Forest Division. The four elephants were collared in two different phases of collaring operations. The details of the collaring operations have been provided as separate reports. The four elephants collared as part of the project by WII-UKFD had provided a total of 138 days of tracking information comprising of 4724 points.

- Some of the bulls identified in the landscape do venture into human-use areas, into villages located in the west bank of River Ganga frequently. The movement of elephant bulls from the east bank (where natural elephant habitats occur) and the west bank (where there are no elephant habitats) is primarily for feeding on cultivated crops by elephants. The movement patterns and the dynamics with regards to elephant individuals, association patterns and others have been documented elaborately in this study. The average daily distance covered by collared elephants from Ganges, into the human use areas on the western bank of the river was 1.12 (±0.75) km.

- High-resolution satellite collars deployed on elephants as part of the study have provided critical information on use of agricultural fields and human-use areas in the landscape. Collared elephants spent 53.9 % of the time in the forest habitats (including river) and 46.1 % of time in non-forest human-use areas, primarily for raiding crops.
- There is a high spatial overlap between sites demarcated for *Kumbh* and elephant use areas. Over 44% (3.28 sq. km) of the designated 7.45 sq km of proposed camping (and parking) sites overlaps with intensive elephant use areas. These are areas primarily bounded between *Gauri-shankar* (on the eastern bank) and Dakshdweep (on the western bank of the Ganges). Of the 10 designated *Kumbh* areas, only *Sapt-sarovar* and *Satidweep – Naya Tapu* complex were not used by elephants.
- Being a meandering river of considerable width, there are many islets (of varying sizes) in the River Ganga. Some of the islets are seasonal and would get inundated during floods, but post monsoon, the draw-down pans of the islets appear to support vegetation that provides forage and cover for elephants. Extensive use of islets in Ganga has been documented in the study, which remains a novel finding. Nine of the 21 identified bulls were observed to use the islets.
- Average speed of collared bulls at dawn was calculated to be 1.35 kmph, followed by dusk – 0.89 kmph, 0.49 kmph at night and 0.19 kmph during the day.

2. Landscape-scale and fine-scale assessment of aspects of HEC:

- In order to get the landscape-level picture of HEC for Haridwar Forest Division, HEC records (crop damage, property damage and casualty) were obtained from FD for a six-year period, 2015 to 2020. A total of 2123 cases of HEC were collated from FD records and mapped in GIS. During the period 2015 to 2020, a total of 93 villages suffered reported HEC. The average number of HEC incidences for a village is 22.82.
- Annually, a total of 44 (±12) villages were affected by HEC in Haridwar Forest Division. Average cases per year were reported to be 353.8 (±136).
- Most cases of HEC in Haridwar Forest Division were consistently due to crop damage (2015 – 94.06%, 2016 – 98.02%, 2017 – 96.96%, 2018 – 94.61%, 2019 – 93.54% and 2020 – 96.35%) with sugarcane being the most affected crop (2015- 69.5%, 2016- 57.89%, 2017- 65.15%, 2018 – 60.04%, 2019 – 67.74% and 2020 – 59.6%).
- In order to develop a fine-scale understanding of HEC, particularly with respect to patterns and possible drivers of crop losses, 22 villages spread across Haridwar, Laksar, Shyampur, Rasiyabad and Chidiyapur ranges of Haridwar Forest Division were selected for intensive monitoring. In the select villages, crop losses due to elephants are being quantified. This phase of the study has just begun and data collection is going on.

3. Trainings and workshops:

- One of the motives of the collaborative project, in addition to the overarching objectives was to raise awareness among the frontline staff about elephant ecology, behaviour, and conflict management, to improve preparedness in tackling difficult conflict situations, especially during challenging times such as the *Maha Kumbh* 2021. So as to make this possible, one workshop and 3 interactive sessions were organized for frontline staff of various ranges and divisions.

Introduction

Many large mammals like the elephant (*Elephas maximus*), rhinoceros (*Rhinoceros unicornis*) and tiger (*Panthera tigris*) sometimes come into conflict with humans resulting in loss of life, livelihood and property. Human-wildlife conflict is one of the major deterrents to conservation efforts as it undermines local support and could increase antipathy towards conservation. There is mounting evidence to show that human–wildlife conflict has been increasing across regions and landscapes in India. This is particularly the case with regards to elephants, which occurs in four major regions across India namely Southern, North East, East Central and Northern. A large fraction of the Northern regional elephant population occurs in the state of Uttarakhand, in the Terai and the adjoining Shivalik hills, most of which occurs in the Corbett – Rajaji landscape complex. Human–Elephant Conflict (HEC) in the landscape is widespread and continues to be a challenge for the management. Effective HEC management, which is recognized as a long-term endeavour with active engagement with local communities would benefit from improved understanding of the elephant demography, habitat use and movement. Considering this, and in view of the *Kumbh* 2021, where potential overlap between elephant movement areas and pilgrim sites was envisioned, a study was undertaken by the Wildlife Institute of India in collaboration with the Uttarakhand Forest Department (UKFD) to address the drivers of HEC in the Rajaji Landscape. The overarching objective of the project is to understand aspects of HEC and suggest appropriate strategies to mitigate conflict.

Briefly, the HEC could be a result of complex interplay of four key factors including habitat, elephant demography and behavior and community responses in terms of land use and resource dependence (Desai & Riddle, 2015; Sukumar, 1994). In order to understand HEC holistically and address its possible root causes, it is important to identify these factors that operate in the context of the landscape. Due to the complex interplay of the factors and compounded by the sheer spatial scale of the problem, managing HEC is a challenge that requires a sustained long-term efforts duly informed by the species biology/ecology in its core. Failure to understand these factors and not catering to the root cause, can result in persistence of the HEC.

Rajaji Tiger Reserve and the adjoining areas in Haridwar and Dehradun Forest Divisions support one of the largest sub-populations of elephants in Uttarakhand. The main threats facing this elephant sub-population in Haridwar Forest Division and adjoining area include tenuous connectivity between Eastern and Western Rajaji across River Ganga limiting animal movement; habitat degradation due to biotic pressure from local communities, incompatible land use changes outside of the forests and rapid expansion of linear infrastructure that often impedes habitat connectivity, compromise habitat attributes and isolate populations.

The HEC scenario in the Rajaji landscape, encompassing adjoining Forest Divisions is as complex as across other range states. Managing HEC to foster co-existence and tolerance in Rajaji TR and adjoining landscapes hinges on effective monitoring of elephant populations. Furthermore, monitoring elephants that regularly venture into human use areas could be useful to understand individual variations in behaviour and its possible drivers. This is of particular relevance in today's context, wherein the ranging areas of several of these bulls spatially juxtapose or overlap with the proposed camping and parking sites for the *Maha Kumbh* 2021.

Crop damage by elephants is another major challenge at the forest-cultivation interface. Although crop damage by elephants is widespread all along the zone of interaction, it is particularly severe in stretches along the Western banks of the Ganges, in village enclaves of Bishanpur, Missarpur, Katarpur, Jagjeetpur, Ajeetpur, etc. and partly in Peeli and Gaindikhata villages, largely falling within the jurisdictions of Haridwar, Laksar, Shyampur, Rasiyabad, Chidiyapur ranges of HFD.

Secondly, a threat more challenging than the problem of crop raiding by elephants is the ever-increasing risk of elephants entering densely populated urban and semi-urban areas, as conurbations of Haridwar, Dehradun and Rishikesh continue to expand, sandwiching elephant habitats.

Several studies on elephants ranging pattern based on their movement patterns (through telemetry studies), habitat use, demography, status of HEC, connectivity of landscape and corridors, and their feeding ecology have been carried out in the past three decades, primarily focusing on the areas inside the protected area (Williams, 2002). The past decade has witnessed a rise in HEC in the landscape, a situation similar to several other landscapes in the country and other elephant range states. This has resulted in the creation of several HEC hotspots that now require quantification of crop and property damage as well as assessment of socio-economic aspects of local communities. The information would help in understanding the willingness and preparedness of communities to participate in conflict mitigation efforts. Elephants being wide-ranging species; the conflict hotspots also tend to be highly dynamic.

Considering the aforementioned details regarding HEC in Rajaji landscape, the present study focuses on a relatively large spatial scale in trying to understand a gradient of conflict intensity. Further, inter-annual comparisons of HEC with respect to spatial extent and intensity would be useful to understand seasonal variations (and possible correlates of such variations) and spatial dynamics (whether some areas in the landscape are predisposed to HEC). Further, as elephants are long-lived species as well with average lifespan of about 50 to 60 years in the wild. Therefore, it is important to assess patterns of conflict for a longer duration covering different seasons of the year across multiple years to make inter-seasonal and inter-annual comparisons. Such inter-seasonal and long term comparisons are useful to determine environmental drivers of conflict.

Statement of Problem

Human-elephant conflict results in huge fiscal losses, loss of human lives and consequently antagonism towards conservation. Managing HEC to foster co-existence and tolerance in Rajaji TR and adjoining landscapes hinges on effective monitoring of elephant populations as well. In particular, understanding how elephants use corridors to move between habitats, bottlenecks that hinder their free movement and the impacts of linear developments on movement patterns are crucial, as such threats could be a subtle trigger for conflict in the locality. In some cases, addressing a threat on the habitat may serve as a strategy to avert HEC. Telemetry data could provide the resolution that is required to understand fine-scale patterns of habitat use and movement by elephants. The data thus generated will prove useful in assessment of structural, functional and fitness value of the landscapes (Wittemyer, et al., 2019).

Further, monitoring elephants that regularly venture into human use areas could be useful to understand individual variations in behavior and the possible drivers. This is urgently required in the case of a group of male elephants that regularly cross River Ganga and raid crops in the western bank of the river in the downstream of Chandi Bridge (Anjani Chaur, the *Kumbh* camping site) where there are no forests. With crops being readily available everywhere, it remains a puzzle as to why elephants cross River Ganga every night and return back to the forests early in the morning. These male elephants operate very close to Haridwar city and any haphazard drive by villagers can direct them towards urban limits triggering a chaotic situation. Further, this group of elephants also moves through well-trodden trails leading into River Ganga and thus, requires a very close monitoring during *Kumbh* season.

The BHEL town ship along the Haridwar range is also vulnerable for elephants to enter urban areas. There were a few human casualties due to elephants in this stretch during the past few years. This stretch too requires close monitoring in order to suggest fine-scale conflict mitigation measures. Uttarakhand FD has already invested on a suite of conflict mitigation strategies. Some of them, like the construction of walls have been expensive, but not very effective, barring a few stretches. It shall be important to reassess the previously effective sections of the wall and monitor outward movement of elephants.

To study the spatiotemporal dynamics of this conflict, a collaborative project was initiated between UKFD and WII in January 2020, with objectives to understand ranging and movement patterns of elephants using the landscape, the extent and nature of loss due to conflict, and the drivers of conflict in order to plan suitable mitigation strategies, with particular focus on the forthcoming *Kumbh* 2021.

Project Objectives

1. Investigating patterns of home range and movement of elephants in select locations within the landscape to serve as a precursor to understand HEC holistically and *Kumbh* in particular.
2. Landscape-level assessment (covering the entire RTR and Haridwar FD) of HEC and its drivers to suggest implementable strategies to mitigate conflict.
3. Intensive monitoring of HEC and carrying out socio-economic surveys in select conflict hotspots to assess preparedness and willingness of local communities to participate in conflict mitigation.

Study Area

The overall study area includes Rajaji Tiger Reserve and its adjoining forest divisions – Haridwar, Dehradun, Lansdowne, Narendranagar and parts of Mussoorie Forest Division. Physiographically, the landscape is part of the Western Himalaya. The landscape is recognized as one of the most productive ecosystems in the world as far as large mammals are concerned. The major vegetation in the landscape comprises of tropical dry and moist deciduous forests, scrub vegetation, alluvial grasslands and forest plantations primarily of *Tectona grandis* and *Eucalyptus spp* (Champion & Seth, 1968;Johnsingh et al., 2004). Vegetation communities as described elaborately by Johnsingh et al (Johnsingh et al., 2004), include (i) Sal (*Shorea robusta*) dominated forests along with its associates (ii) Sal-mixed forests of *Shorea robusta – Mallotus philippensis – Lagerstroemia parviflora* series (iii) riverine forests of *Acacia catechu – Dalbergia sisoo – Syzygium cumuni* series (iv) mixed forests of *Lagerstroemia parviflora – Holoptelea integrifolia – Ehretia laevis – Adina cordifolia – Anogeissus latifolia* series (v) forest plantations (Johnsingh et al, 2004). With respect to faunal aspects, along with flagship species like tiger (*Panthera tigiris*), and Asian elephants (*Elephas maximus*), the area is also home to sambar (*Rusa unicolor*), chital (*Axis axis*), nilgai (*Boselaphus tragocamelus*), wild pig (*Sus scrofa*), leopard (*Panthera pardus*), hyena (*Hyaena hyaena*) and diverse avifauna and herpetofauna. The area receives maximum rainfall between mid-June to September, followed by the onset of winter from November through February. January to May marks the dry season in the area. Major occupation of the communities dwelling along the wildlife habitat includes pastoralism and agriculture. Major crops grown in the area includes sugarcane (*Saccharum officinarum*), paddy (*Oryza sativa*), wheat (*Triticum aestivum*), maize and millets. Although seasonal rainfall is imperative for growing crops such as paddy, agriculture in the landscape is largely sustained by network of irrigation systems.

Rajaji tiger reserve is a protected area (PA) with high degree of legal protection. However, outside of the PA, there is substantial pressure to the forests from land use change, resource dependence (fodder and firewood collection) and cascading effect of developmental activities (road, rail networks). An estimated population of about 350 elephants has been reported for the area (Wild Asiatic Elephant Population Estimation Uttarakhand, 2015).

Although the larger study area comprises of the entire Rajaji landscape as described above, based on the immediate needs to manage HEC around the proposed *Kumbh* 2021 camping site, monitoring of elephant movement, habitat use and physical barriers initiated during March 2020 centered around Shyampur, Haridwar, Chidiyapur, Rasiyabad and Laksar ranges of the Haridwar Forest Division (Figure 1).

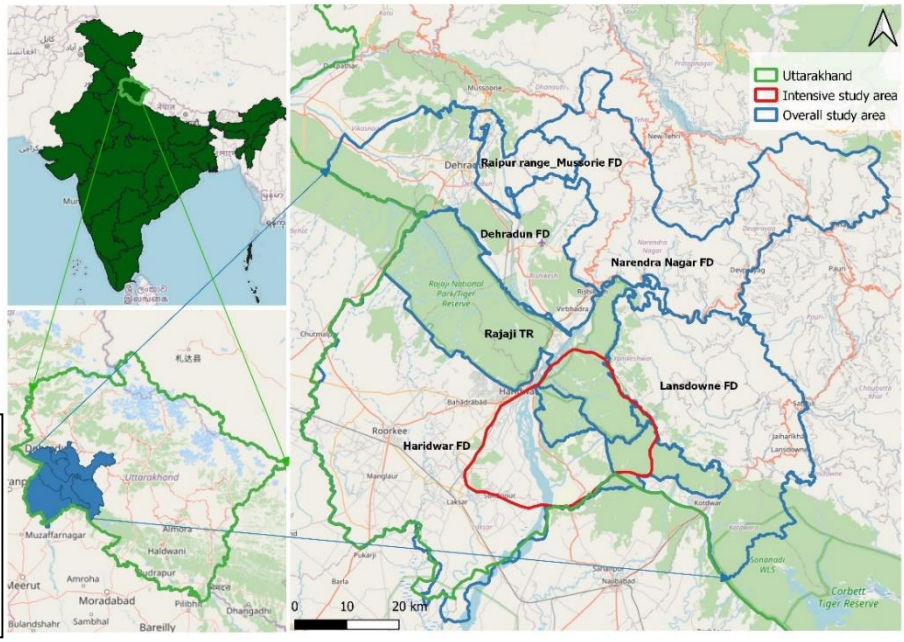


Figure 1: Intensive study area (in red) comprises of eastern ranges of Rajaji TR, Haridwar Forest Division and parts of Haridwar and Laksar range.

Among these areas, two major daytime refugias for elephants viz. Dassowalla forests and Anjani Chaur (in Rasiyabad unit and Shyampur range respectively) were identified based on continuous monitoring and due to their strategic importance of being juxtaposed to sites demarcated for *Kumbh* 2021, these two sites were intensively monitored. Additionally, Shyampur canal bank and islets in Ganga river were regularly monitored to register and identify elephants as part of photographic inventory of elephants. During foot tracking, elephant signs were recorded in addition to all possible direct sightings. In case of direct sighting, photographs are recorded which are used to build an elephant ID database for the intense study area.

OBJECTIVE 1: INVESTIGATING PATTERNS OF HOME RANGE AND MOVEMENT OF ELEPHANTS IN SELECT LOCATIONS WITHIN THE LANDSCAPE TO SERVE AS A PRECURSOR TO UNDERSTAND HEC HOLISTICALLY AND *KUMBH* IN PARTICULAR

Introduction

Ranging behaviour of animals can be explained by two main descriptors namely the home range and spatial organization of individuals (Fernando et al., 2008). Burt (1943) outlined the basic concept of home range as "area traversed by an individual in its normal activities of food gathering, mating, and caring for young. Occasional sallies outside the area, perhaps exploratory in nature are generally not considered while defining home range". Powell & Mitchell (2012) defined home range as part of animal's cognitive map that it chooses to keep up-to-date with the status of resources (including food, potential mates, safe sites, and so forth). Home range is a decision making process shaped by natural selection to optimize use of spatially discrete resources to maximize fitness. Understanding home ranges can provide important insights on habitat requirement, management interventions that can help in optimizing habitat conditions and identifying areas that are critical for animals.

Elephants that occur in relatively intact natural habitats exhibit profound fidelity to their home ranges. Due to this site fidelity their movement patterns may be predictable (Moss, 1988). Generally, in relatively intact habitats where optimal habitat conditions prevail for elephants, their home ranges tend to be relatively small. To illustrate, home range of elephants in the intact habitats of the Nilgiris was estimated to be around 400 km2 (Desai, 1991) whereas in fragmented habitats, elephant home ranges tend to be comparatively very large (in the fragmented forests of north West Bengal it was estimated to be over 3500 km2) (Sukumar, 2003).

Pinpointing elephants' positions periodically using high-resolution satellite collars can provide fine-scale details about their space use. It will help in generating high-quality maps showing how elephants traverse the mosaic landscape. It is also possible visualize their intensive-use 'core' areas and identify habitats that can be improved to support elephants. Moreover, collared elephants can provide details on patterns of conflict as well –seasonality of damages to crops and property, and their general time-activity patterns. Such details can help us formulate site-specific conflict management strategies and also in providing evidence-based policy recommendations to the Government.

As part of the project, it was decided to collar a maximum of 10 elephants in the landscape. The idea was to try and collar as many elephants as possible keeping field practicalities and logistics in consideration. Irrespective of the number of elephants, the idea was to try and collar a few individuals that particularly operate in the potential *Kumbh* sites so that fine-scale planning to reconcile *Kumbh* safety and elephants' habitat requirements.

Monitoring of Elephants (Pre-collaring)

Between March – October 2020, WII field team surveyed the Eastern and Western ranges of Haridwar Forest Division intensively and documented the ranging pattern of elephants involved in HEC. The study identified that there were at least 34 identified male elephants of varied age class that range in the eastern ranges of Haridwar Forest Division, of which 21 individuals (males) have been recorded to cross the Ganges and raid crops along the western bank of the river. Elephant movement was tracked using re-sighting records, referring to the ID database, and individual specific usage of the intense study area was noted during the on-ground tracking exercise. This was preceded by intense ground survey for a year to build an individual ID database by identifying elephants based on unique morphological features (Vidya et al., 2014), Fig.2. The physical features used to ID the individuals included the tusk patterns (in case of tusked males); tail and tail brush patterns; ear folds, tears, nicks, and shape and other unique marks such as warts, cuts, (healed) major wound marks etc.

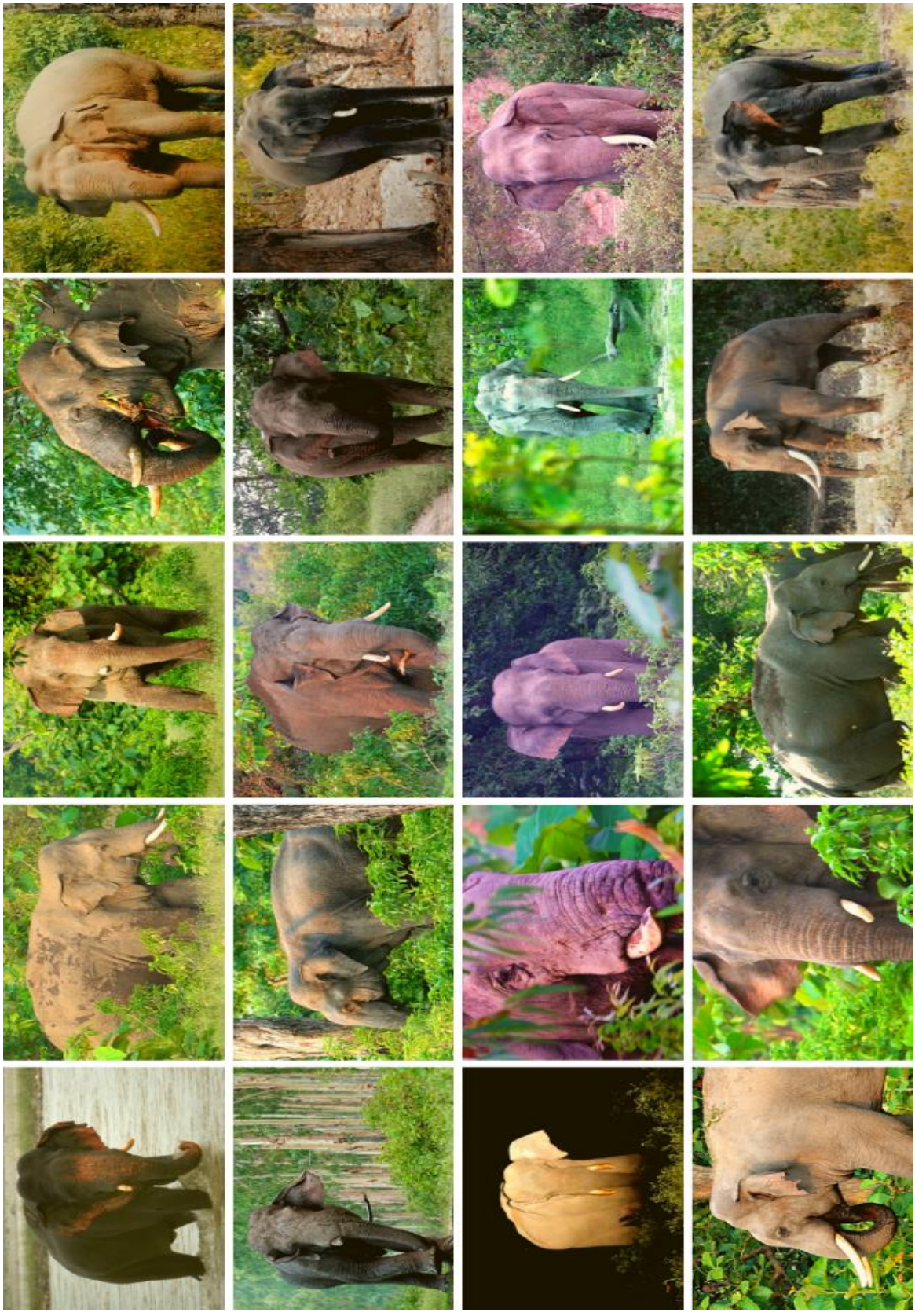


Figure 2: Individuals identified as part of the monitoring programme

The sighting re-sighting records also helped in understand their ranging behaviour, association patterns between individual elephants (between bulls and female groups) and also shed light into their body condition (Figure 3).

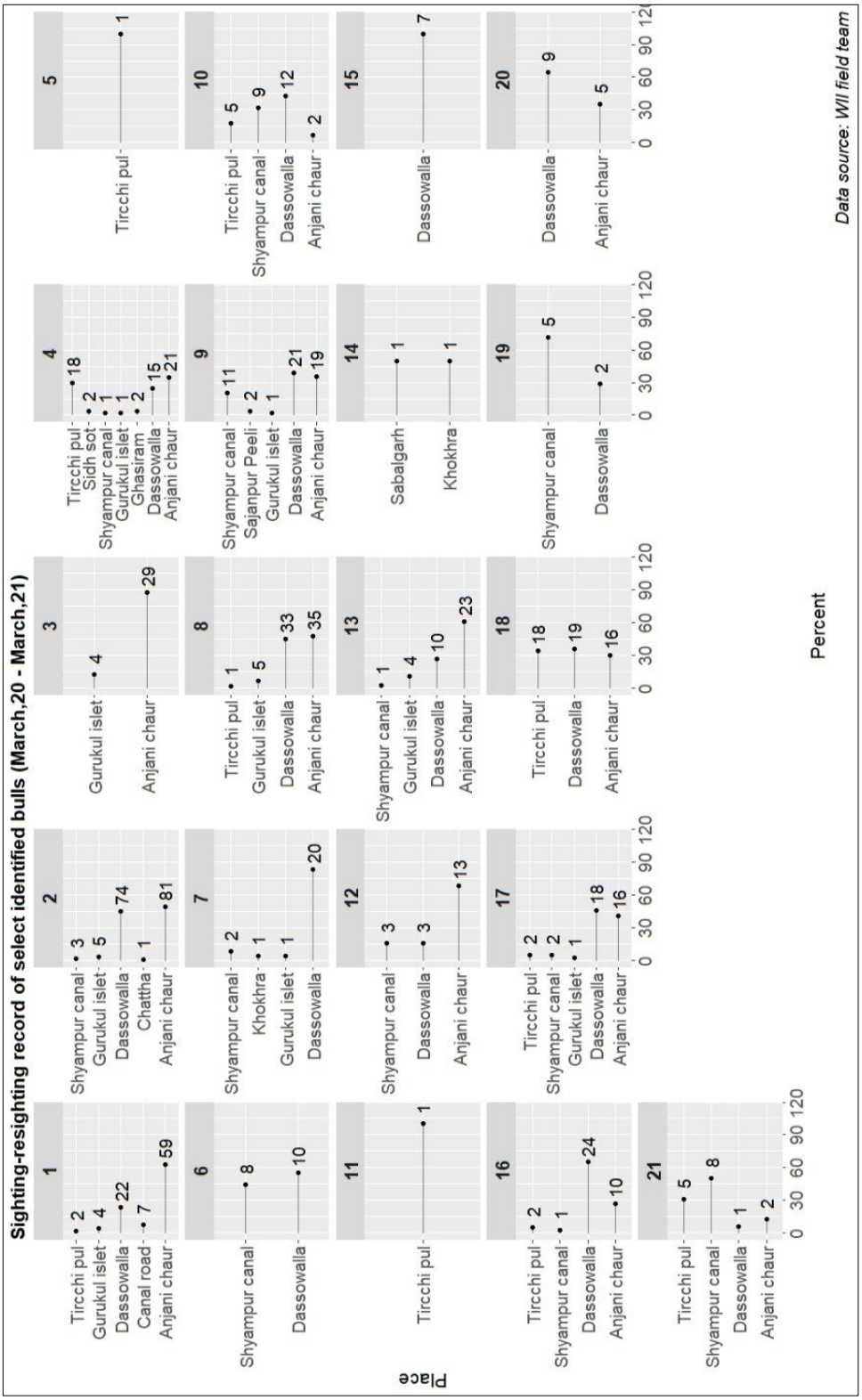


Figure 3: Direct sighting – re-sighting record of select bull elephants observed to use the areas in and around the proposed Kumbh 2021 sites. Note: The field team could not operate between 15/3/2020 to 1/6/2020 due to CoVID19 related restrictions.

Animal Capture and Collaring

Preparatory activities: Being part of the ongoing project wherein monitoring had been continuous since March 2020, preparatory measures for the collaring, particularly with regard to tracking elephants to understand potential capture sites was already in place. The team had mapped coarse scale movement of identified individuals, which helped in ascertaining ideal locations to smoothly carry out the operation. Among the 21 identified individuals, potential targets for collaring and monitoring were chosen based on their age and size classes, and their association patterns (as understood through close observations).

Veterinary aspects of the preparatory measures included procurement of narcotics and reversals from the M/S Wildlife Pharmaceuticals Inc., South Africa. Other basic and emergency medications were also stocked appropriately.

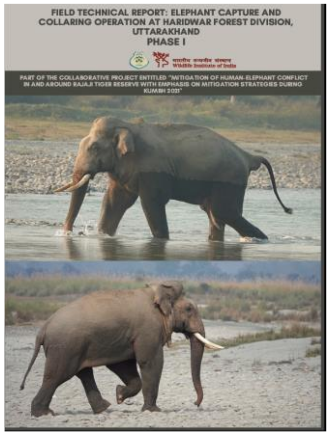
Collars for the operation were provided by GIZ. The units are produced by M/S Africa Wildlife Tracking Inc. and are iridium satellite based. These collars were kept ready by syncing the time intervals appropriately before the operations, and mock drills on deploying them tried out to provide hands-on experience to the field tracking team. Other accessories including toolkits, ropes, and equipment were procured according to a checklist prepared previously, and were kept organized for immediate use.

Most crucial aspect of preparation for any animal handling exercise is having an experienced tracking team, who can not only assist in monitoring the animals, but can also aid in tracking the animals down as soon as they are darted. To strengthen the existing tracking team, two trackers belong to the Malasar community, who have been engaged in mahout profession since generations, and have a fair understanding of elephants, their ways and lives from Kozhikamuthi in the Anamalais were added to the team since December 2020. In addition, select individuals from the UKFD brought fine-scale knowledge of the sites, which further contributed to intense tracking during the operation.

Once suitable conditions prevailed, select identified bulls were chemically immobilized and collared during phase I and phase II operations that were conducted between 10th- 20th October and 23rd - 27th December 2020. As part of the project, four individuals were captured, collared and tracked using both on-ground tracking using VHF unit and through satellite data.

Animal Collaring

During the first phase, animal identified as UKM07 was collared on the 15th of October 202 at Dassowala range. The collar-team and the tracking team took position overlooking river Ganga so as to locate elephants as they cross the Ganges and relay the information to the darting team. The bull identified for collaring, UKM007 was observed at the lure site feeding on sugarcane. The animal was remotely darted using narcotic (Etorphine hydrochloride) employing Dan-Inject syringe projector (Mod JM). The bull came in lateral recumbency and after ensuring sedation safe for approach and handling was achieved; the animal was collared. The physiological parameters were monitored continuously. Drug reversal was carried out using Naltrexone hydrochloride. As part of the phase II collaring exercise, three adult bulls were collared in Rasiyabad unit and Shyampur range jurisdictions of the Haridwar Forest Divisions between the 23rd and 27th of December 2020. The animals were part of 21 identified bull and were being continuously monitored since March 2020. The three animals, identified as UKM02, UKM04, and UKM17 were then similarly immobilized and collared on 24th, 26th and 27th of December 2020 respectively. The reports of the Phase Ii & phase II collaring had been submitted to the Department.



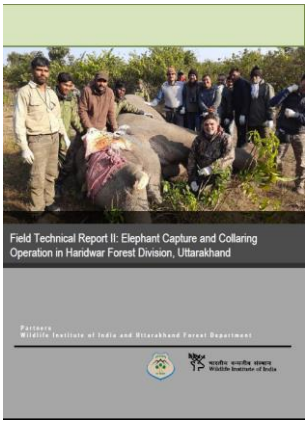
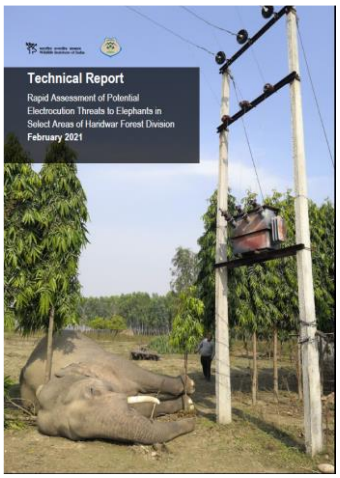


Table 1: Details of collared individuals

Sl. No	Date of collaring	Location of capture	Individual ID	Remarks
1	15th Oct 2020	Dassowalla	UKM07	Tracking data available for 44 days. Got electrocuted on 23rd of November 2020 in Bishanpur Kundi
2	24th Dec 2020	Dassowalla	UKM02	Collar functional with almost 110 days of data as on 12th April 2021
3	26th Dec 2020	Gurukul islet	UKM04	Tracking data available for 52 days. Collar dropped by animal on 16th February 2021.
4	27th Dec 2020	Anjani Chaur	UKM17	Tracking data available for 18 days. Collar dropped by animal on 13th January 2021

Electrocution of UKM07



Collared individual UKM07 was frequently using the islets along the Ganges. It was observed to be taking refuge in the Gurukul islet and Dassowalla during the day. On the 23rd of November 2020, the animal came into contact with a low-lying high-tension transformer used for drawing support for irrigation and succumbed on one of the islets. Detailed post-mortem conducted by the Government Veterinary team confirmed death due to electrocution.

A rapid assessment of potential electrocution sites was carried out. The sites were mapped and a detailed report with possible mitigation strategies was submitted to the UKFD in the form of a technical report (WII, 2021).

Dropping of Collars

Of the three animals collared as part of the phase II collaring, collars of UKM17 and UKM04 dropped during January and February 2021, at Dassowalla and Anjani Chaur respectively. The collar of UKM17, christened Mahesh, deployed on 27th of December 2020, dropped off between the 13th and 14th of January 2021. The final GPS location of the animal was obtained on the 13th January at 1330 h. The field team was able to trace the collar in Dassowalla (North Nallowala Beat, Compartment No. 5 (29.832570°, 78.194660°), with the satellite receiver unit ruined completely. Previous observations, prior to collaring, have indicated that the individual UKM17 used the landscape extensively, associating with at least three other males. The animal was seen along Tiger Trail with other bulls a day prior to the collar drop-off near Dassowalla watchtower.

Likewise, the collar of UKM04 was observed to have dropped on the 16th of February 2021, in the Ganges, along Anjani Chaur. Last data point was obtained at Tirchi pul on the previous evening (6:30 PM), following which no satellite signals were received. VHF signal based tracking, however, indicated the presence of the collar in the river, but heavy undercurrents, and murkiness of the water following the landslides upstream challenged searching for the unit underwater, thereby resulting in permanent loss of the same. It was assumed based on previous observations that the collar might have been removed during play fighting or sparring commonly observed among these young bulls, wherein collar often becomes a target object with the other animals pulling the belt.

UKM017 provided satellite data for 18 days, while UKM04 provided data for 52 days. The details regarding satellite data obtained from these two collars, that of UKM07 (animal died), and UKM02 (active collar) are discussed in the following section.

Satellite-based tracking of collared individuals

The satellite data obtained from the four collared animals validated several of the field-based observations collected by the team since March 2020, both in terms of their ranging patterns, and also in terms of their behavioural aspects. With regard to their ranging and use of the Haridwar landscape, it was evident that, all four collared elephants and the individuals associated with these, in addition to other identified animals in the region, extensively used the human-dominated landscape, covering major village enclaves on the Western Bank of Haridwar viz., Bishenpur, Bhogpur,

Katarpur-Alipur, Jagjeetpur, Devpur-Ahatmal etc., on the Eastern Bank such as Shyampur, Gajiwali, Bahar Peeli, Peeli Padav, Nalowala, Gaindikhata, upto Chattha (in Uttar Pradesh). The area covered by these collared individuals in terms of 95% Kernel Density Estimation (KDE) and Minimum Convex Polygon (MCP) is provided in Table 2.

Figure 4a provides space use (95% Kernel Density Estimation) of each collared bull, based on fine-scale satellite tracking between 15th October, 2020 and 12th April 2021 whereas the home range of collared individuals prior to and post collaring is provided in Figure 4b.

Table 2: Home range estimation (based on Kernel Density) of the four collared individuals

S. No.	Individual ID	Period (days)	95% KDE (km^2)	MCP (km^2)
1	UKM07	48	8.5	97.45
2	UKM02	110	135	324.81
3	UKM04	52	14.8	75.51
4	UKM017	18	28.29	117.08

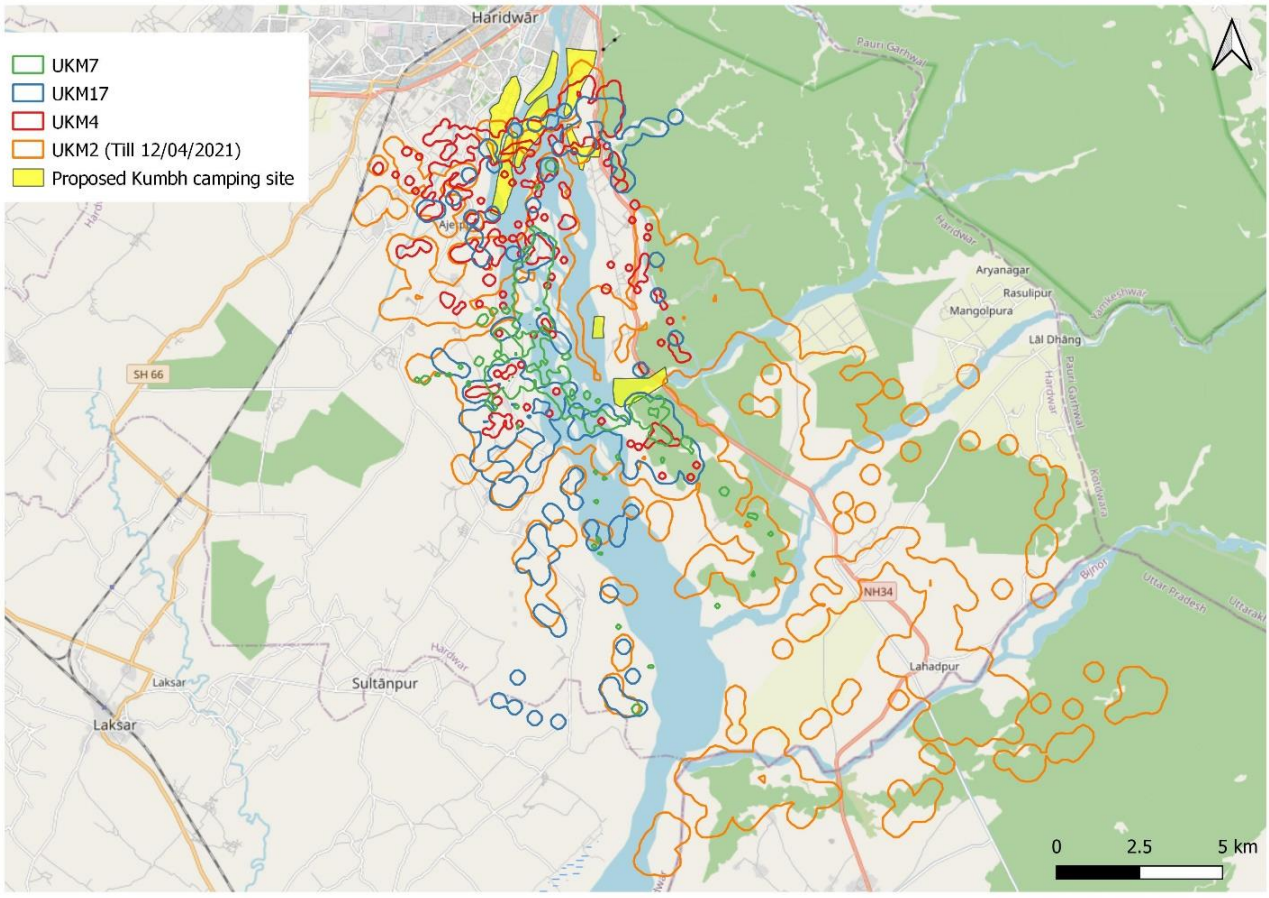


Figure 4a: Space use (95% KDE) of each collared bull

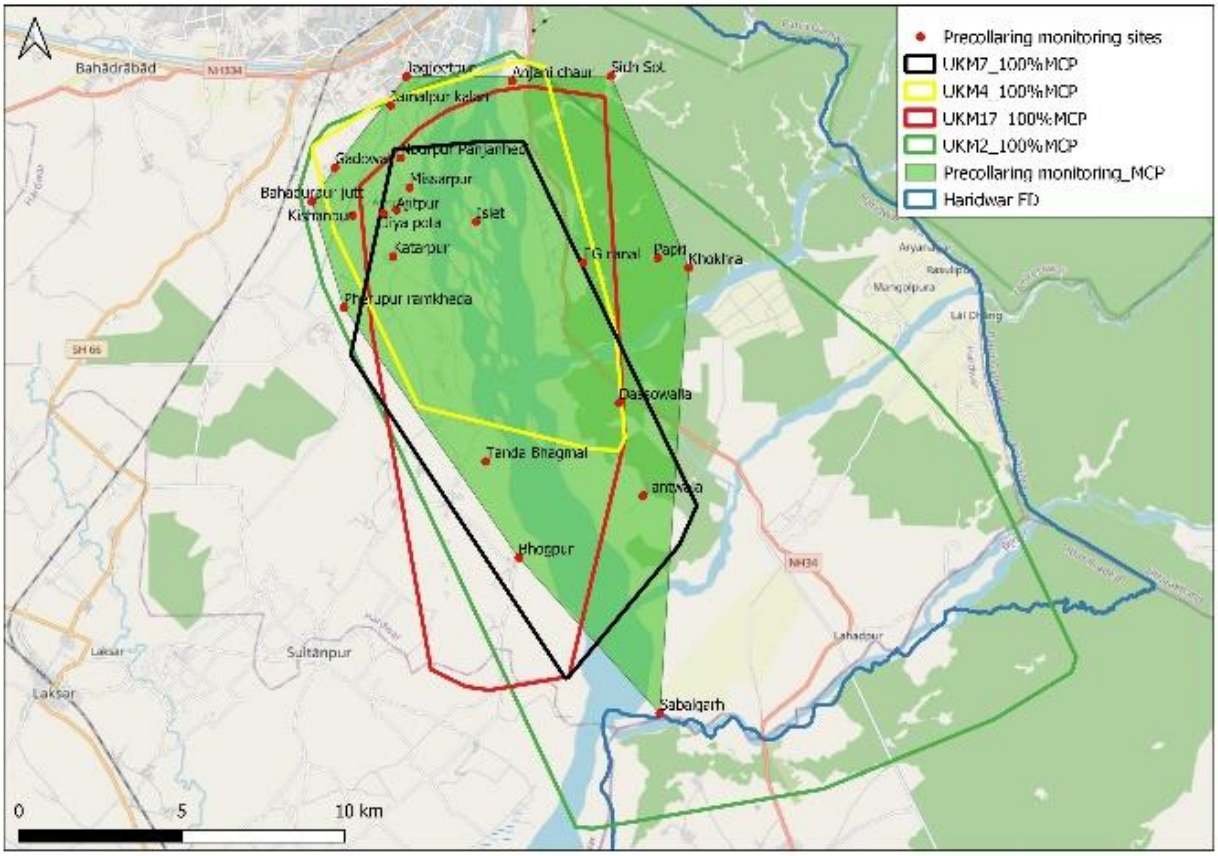


Figure 4b: Home ranges (MCP) of collared bulls prior to and after collaring

Movement with respect to *Kumbh* sites

Monitoring of elephants on foot, prior to radio collaring had indicated high affinity of elephants to the thickets of Anjani, *Mallotus*-dominated East Ganga Canal side, and Dassowalla forests. In addition to these, elephants were also observed to extensively use the Gurukul islet, which is largely open, dominated by *Saccharum bengalensis* interspersed with *Bombax ceiba* and *Acacia catechu* trees. These diurnal refuges and the areas that are accessed by the bulls during night hours spatially overlap with the proposed *Kumbh* camping and parking sites making these areas vulnerable for human elephant encounters during the *Kumbh*. The details were communicated to the Department for appropriate action at their end.

There was a high spatial overlap between sites demarcated for *Kumbh* and elephant use areas. A total of 44% (3.28 sq. km) of the 7.45 sq km of proposed camping (and parking) sites overlapped with intensive elephant use areas. These are areas primarily bounded between Gauri shankar (on the eastern bank) and Daksh dweep (on the western bank of the Ganges). Of the 10 designated *Kumbh* areas, only Sapt sarovar and Sati dweep – Naya Tapu complex were not used by elephants (Figure 5 a and b).

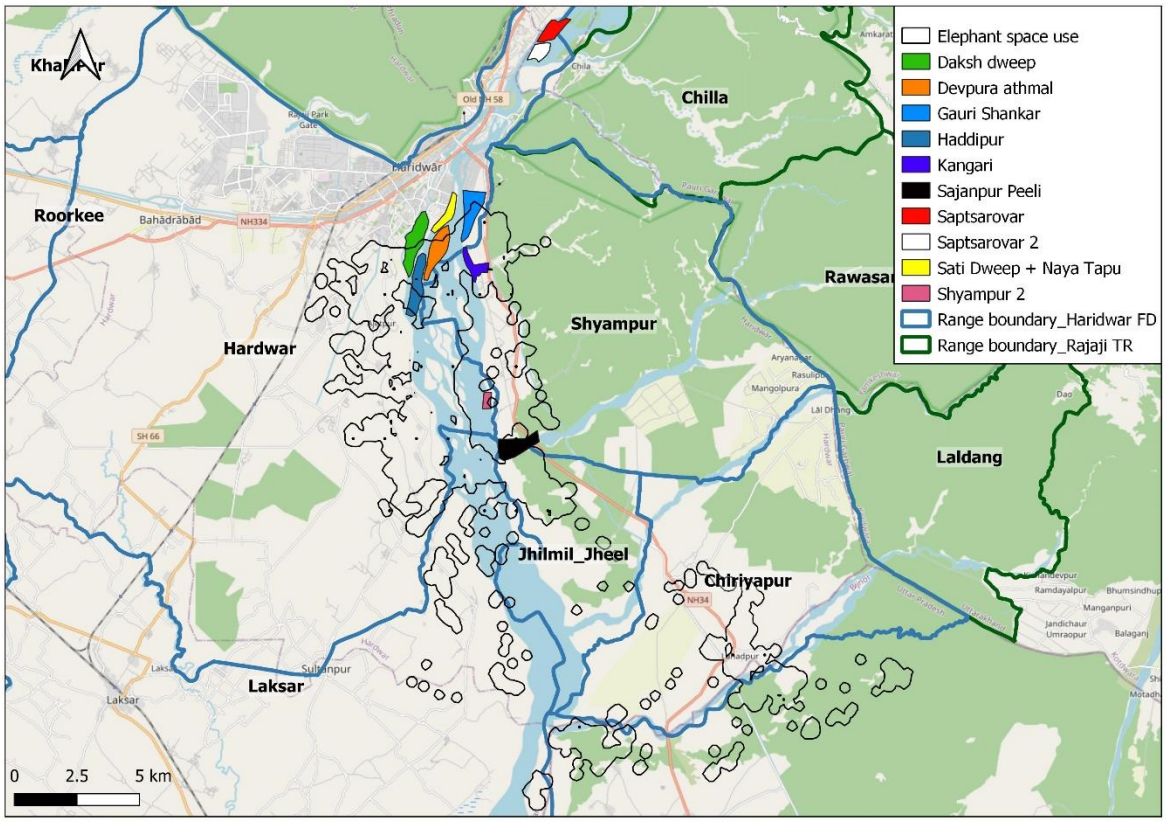


Figure 5a: Proposed camping sites for Kumbh 2021 with the overlap of collared bull space use.

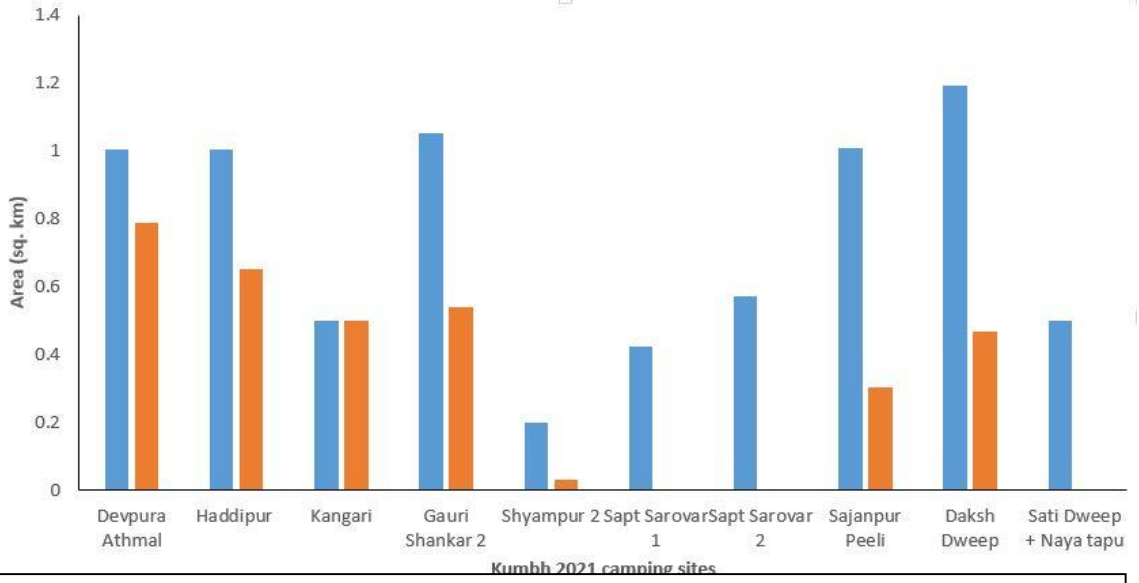


Figure 5b: Graphical representation of percent of sites overlapping with elephant use area.

Other fine-scale movement pattern

To understand the distance covered by the crop raiding bulls (collared), from the western bank of the Ganges to the human-use areas, we measured the distance of each hourly GPS location falling on the western side of the Ganges, from the boundary of its western bank. Figure 6a shows the distance covered by UKM2,4,7 and 17. Average distance covered by collared elephants from Ganges, into the human use areas on the western bank of the river was 1.12 (±0.75) km.

Exploratory data analysis has revealed interesting temporal (day/night) pattern of space use by collared bulls. While the GPS fixes in daylight hours (6:30 AM to 6:30 PM) fall largely inside their refugia /habitat, night time locations (7:30 PM to 5:30 AM) were observed to falls inside crop fields/human-use areas. (Figure 6b).

Hourly fixes collected from UKM2,4,7 and 17 were used to overlay the same with Forest Survey of India's (2017) of Uttarakhand and Uttar Pradesh data (forest type), to reveal the percentage of time spent by the collared bulls in forested and non-forested areas (Figure 6c).

Fine-scale diel (24 hour) movement dynamics of collared bulls also suggested their crepuscular behaviour, where the bull elephants tend to rest in their refugia during major part of the daylight hours and tend to be more active during twilight (dawn/dusk) hours (primarily while going for and returning from crop raids). This information may prove pivotal in designing HEC mitigation strategies in the affected areas. (Figure 6d).

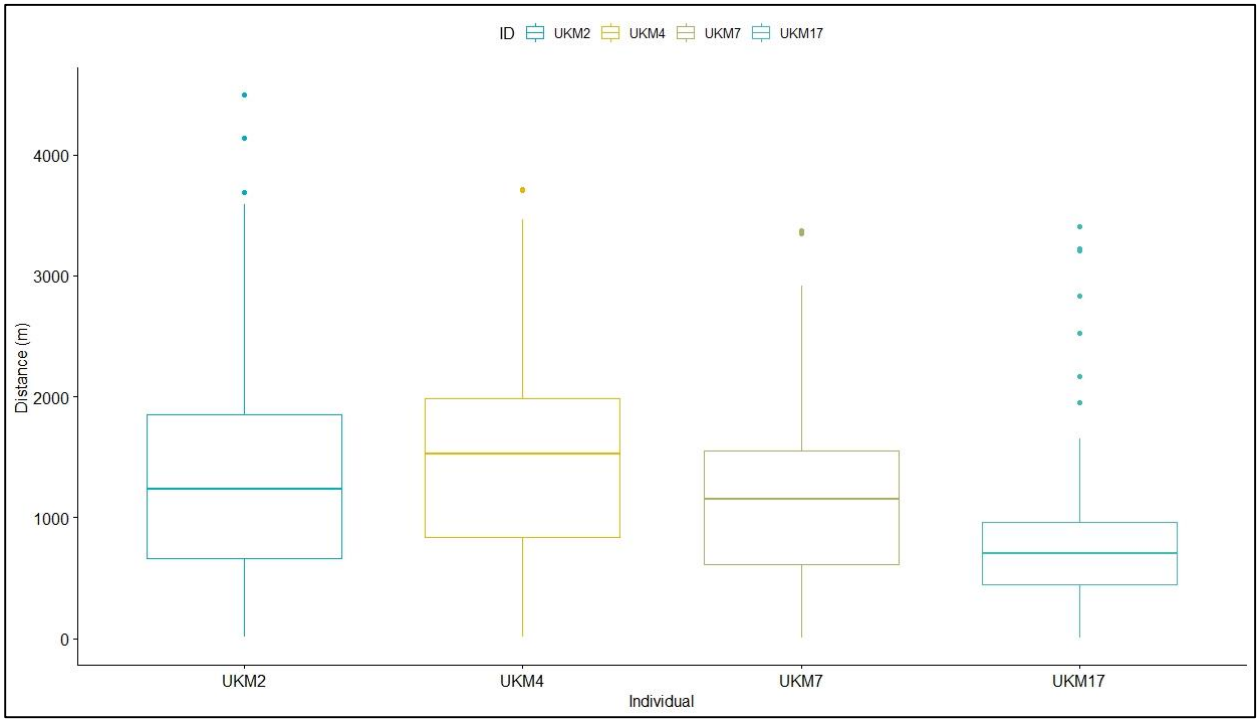


Figure 6a: Distance covered by the collared bulls from the western bank of the Ganges, into the human-use areas.

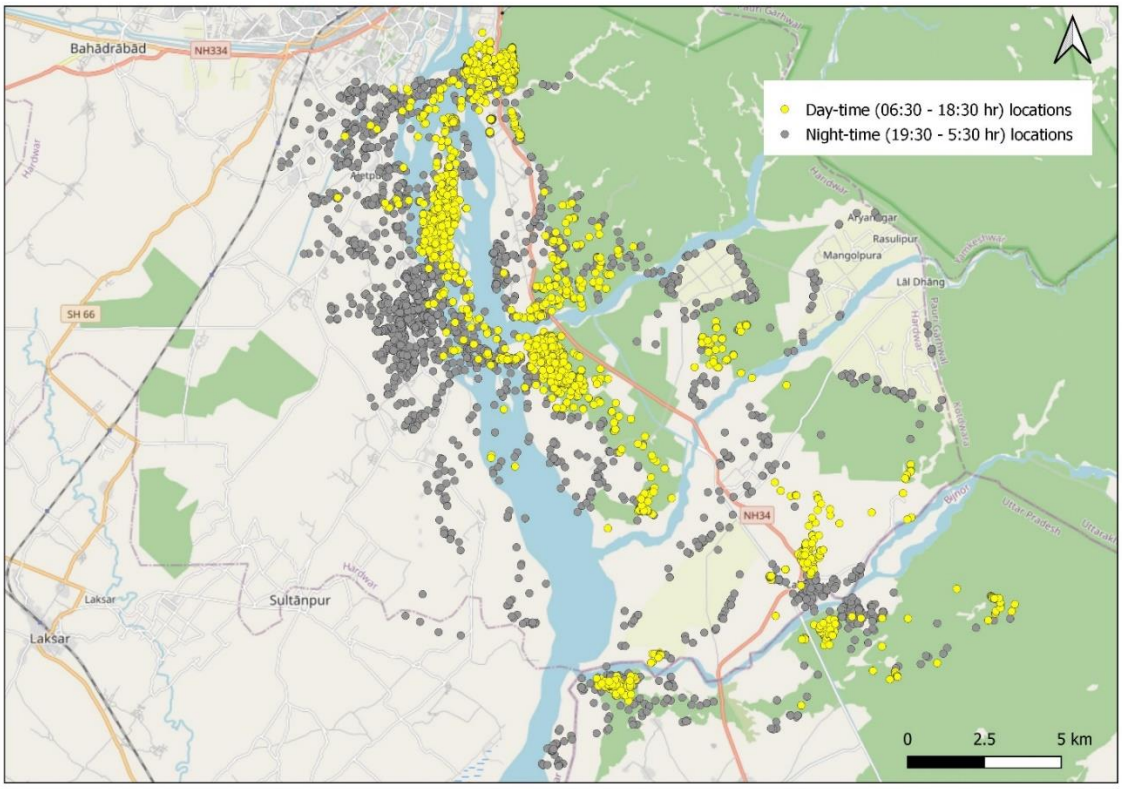


Figure 6b: Temporal (day/night) pattern of space use by collared bulls

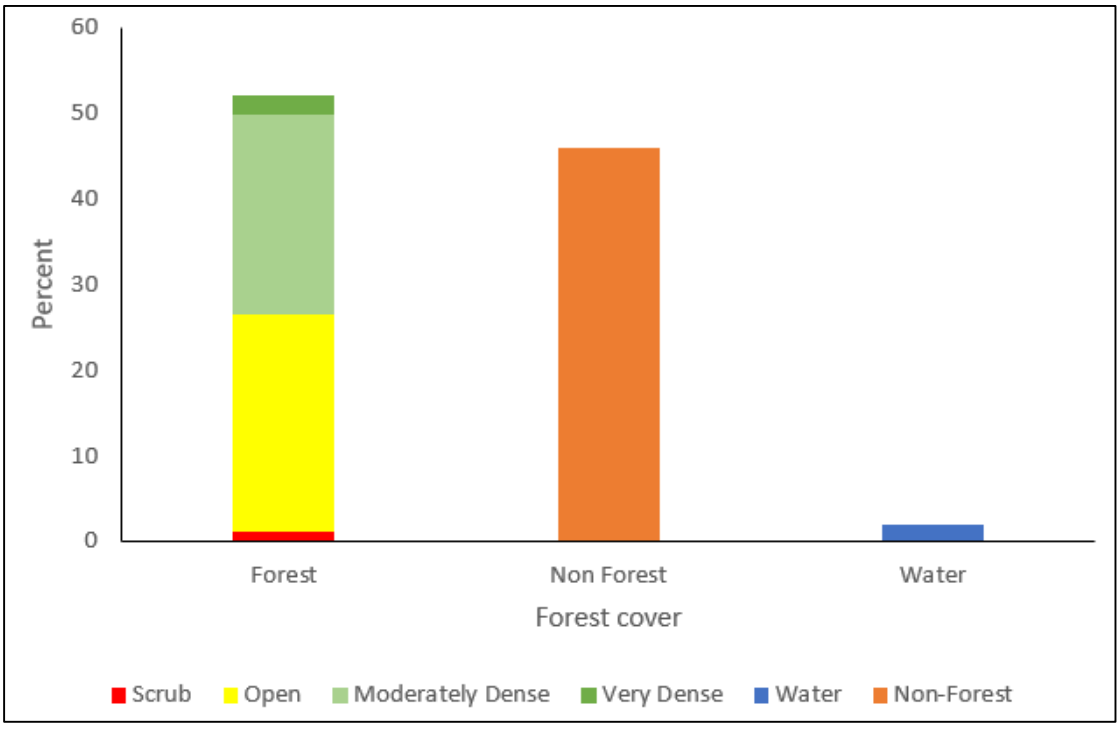


Figure 6c: Percent of GPS fixes (hourly) falling inside forested and non-forested areas

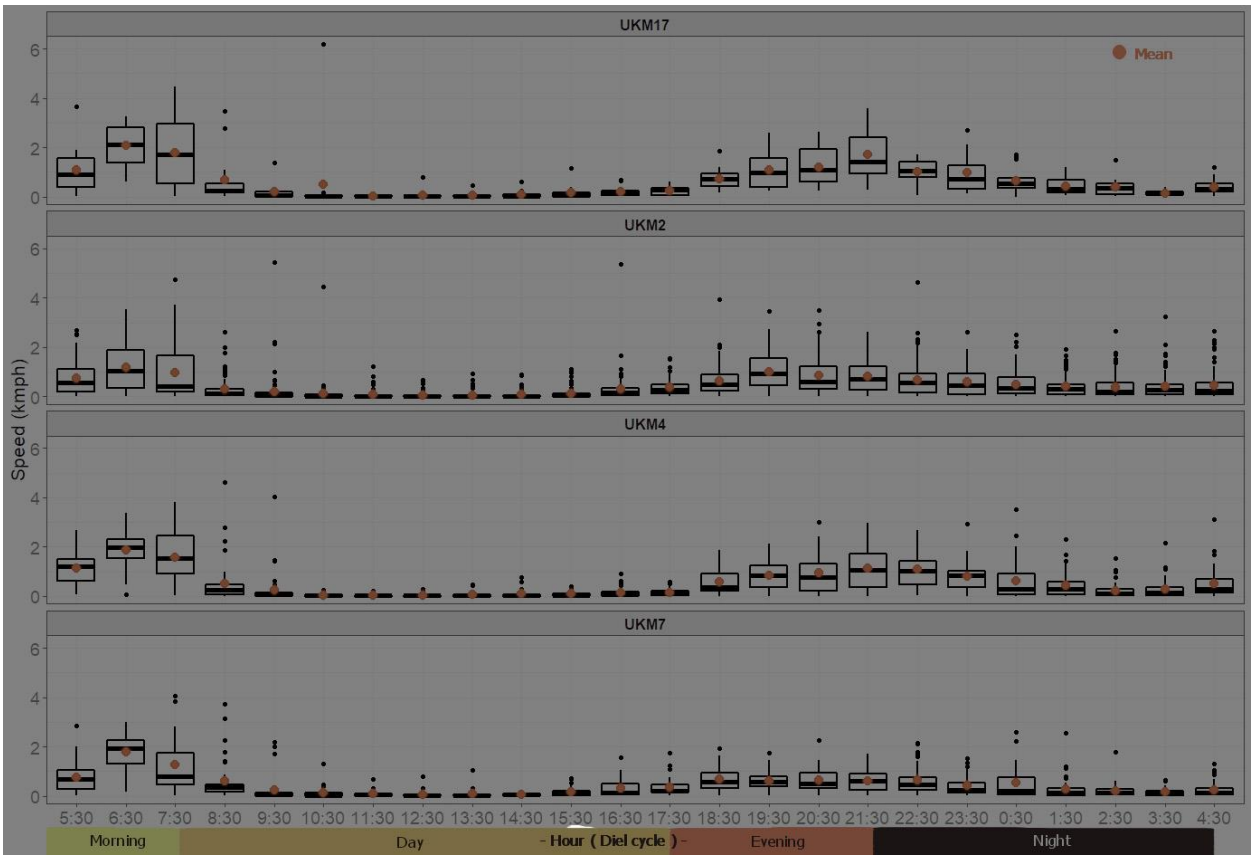


Figure 6d: Fine-scale diel movement dynamics of collared bulls.

To understand the effect of barriers and other protection measures (guarding, patrolling, alert systems) set up by the forest department to curb HEC in the area (especially during *Kumbh* 2021), data of the barriers (fences and structures) installed to restrict elephant movement was collected from the Haridwar Forest Division.

The cemented stone wall stretching 1.5 km was raised from below Ganga Vatika to Ganga Pollution treatment plant in Missarpur. The Gabion structure was made from Missarpur till Fatwa, close to Bhogpur. These structures were reinforced with electric fencing. Similar form of electric fencing was installed from the Nileshwar Mahadev temple to Peeli river along the NH34, and also in parts of Anjani Chaur (Figure 7).

Detailed analysis of movement of elephants prior to and post installation of these barriers is being carried out by the project team.

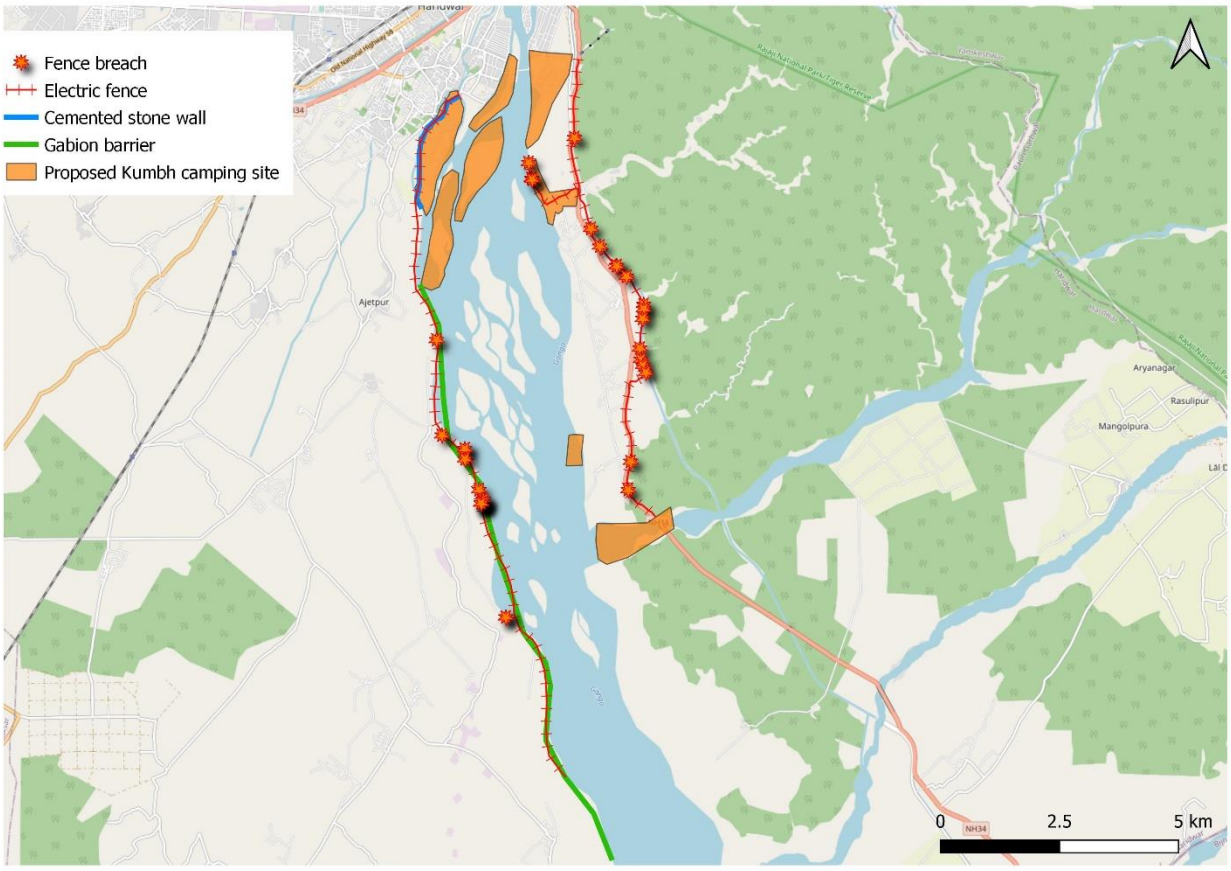


Figure 7: Map highlighting the electric fence, Gabion barrier and cemented stone wall placed by the forest department to restrict the movement of elephants in the Kumbh 2021 camping sites.

Camera-trap based monitoring of elephants

In addition to intense ground tracking and satellite-based remote monitoring of elephants, the project, in order to obtain landscape level information on habitat-usage and movement patterns of elephants, also deployed camera traps in Dassowalla and Anjani Chaur on a trial basis. The camera trapping exercise carried out revealed presence of tigers, leopards, hyenas, porcupines, and large ungulates such as nilgai, sambar, and chital, in addition to recording movement of regular individuals.

Based on successful retrieval of valuable information on elephant usage of the study area through these camera traps, the project envisages using camera traps more extensively at the larger landscape level in the coming months to intensify the data collection process.

Images of Elephants and other species captured through camera traps.

Based on the on-foot monitoring, telemetry and the camera-trap data, a broad spatial range of bull elephants and female groups have been provided as figure 8.

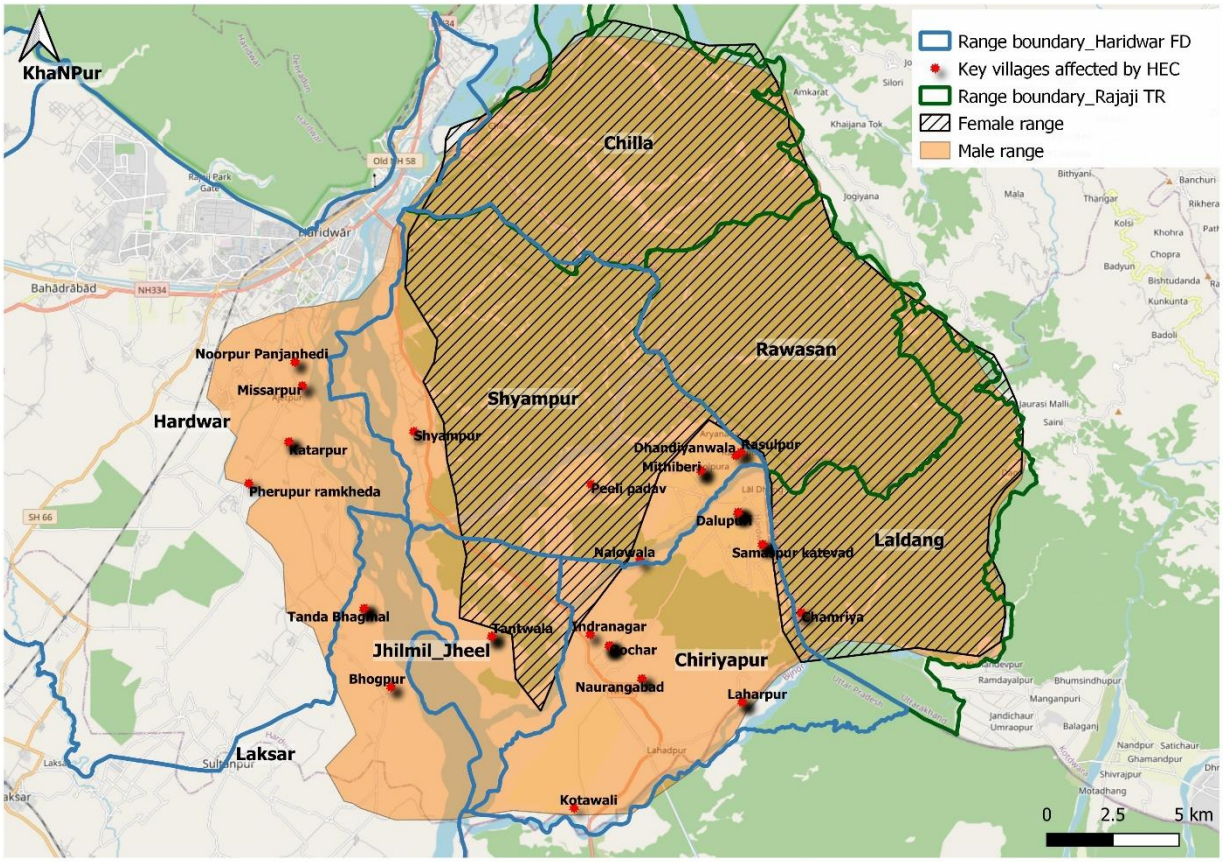


Figure 8. Spatial ranging pattern of male and female/mixed groups as per sighting/ re-sighting and telemetry data.

Musth and the ranging pattern

Post puberty, adult male elephant goes through physical, physiological and behavioural changes that recur annually. The phenomenon is termed as musth. This period lasting for 2-3 months, witnesses heightened sexual interest in unrelated females and aggression toward other males (Fernando et al., 2008; Sukumar, 2003). Discharge of a copious fluid from the temporal gland and urine dribbling is also observed in musth bulls.

When perceived through the framework of social organization and physiology of elephants, musth can be seen as a behavioral strategy fixated in the species to signal both, the potential mates and the competitors, to ultimately aid in reproductive fitness. While proximate reasons for this costly expression may be traced to the rise in testosterone levels, facilitated by nutrition and body condition, the ultimate reasons are rooted in reproductive fitness (behavioural strategy related to mate choice). During the period of musth, bulls invest most of their time ranging in search for unrelated estrus females, mating and guarding them against other competitors. Due to this, musth range of bull elephants tend to be larger than the non-musth range. The period of musth observed in identified bulls is provided in Table 3.

Table 3: Period of Musth recorded in identified bulls

Individual ID	UKM2	UKM4	UKM7	UKM8	UKM9		UKM10
Year	2021	2020	2020	2021	2020	2021	2021
Months	Jan	Jan	Jan	Jan	Jan	Jan	Jan
	Feb	Feb	Feb	Feb	Feb	Feb	Feb
	Mar	Mar	Mar	Mar	Mar	Mar	Mar
	Apr	Apr	Apr	Apr	Apr*	Apr	Apr
	May	May	May	May	May*	May	May
	Jun	Jun	Jun	Jun	Jun	Jun	Jun
	Jul	Jul	Jul	Jul	Jul	Jul	Jul
	Aug	Aug	Aug	Aug	Aug	Aug	Aug
	Sep	Sep	Sep	Sep	Sep	Sep	Sep
	Oct	Oct	Oct	Oct	Oct	Oct	Oct
	Nov	Nov	Nov	Nov	Nov	Nov	Nov
	Dec	Dec	Dec	Dec	Dec	Dec	Dec

*No Observations were made due to COVID related restrictions in travel to field

The musth and non-musth range of collared bull based on 100% MCP is provided in Figure 10. The area covered during musth and non-musth phase for UKM2 were calculated to be 157.61 sq. km and 292.25 sq. km respectively.

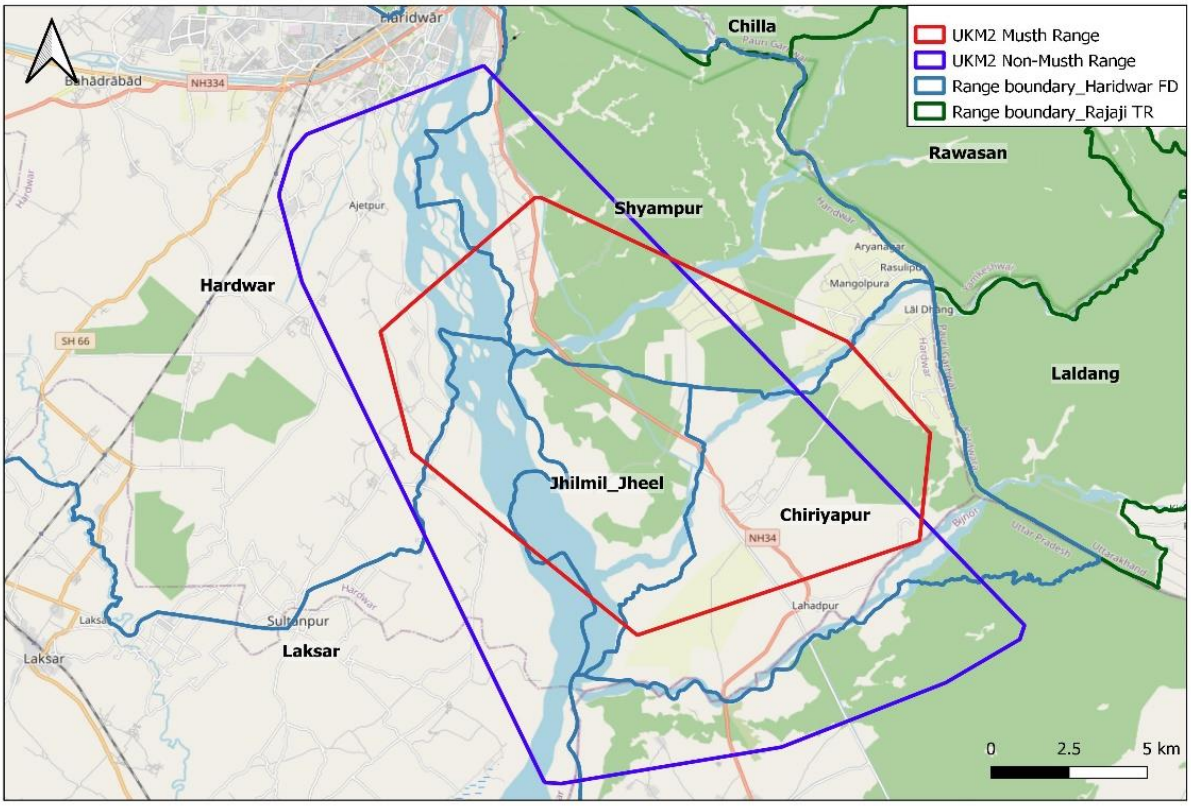


Figure 10: Musth (March, April 2021) and non-musth range (25/12/2020 to 2/3/2021) of a collared bull – UKM2, based on 100% Minimum Convex Polygon.

Workshops and interactive sessions

One of the motives of the collaborative project, in addition to the overarching objectives, is to raise awareness levels among the frontline staff about elephant ecology, behaviour, and conflict management, to improve preparedness in tackling difficult conflict situations, especially during challenging times such as that during the Maha *Kumbh* Mela. So as to make this possible, workshops and interaction sessions were organized for frontline staff of various ranges and divisions as indicated in table 3. In addition to this, more similar workshops are planned during the course of the project. Moreover, the field team, through their daily interactions with ground staff also attempts to impart as much field craft and science-based management aspects.

Table 3: Details of workshops and interactive sessions organized as part of the project

Sl. No.	Date	Place	Title of workshop/interaction session	No. of participants
1	11th Dec 2020	Rasiyabad	Elephant Behaviour, Ecology, and Conflict Management	75
2	9th Jan 2021	Anjani Chaur	VHF tracking of collared individuals	8
3	12th Jan 2021	Anjani Chaur	VHF tracking of collared individuals	7
4	13th Jan 2021	Rasiyabad	Interactive session with Padmashri Dr K.K Sarma on HEC management	7


Workshop and RRT training on
Ecology, and Conflict
field craft on elephan
and rescue operations
Haridwar Forest Division

OBJECTIVE 2: LANDSCAPE-LEVEL ASSESSMENT (COVERING THE ENTIRE RTR AND HARIDWAR FD) OF HEC AND ITS DRIVERS TO SUGGEST IMPLEMENTABLE STRATEGIES TO MITIGATE CONFLICT

Introduction

Across the Asian elephant range states, HEC is primarily governed by the interplay of two factors namely the conversions of elephant habitats into of human-use areas (such as agriculture fields) and the elephants' response to it. Habitat loss due to anthropogenic activities, followed by habitat degradation and fragmentation saturates habitat conditions for elephants. Human–Elephant Conflict is multifaceted and evidence-based approach to address conflict is critical. As a part of the project objective, assessment of HEC was attempted with the following objectives.

1. Landscape-level assessment of crop losses due to elephants to understand the spatial spread and intensity based on the secondary records collated from the Forest Department
2. Fine-scale assessment of crop losses by elephants in the select villages
3. Assessment of efficacy of barriers put up by the Forest Department to prevent elephants from moving into human-use agricultural areas.

Method

To assess the cases and causes of HEC in the landscape, the team followed a combination of a) standardized data collection protocol (Hoare, 2015) for primary data collection from sites of HEC (crop damage, casualty, property damage) and b) analysis of secondary data from the forest department records.

Result

Analysis of secondary data for the period 2015 to 2020 (October) for Haridwar FD revealed that over the years, most cases of HEC in Haridwar Forest Division were consistently due to crop damage (2015 – 94.06%, 2016 – 98.02%, 2017 – 96.96%, 2018 – 94.61%, 2019 – 93.54% and 2020 – 96.35%) with sugarcane being the most affected crop (2015- 69.5%, 2016- 57.89%, 2017- 65.15%, 2018 – 60.04%, 2019 – 67.74% and 2020 – 59.6%).

Agriculture field adjoining the southern boundaries of Rajaji TR, and along the banks of the Ganges were regularly affected due to HEC (Figure 11). A total of 93 villages were affect by HEC between 2015 to 2020, with most of the villages (30) falling along the southern boundary of western Rajaji TR (Khanpur range of Haridwar FD), followed by villages in the Haridwar range (28) and Chidiyapur range (20). HEC cases in Shyampur, Laksar and Rasiyabad were mainly clustered around village enclaves bounded by forest patches. Space attributes such as shape of the village enclave and their location with respect to elephant habitat (or forest patches) may explain the distribution of the cases of HEC in different areas of the landscape.

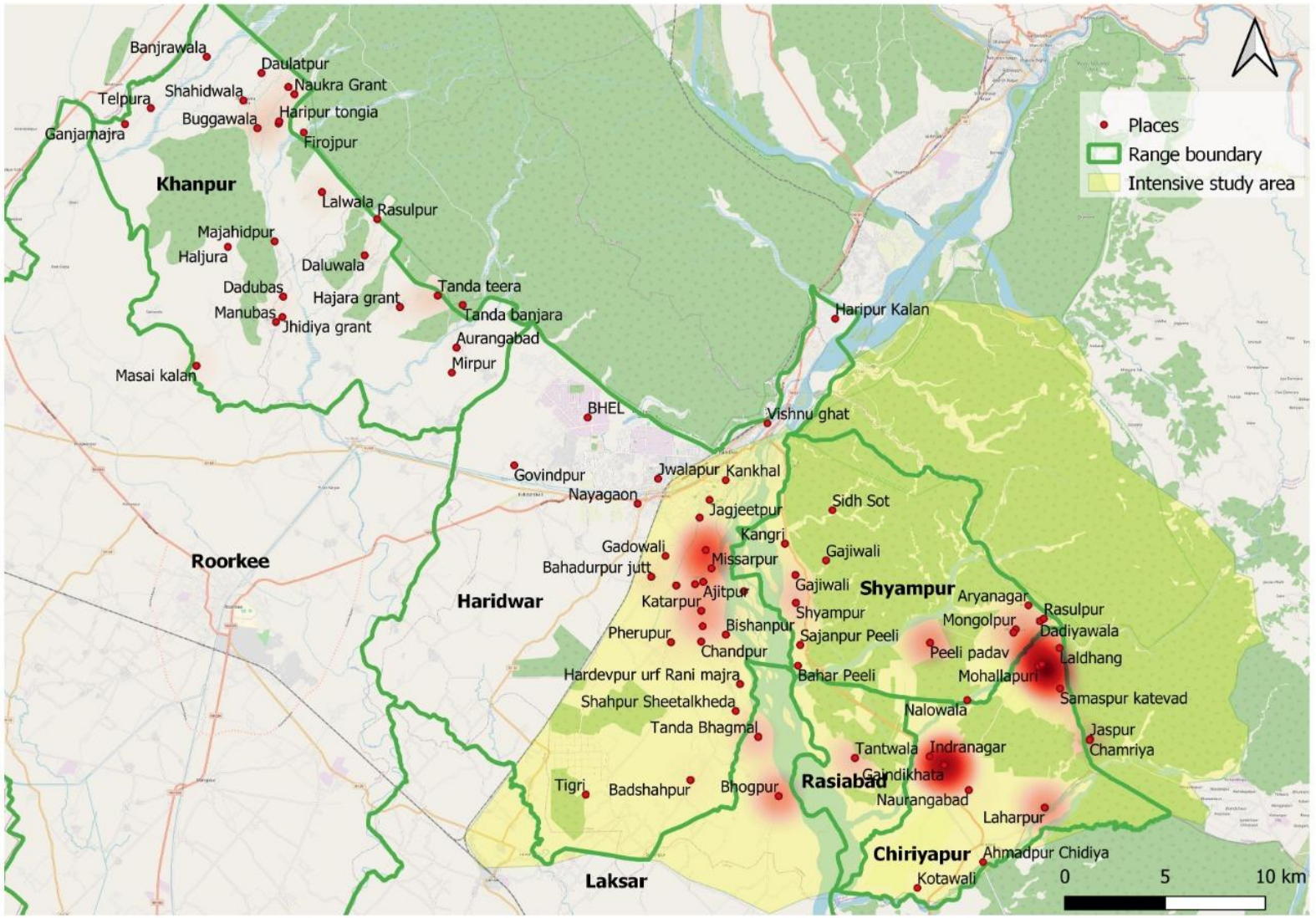


Figure 11. Map highlighting hotspots of HEC in Haridwar Forest Division as per the total HEC compensation records (2015-2020).

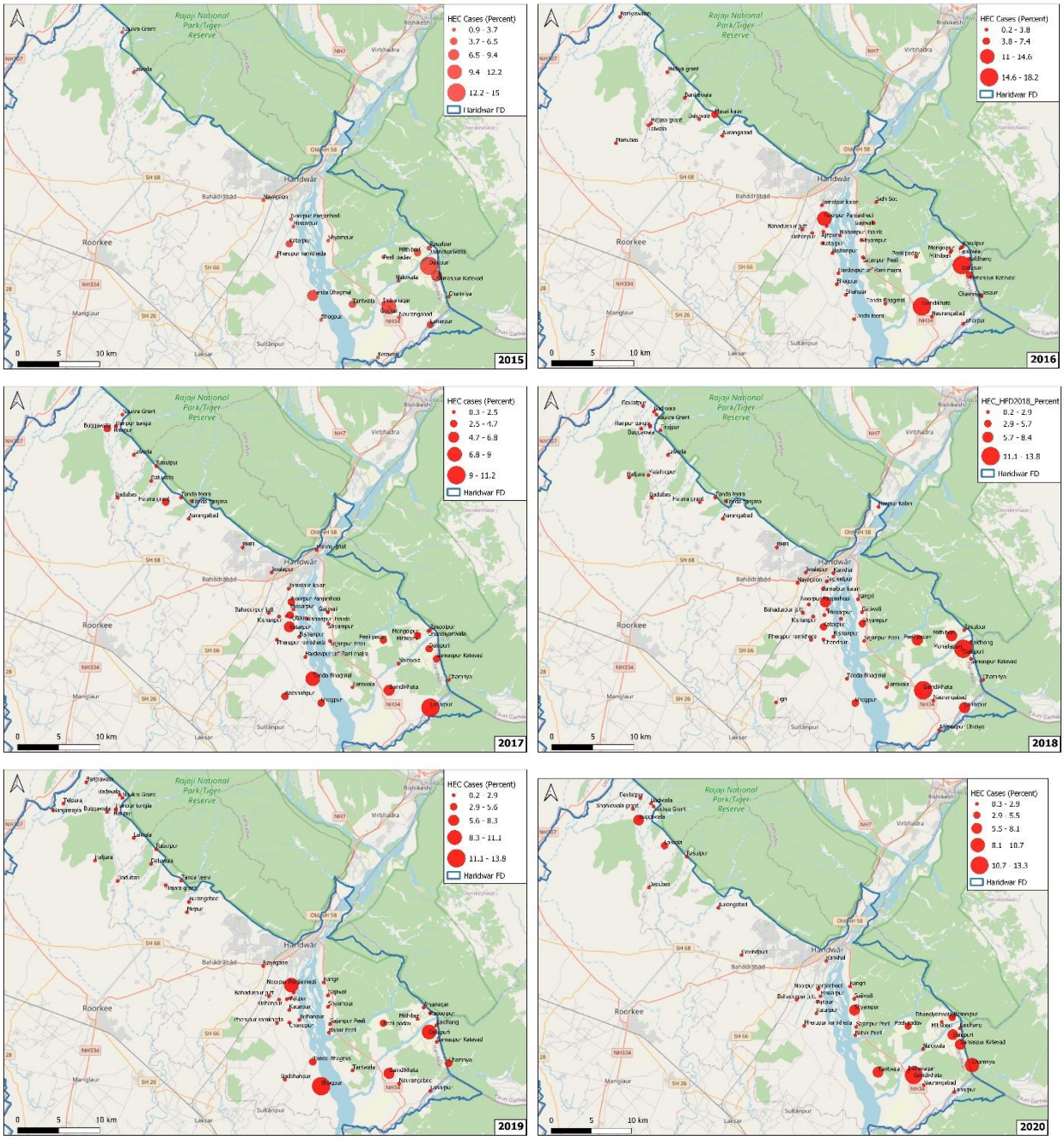


Figure 12. Year-wise spatial pattern of HEC in Haridwar Forest Division (2015 to 2020)

Primary observations suggest that most of these crop damage incidents were caused by male elephants of various age classes. Most cases of HEC in Haridwar Forest Division were consistently due to crop damage (2015 – 94.06%, 2016 – 98.02%, 2017 – 96.96%, 2018 – 94.61%, 2019 – 93.54% and 2020 – 96.35%) with sugarcane being the most affected crop (2015- 69.5%, 2016- 57.89%, 2017- 65.15%, 2018 – 60.04%, 2019 – 67.74% and 2020 – 59.6%) (Figure 13a). The details of HEC cases and the villages affected each year is provided in Figure 13b.

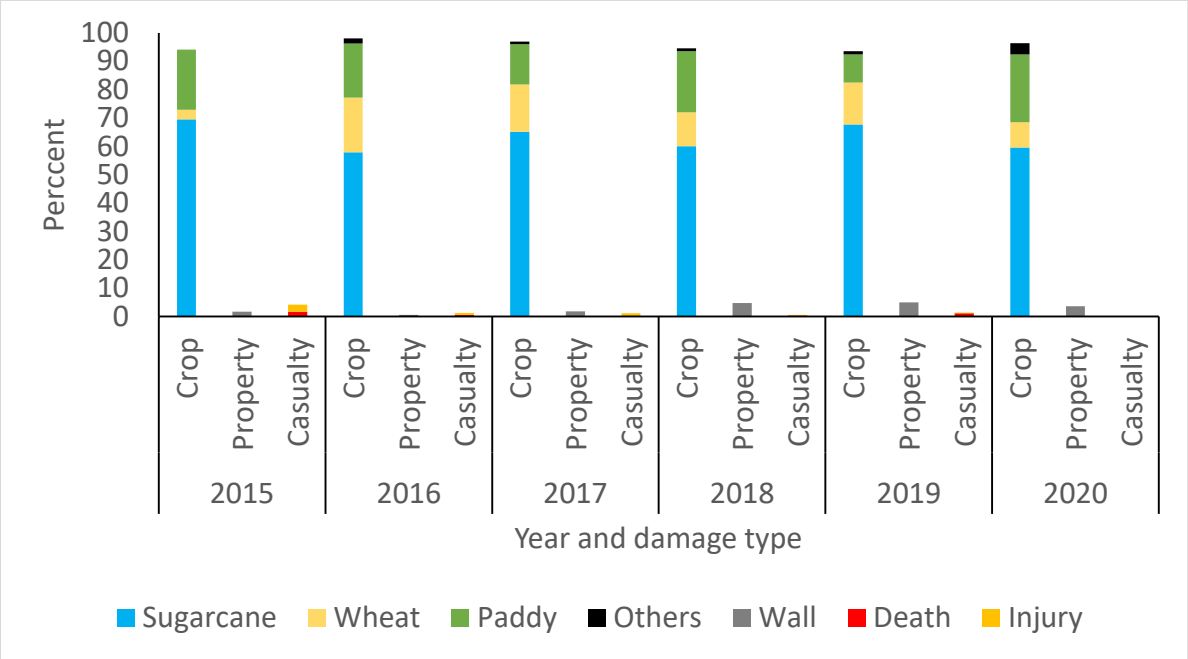


Figure 13a: Year-wise cases of HEC in Haridwar Forest Division

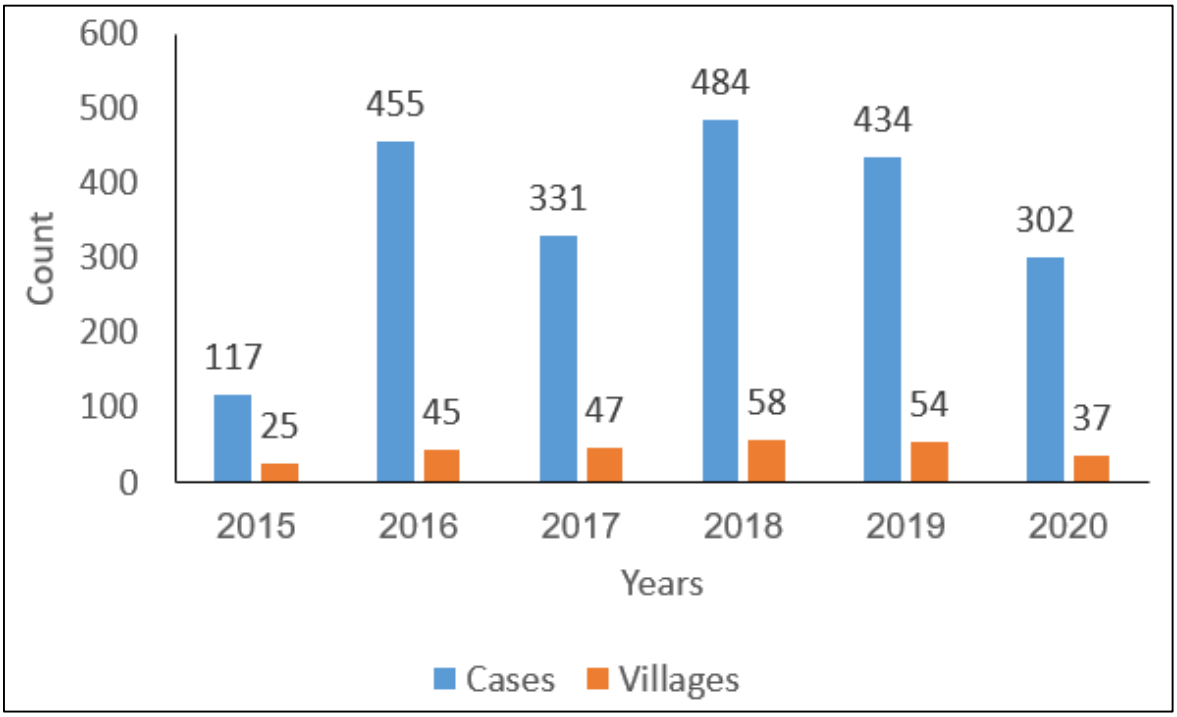


Figure 13 b: Number of HEC cases and villages affected per year

Though the proximate reason for HEC in the landscape may be attributed to the higher palatability (citation) of cultivated crops, such as sugarcane, it can also be governed by the optimal foraging theory that indicates maximizing output with minimum investment (time/effort) and reproductive fitness. The reason for males of the species coming into conflict can be understood based on their social organization and the mating system that is primarily polygynous with obvious sexual dimorphism. While females would have chance to contribute more equally to the next generation, males may not have such representation due to dominance hierarchy. Therefore, stakes are high for male elephants to obtain higher nutrition, attain improved body condition and large size to ultimately dominate other bulls and improve its biological fitness (Sukumar, 1991). In the process males have been known to take considerable risk. This may be one of the key reasons why males of the species are more involved to HEC as compared to cow elephants. Hence, while optimal foraging theory may explain the attraction of elephants towards more nutritious, palatable crops; it is the social organization that shed light into the sex-based representation of elephants in HEC.

Primary data pertaining to crop raiding by elephants, is being collected from select villages across the eastern and western ranges of Haridwar Forest Davison to gain fine-scale understanding of crop raiding incidents (the most common and acute form of HEC in the region).

OBJECTIVE 3: INTENSIVE MONITORING OF HEC AND CARRYING OUT SOCIO-ECONOMIC SURVEYS IN SELECT CONFLICT HOTSPOTS TO ASSESS PREPAREDNESS AND WILLINGNESS OF LOCAL COMMUNITIES TO PARTICIPATE IN CONFLICT MITIGATION

Introduction

Conflict between humans and elephants present one of the best examples of two superficially distinct animals sharing common biological needs and competing over these resources whenever they come into contact (Graham, 1973). The interface between wildlife habitat and agricultural lands is a complex and dynamic zone. Elephants are highly social and intelligent animals and their excellent communication and cognitive skills, combined with dietary and behavioural flexibility make them extremely adaptable and effective crop-raiders. In most parts of the country, people perceive wildlife as a public / state property. State institutions that manage protected areas are, therefore, considered responsible for control of 'their' animals (Woodroffe, 2005). Those affected by HEC may perceive the incidents of HEC as "public" property causing "personal" loss, resulting in gradual erosion of the age-old cultural aspects of conservation associated with the species (Desai, A., Riddle, 2015). With the change of attitude and perception of communities, wildlife authorities may find it financially and logistically challenging to manage HEC in coming times.

Beyond the visible/direct costs associated with HEC, there are numerous indirect costs, that are difficult to quantify. These indirect costs include (not limited to) expenditures towards torches, mashaals, crackers to guard against elephants, loss of school attendance due to fear of HEC, inadequate sleep and the resultant health risks/loss of productivity, exposure to other illnesses (malaria, etc) due to crop guarding in fields at night (Woodroffe, 2005). The combination of such direct and indirect costs associated with HEC makes it imperative to understand the response of communities towards the threat to their lives and livelihoods, and how their response shapes the ecology of the elephant landscape around them.

Method

To identify villages across the high conflict zone of Haridwar forest division, the telemetry data obtained from collared bulls was superimposed on the conflict data (2015-2020) provided by the division office. This was further validated based on primary data collected under the project and the map of the villages for socio-economic survey within the intensive study were selected (Figure 14).

Result

To assess the socio-economic dimensions of HEC in landscape, it is planned to conduct questionnaire survey administered to local communities living in and around the Rajaji TR/elephant habitats. 22 villages have been selected for the same. The questionnaire is designed with the objective to identify the types and severity of HEC (cost per household); determine major obstacles rural communities face to improving their quality of life, and whether this differs among villages with and without HEC; assess general attitudes toward elephant conservation; and identify the mitigation strategies that are acceptable and can be successfully implemented. The outcome of the survey will help in understanding following:

1. Driving forces of land use change that impel people to plant crops in high-risk areas
2. Assess the severity of the conflict by documenting the spatial and social distribution of wildlife damage, and the varying capacity of individuals to cope with such losses.

3. Highlight the social factors that intensify human–wildlife conflict or favors coexistence.

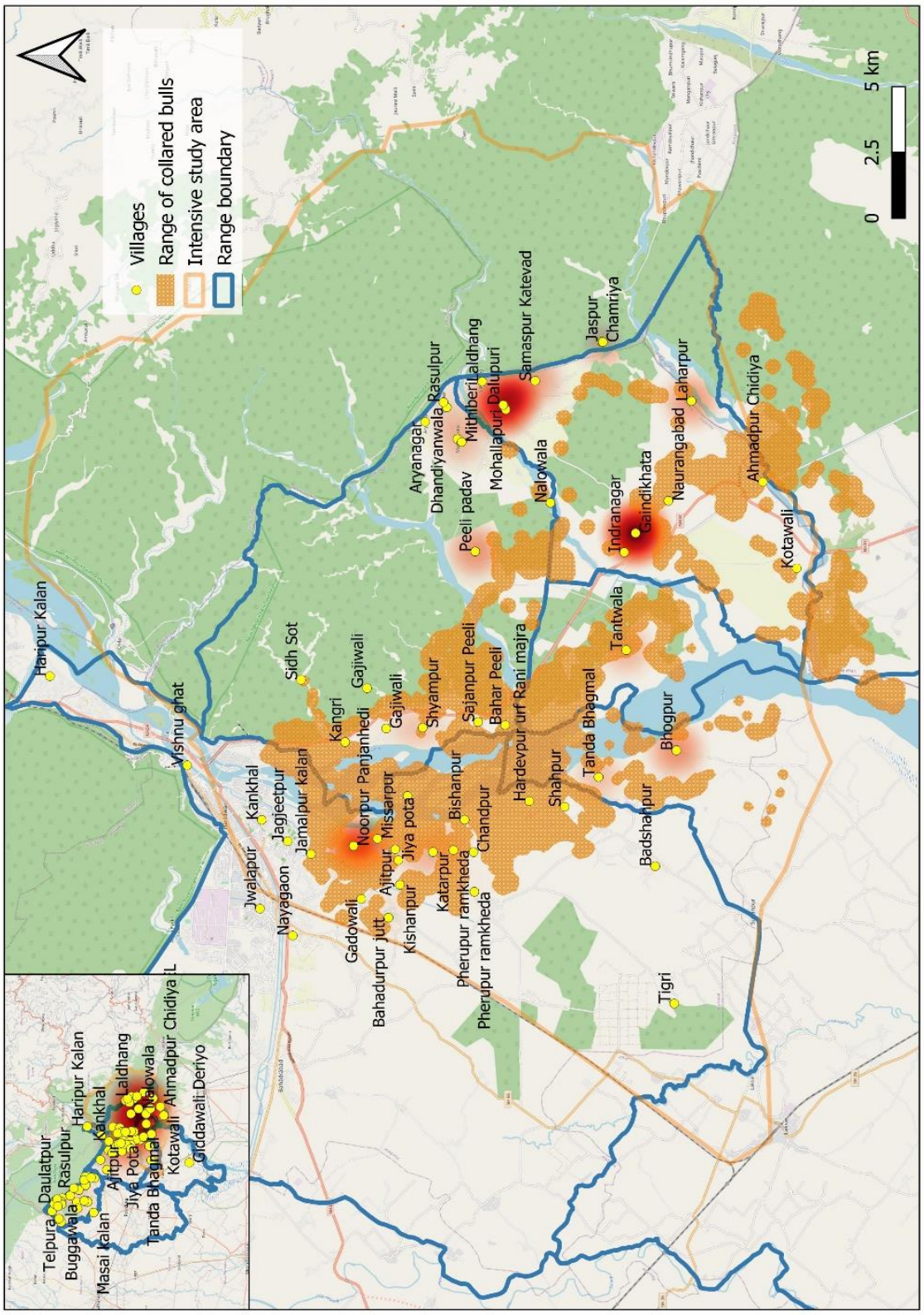


Figure 14. Map highlighting villages selected for socio-economic survey within the intensive study area, based on primary and secondary data collected from field and superimposed with telemetry data

Future Plan

- Fine-scale assessment of HEC at the landscape level to be carried out to understand the drivers of HEC at landscape-level.
- Effect of various mitigation measures already in place would be evaluated
- Demographic study of elephants will be carried out within the eastern ranges of Rajaji Tiger Reserve and the eastern ranges of Haridwar Forest Division to understand the population structure and size.
- Socio-economic survey will be carried out to ascertain the drivers of HEC, its severity and to gauge the perception and attitude of affected communities.

Publications

Wildlife Institute of India (2020). Field Technical Report 1: Elephant Capture and Collaring Operation in Haridwar Forest Division, Uttarakhand, WII-UKFD Collaborative project. Pp.15

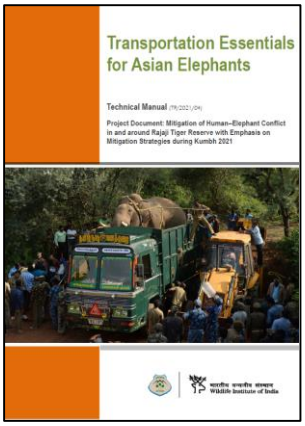
Wildlife Institute of India (2021). Field Technical Report 2: Elephant Capture and Collaring Operation in Haridwar Forest Division, Uttarakhand, WII-UKFD Collaborative project. Pp.16

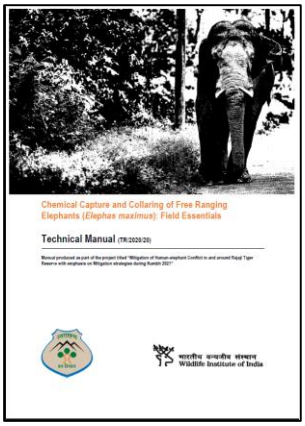
Wildlife Institute of India (2021). Identification manual of select bull elephants of Haridwar Forest Division. Technical manual. WII-UKFD collaborative project

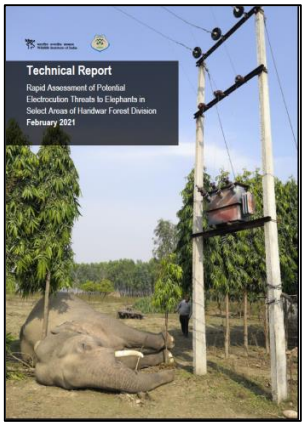
Wildlife Institute of India (2021). Technical Report: Rapid Assessment of Electrocution Threats in select Areas of Haridwar Forest Division with Special Reference to Elephant Movement in the Landscape, WII-UKFD Collaborative project. WII TR No./2021/07. Pp 35.

Nigam, P., Pandav, B., Habib, B., Lakshminarayanan, N., and Malik, P.K. (2020). Chemical Capture and Collaring of Free-ranging Elephants (*Elephas maximus*): Field Essentials. Technical Manual. Wildlife Institute of India TR/2020/20. Pp 29.

Wildlife Institute of India (WII). (2021) Transportation Essentials for Asian Elephants (Technical Manual). Uttarakhand Forest Department-Wildlife Institute of India collaborative project. TR/2021/04. Pp28







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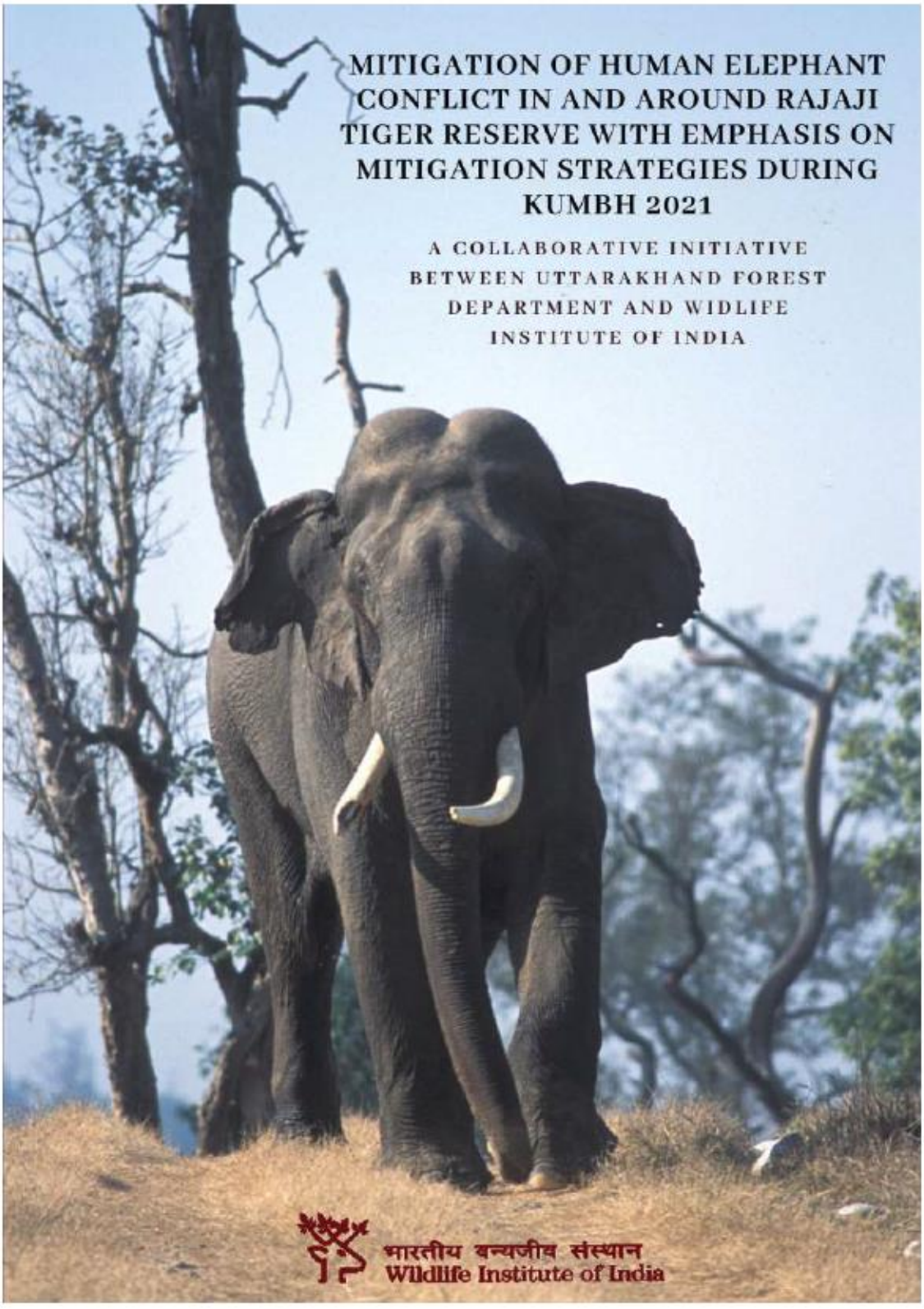
Annexure I


MITIGATION OF HUMAN ELEPHANT CONFLICT IN AND AROUND RAJAJI TIGER RESERVE WITH EMPHASIS ON MITIGATION STRATEGIES DURING KUMBH 2021
A COLLABORATIVE INITIATIVE BETWEEN UTTARAKHAND FOREST DEPARTMENT AND WIDLIFE INSTITUTE OF INDIA
भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Mitigation of human elephant conflict in and around Rajaji Tiger Reserve with emphasis on mitigation strategies during Kumbh 2021

A collaborative initiative between Uttarakhand Forest Department and Widlife Institute of India

Project Investigators

Dr. Bivash Pandav, WII
Dr. Parag Nigam, WII
Dr. Samrat Mondol, WII
N. Lakshminarayanan, WII

Advisor
Dr. P.K. Malik, WII

Collaborators (from UKFD)
Director, Rajaji Tiger Reserve
DFO, Haridwar Forest Division

Project Proponent: Elephant Cell, Wildlife Institute of India
(An autonomous institution of the Ministry of Environment, Forests and Climate Change, Government of India)
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Introduction

Rajaji Tiger Reserve and the adjoining areas in Haridwar and Dehradun Forest Divisions support one of the largest sub-populations within the North Western regional elephant population occurring along the foothills of the Himalayas. The main threats facing this elephant sub-population are tenuous connectivity between Eastern and Western Rajaji across River Ganga, increasing isolation of the reserve due to rapid conversion of land-use outside, threats due to linear infrastructure and human–elephant conflict (HEC). Managing HEC situation in Rajaji TR and the adjoining Forest Divisions is intricate. Crop damage by elephants is a major challenge in the forest-cultivation-interface. Although crop damage by elephants is widespread all along the zone of interaction, it is particularly severe in stretches along the southern boundary of Western Rajaji, in village enclaves of Peeli and Gaidikahta in Haridwar FD and in villages between Laldhang and Kotdwar in Lansdowne Forest Division. Secondly, a threat more challenging than the problem of crop raiding by elephants is the ever-increasing risk of elephants entering densely populated urban and semi-urban areas, as conurbations of Haridwar, Dehradun and Rishikesh continue to expand, sandwiching elephant habitats.

The suite of research topics carried out on elephants in the landscape include: ranging behavior assessed through telemetry studies (Williams et. al., 2008), habitat utilization patterns, demographic studies (Williams A. J., Johnsingh, A.J.T. & Krausman, P.R. 2007), assessment of human-elephant conflict (Williams A. J., Johnsingh, A.J.T. & Krausman, P.R., 2001), assessment of structural corridor, and foraging ecology of the elephants (Johnsingh et. al., 2006).

During the last few years, HEC appears to have increased in certain localized areas (the same villages have repeated incidences) within the landscape creating conflict hotspots. In these select conflict hotspots, it is important to quantify the extent of the problem such as damage to crops and property and at the same time assess socio-economic aspects of local communities to understand their willingness and preparedness to participate in conflict mitigation efforts. As elephants are wide-ranging species, conflict hotspots can easily shift over time in response to local mitigation efforts. Therefore, to holistically understand the problem, our area of investigation of HEC should be targeted at a larger spatial scale covering a gradient of conflict intensity across the landscape. Further, elephants are long-lived species as well with average lifespan of about 50 to 60 years in the wild. Therefore, it is important to assess patterns of conflict for a longer duration covering different seasons of the year across multiple years to make inter-seasonal and inter-annual comparisons. Such inter-seasonal comparisons are useful to determine environmental drivers of conflict.

As a part of the ongoing project titled "Conservation Management of Elephants in Chhattisgarh: Capacity building initiative on the Dispersal and Ranging Patterns of Elephants for Effective Management of Human-Elephant Interactions" WII, together with Chhattisgarh Forest Department has successfully collared 6 elephants in Northern Chhattisgarh. Imperative insights provided by the collared elephants have been pivotal in understanding their ranging behavior. Moreover, monitoring the movement of these collared individuals and responsible data sharing has contributed in effective management of HEC.

Statement of Problem

Human-elephant conflict results in huge fiscal losses, loss of human lives and consequently antagonism towards conservation (Desai & Riddle, 2015). Managing HEC to foster co-existence and tolerance in Rajaji TR and adjoining landscapes hinges on effective monitoring of elephant populations as well. In particular, understanding how elephants use corridors to move between habitats, bottlenecks that hinder their free movement and the impacts of linear developments on movement patterns are crucial, as such threats could be a subtle trigger for conflict in the locality. In some cases, addressing a threat on the habitat may serve as a strategy to avert HEC. Telemetry data could provide the resolution that is required to understand fine-scale patterns of habitat use and movement by elephants. The data thus generated will prove useful in assessment of structural, functional and fitness value of the landscapes (George Wittemyer, 2019).

Further, monitoring elephants that regularly venture into human use areas could be useful to understand individual variations in behavior and the possible drivers. This is urgently required in the case of a group of male elephants that regularly cross River Ganga and raid crops in the western bank of the river in the downstream of Chandi Bridge (Anjani Chaur, the Kumbh camping site) where there are no forests. With crops being readily available everywhere, it remains a puzzle as to why elephants cross River Ganga every night and return back to the forests early in the morning. These male elephants operate very close to Haridwar city and any haphazard drive by villagers can direct them towards urban limits triggering a chaotic situation. Further, this group of elephants also moves through well-trodden trails leading into River Ganga and thus, requires a very close monitoring during Kumbh season.

The BHEL town ship along the Haridwar range is also vulnerable for elephants to enter urban areas. There were a few human casualties due to elephants in this stretch during the past few years. This stretch too requires close monitoring in order to suggest fine-scale conflict mitigation measures. Uttarakhand FD has already invested on a suite of conflict mitigation strategies. Some of them, like the construction of walls have been expensive, but not very effective, barring a few stretches (Natarajan et al, 2017). It shall be important to reassess the previously effective sections of the wall and monitor outward movement of elephants.

Project objectives

The project envisages the following:

1. Investigating patterns of Home Range and movement of elephants in select locations within the landscape to serve as a precursor to understand HEC holistically and Kumbh in particular

2. Landscape-level assessment (covering the entire RTR and Haridwar FD) of HEC and its drivers to suggest implementable strategies to mitigate conflict.

3. Intensive monitoring of HEC and carrying out socio-economic surveys in select conflict hotspots to assess preparedness and willingness of local communities to participate in conflict mitigation.

Methods

I. Satellite collaring elephants to understand home range and movement patterns

a. It would be useful to collar two to three adult bulls in Shyampur Range, Haridwar FD, identified from the group of males that regularly cross River Ganga for crop raiding. Collaring these bulls will not only help the management in understanding crop raiding behavior of these male elephants, but may also serve as an early warning tool to alert public commuting through the highway and villages across the river.

b. Similarly, identifying couple of bulls from the group that regularly operate in BHEL Township and adjoining areas of the Tiger Reserve between Motichur and Haridwar ranges will be useful to understand elephant movement in these areas. Closely following their movement will also indicate the weak points in the existing barriers (brick and rubble walls), which can be strengthened so that probability of movement into urban areas can be minimized.

c. Further, collaring couple of females in the herd in Raiwala and Motichur areas would be useful to assess use of corridors in the area and elephant movement along River Ganga. Therefore, collaring at least six elephants and following them closely will be useful to understand movement patterns, and aspects of conflict in the Rajaji landscape.

d. *Collar particulars:* We intend to use satellite collars on elephants. These collars can be programmed to provide GPS fixes at periodic intervals. These collars are quite flexible and the upload intervals can be as frequent as every one-hour, which can be specifically useful when monitoring needs to be very intensive. In addition to satellite transmitters, there will be a built-in VHF transmitter that can be used for manual tracking as well.

e. *Drug details*: Elephants will be immobilized with suitable narcotic drugs for fitting the collars.

f. *Tracking team:* It is essential to ground-track and monitor elephants regularly. Only through ground tracking, can we get details on association patterns; elephant group dynamics and other behaviors. A ground team comprising of able trackers and field staff of the respective ranges will be identified and trained in use of telemetry gears and recording basic data.

II. Landscape-level assessment of HEC

1. **Monitoring elephant movement along the existing physical barriers**

   In a few stretches along the southern boundary of Western Rajaji TR and in the Laldhang – Kotdwar, the problem of crop damage by elephants is severe. There are already physical barriers (rubble & brick walls and solar-power fences) in these stretches, which, during our previous surveys showed numerous breaches.

   Additionally, elephants and other herbivores use the *rau* exit locations as well to venture into crop fields. We will deploy camera traps in select locations to understand temporal details (exit and entry time into forests by elephants), elephant group dynamics, and identification of individual elephants that regularly get into conflict. We will use the technique of identifying elephants that has been successfully used in both Africa and Asia for the last many decades (Douglas-Hamilton et al, 1975; Moss, 1988; Vidya et al, 2014; De Silva et al, 2013).

2. **Evaluating intensity of conflict based on relative abundance of elephants**

a. Based on Forest Department crop damage records for a minimum of three-year period, the entire section in the southern boundary of Western Rajaji TR and Laldhang to Kotdwar sections will be stratified into high medium and low conflict zones. Total elephant raids will be used as a surrogate for the severity of conflict intensity. The intensity of conflict will be mapped in 2-km^2 grids (that will be overlaid on the boundary to have 1-km coverage on either side).

b. In each grid falling within the forest, 1-km transects will be marked and sign survey will be conducted to record relative abundance of elephants. Along with elephant abundance, habitat attributes such as water and fodder availability, human imprint on the habitat and others will be recorded.

c. The relative abundance of elephants will be correlated with intensity of conflict and the plausible effect of habitat attributes on the intensity of conflict will be assessed

III. Intensive monitoring of HEC and socio-economic assessment in select hotspots

1. In certain select conflict hotspots (where the intensity of conflict – in terms of crop damage is very high) primary data on extent of crop damage, hectarage of cultivated crops, group of elephants involved, and human deaths and injuries will be intensively monitored.

2. In these select hotspots, socio-economic assessment of local communities will be carried out to gauge their perceptions about conflict and overall willingness to participate in conflict management. In some of these hotspots, novel conflict mitigation strategies will be experimented to test their applicability

Outputs

1. Comprehensive studies on elephant home range and movement using telemetry are over 20 years old in Rajaji. The telemetry study that we propose can provide the high-resolution information (in the forms of maps and habitat use contours) that is required for informed conflict management during Kumbh 2021. Such high-resolution data may be particularly useful considering the fact that the land-use around Rajaji TR and adjoining landscapes has witnessed substantial changes with increasing pressure on corridors.

2. Conflict management is usually a long-term endeavor and preparedness to face uncertainties is often the best strategy to handle conflict. Generating baseline information and data on conflict will be useful for the management to prioritize mitigation strategies in sensitive areas. The study will generate conflict intensity maps, catalogue of identified elephants using human-use areas, weak sections/points in barriers that can be repaired and relative abundance of elephants in conflict hotspots.

Budget

Sl. No.	Particulars	Unit	Source					
			Uttarakhand Forest Department			Wildlife Institute of India		
			FY2019-20 (1st Year) 1/1/20 – 31/3/20 (3 months)	FY 2020-21 (2nd Year) 1/4/20 – 31/3/21 (12 months)	FY 2021-22 (3rd Year) 1/4/21 – 31/12/21 (9 months)	FY2019-20 (1st Year) 1/1/20 – 31/3/20 (3 months)	FY 2020-21 (2nd Year) 1/4/20 – 31/3/21 (12 months)	FY 2021-22 (3rd Year) 1/4/21 – 31/12/21 (9 months)
1	Procurement of satellite collars, accessories, and hiring satellite space	10 collars (3 in FY 2019-20, 10 in FY 2020-21) @ Rs. 300000 per collar	9,00,000	21,00,000				
2	Fellowship for a Project Fellow	Rs. 35000 + allowances X 24 months x 1 researcher				1,25,000	5,00,000	3,75,000
3	Fellowship for a Project Biologist	Rs. 40,000 X 24 months x 1 biologist	1,20,000	4,80,000	3,60,000			
4	Manpower (Full-time field assistants (5))	Rs. 12000 x 24 months x 5 assistants	1,80,000	7,20,000	5,40,000			
5	Travel (Vehicle Hiring, POL)	Rs 30000 per month x 24 months x 1 vehicle	90,000	3,60,000	2,70,000			
		@Rs. 20,000 per month	60,000	2,40,000	1,80,000			
6	Base camp expenditure	Lump sum	30,000	1,20,000	90,000	15,000	60,000	45,000
	Immobilization essentials (Drugs & accessories)	Lump sum	80,000	3,20,000		80,000	3,20,000	
7	Investigators Travel for project implementation	Lump sum	50,000	2,00,000	1,50,000			
8	Purchase of GIS software and layers	Lump sum					10,00,000	
9	Contingency (Report Writing, stationary, IT support and incidental charges)	Lump sum	18,750	75,000	56,250	18,750	75,000	56,250
10	Miscellaneous	Lump sum	25,000	1,00,000	75,000	12,500	50,000	37,500
	Sub Total		15,53,750	47,15,000	17,21,250	2,51,250	20,05,000	5,13,750
	Total			**79,90,000**			**27,70,000**	
	Grand Total				**1,07,60,000**			

Estimated timeline

Year	2019		2020												2021									
Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct
Activity																								
Permission to radio-collar from Government of India																								
Radio-collaring of 6 elephants																								
Fieldwork																								
Half yearly report Submission																								
Final Report Submission																								

Two years with assessment across different seasons. Field-work will be initiated upon receiving funding commitments and necessary permission from Uttarakhand Forest Department. Animals will be radio collared upon receiving due permission from Government of India and the Chief Wildlife Warden, Government of Uttarakhand in the first six months of the project. Director, Rajaji Tiger Reserve and DFOs of Haridwar and Lansdowne Forest Divisions will receive information on movement of radio collared elephants on an hourly basis every day. Field data collected will be analyzed at regular intervals and quarterly report will be submitted to the office of Chief Wildlife Warden as well as concerned officials in the field.

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Annexure II

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

MEMORANDUM OF UNDERSTANDING BETWEEN THE UTTARAKHAND FOREST DEPARTMENT AND THE WILDLIFE INSTITUTE OF INDIA, DEHRADUN FOR COLLABORATIVE RESEARCH STUDY ENTITLED "MITIGATION OF HUMAN ELEPHANT CONFLICT IN AND AROUND RAJAJI TIGER RESERVE WITH EMPHASIS ON MITIGATION STRATEGIES DURING KUMBH 2021"

This Memorandum of Understanding (MoU) confirms a collaborative research project between the Uttarakhand Forest Department and the Wildlife Institute of India, Dehradun (herein referred to as the parties) who have reached the following understandings:

1. The research project entitled **"Mitigation of human elephant conflict in and around Rajaji Tiger Reserve with emphasis on mitigation strategies during Kumbh 2021"** will be conducted by Dr. Bivash Pandav, Scientist-F; Dr. Parag Nigam, Scientist F; Dr. Samrat Mondal, Scientist E and Shri N. Lakshminarayanan, Project Scientist, Elephant Cell as project investigators along with Dr. Dhananjai Mohan and Dr. P.K. Malik as the advisors from Wildlife Institute of India.

2. Chief Conservator of Forests, Garhwal will be the Nodal Officer from UKFD to co-ordinate the activities of the project along with Director Rajaji Tiger Reserve and DFOs of Haridwar, Dehradun, Lansdowne and Mussorie Forest Divisions.

3. The research project includes fieldwork in Rajaji Tiger Reserve (RTR) and adjoining forest divisions (Dehradun, Haridwar, Lansdowne and parts of Mussorie Forest Division)

4. Chief Wildlife Warden (hereinafter CWLW) shall issue a formal office order of approval for the implementation of the research project. CWLW shall also issue research permission for the project in the name of investigators from WII, Research Fellows of the project and other support personnel such as Interns, Volunteers and Field Assistants, and this shall cover field data collection and collection of biological samples to meet the project objectives.

5. Field Director/ Conservator of Forest/ Deputy Conservator of Forest of respective protected area/forest shall facilitate the project in the field and shall arrange to provide logistic support in terms of staff in field during capture operations and monitoring, local communication network (wireless)

and service for radio tracking and monitoring of elephants as and when required.

6. Funding shall be provided in installments as per the approved budget, as agreed upon by both parties.

7. The WII shall recruit research fellows/project personnel, procure equipment, establish a base-camp and enable necessary logistics for the project as outlined in the project proposal.

8. The WII undertakes to carry out the assignment in accordance with the highest standard of professional and ethical competence and integrity, having due regards to the nature and purpose of the assignment, and to ensure that the staff assigned to perform the services under the WII, will conduct themselves in a manner consistent herewith. WII will collaborate/seek expertise from other agencies/experts as and when required.

9. WII and UKFD shall attempt in good faith to negotiate a settlement to any dispute between them arising out of or in connection with this MoU. In the event of any dispute under this MoU, all disputes should be settled through mutual consultation and negotiation.

10. No party shall be liable to any other party for any delay or non-performance of its obligation under this MoU arising from any cause beyond its reasonable control unless conclusive evidence to its contrary is provided.

11. The present MoU shall come into effect from the date of its signature and shall remain in effect for a period of two (2) years. Thereafter, it will be renewable by a mutual consent of the parties, unless either parties may terminate the present MoU by giving a written notice of its intention to terminate to the other parties at least six (6) months in advance. This MoU may be amended in writing at any time as decided and agreed by the mutual written consent of the parties.

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

In witness whereof, the undersigned being duly authorized thereto have signed this MoU.

Signed at Dehradun on 22 day of January 2020 at Dehradun (Uttarakhand) by Party No. I **UKFD**

Signed at Dehradun on 22 day of January 2020 at Dehradun (Uttarakhand) by Party No. II **WII**

Signed on Behalf of Wildlife Institute of India, Dehradun	**Signed on Behalf of The Government of the State of Uttarakhand through Uttarakhand Forest Department**
Director, Wildlife Institute of India, Dehradun	**Principal Chief Conservator of Forests (Wildlife) & Chief Wildlife Warden, Government of Uttarakhand**

निदेशक/Director
भारतीय वन्यजीव संस्थान
WILDLIFE INSTITUTE OF INDIA
देहरादून/Dehradun

WILDLIFE INSTITUTE OF INDIA · CHANDRABANI, DEHRADUN ·

Witness:

Name: BIVASH PANDAV

Signature: Bivash Pandav

Witness:

Name: Lalit Kumar

Signature: Lalit

Annexure III

कार्यालय प्रमुख वन संरक्षक (वन्य जीव)/मुख्य वन्यजीव प्रतिपालक, उत्तराखण्ड

85, राजपुर रोड, देहरादून (उत्तराखंड) फोन – 0135– 2742884 फैक्स नं० 2745691 email : cwlwua@yahoo.co.in

पत्र संख्या –2916/5-6 देहरादून, दिनांक 06 फरवरी, 2020

सेवा मे,

निदेशक,
भारतीय वन्यजीव संस्थान,
देहरादून।

विषयः– Permission for Mitigation of Human Elephant conflict in and around Rajaji Tiger Reserve with emphasis on mitigation strategies during Kumnh 2021.

संदर्भः– आपका पत्रांक WII/EleCell/Proposal-UK/2019, दिनांक 5 फरवरी 2020

महोदय,

आपके उपरोक्त संदर्भित पत्र से "Mitigation of Human Elephant conflict in and around Rajaji Tiger Reserve with emphasis on mitigation strategies during Kumnh 2021" हेतु चाही गयी अनुमति निम्न शर्तो के अधीन प्रदान की जाती हैः–

1. किसी भी प्रकार से वन्य प्राणियों/वनस्पतियों को नुकसान नहीं पहुंचाया जायेगा और कोई पौधा या उसका अंश प्राणी नष्ट करने की अनुमति नहीं है।
2. शोध/अध्ययन के दौरान वन संरक्षण अधिनियम 1980, भारतीय वन अधिनियम 1927, जैव विविधता अधिनियम 2002 एवं भारतीय वन्य जीव (संरक्षण) अधिनियम, 1972 यथा संशोधित 2006 का कोई उल्लघंन नहीं किया जायेगा।
3. वन क्षेत्रों में शोध/अध्ययन कार्यक्रम आरम्भ करने से पूर्व सम्बन्धित अधिकारी को सूचित कराना होगा एवं अपना प्रस्तावित कार्यक्रम प्रभाग कार्यालय को सूचित करना होगा।
4. किसी भी प्रकार का प्रतिकूल दृश्य/गतिविधि देखे जाने पर, जो ज्ञात न हो, की सूचना स्थानीय अधिकारी को देनी होगी।
5. उक्त शोध/अध्ययन की रिर्पोट के Field Data एवं Final Report की एक प्रति संबधित प्रभागीय कार्यालय एवं इस कार्यालय को भी उपलब्ध करायेंगे।
6. आई०डी० प्रुफ, वाहन संख्या आदि का विवरण रेंज कार्यालय में प्रेषित किया जाना आवश्यक है।
7. वन क्षेत्रों के अन्तर्गत आग्नेय अस्त्र साथ नही ले जाया जायेगा।
8. वन्य जन्तुओं से या किसी अन्य प्रकार से जनधन की हानि के लिये आप स्वयं जिम्मेदार होंगे।

भवदीय,

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