

Research Article

Human-carnivore interaction during the COVID-19 pandemic in Bangladesh

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ABSTRACT

A study on human-carnivore interaction during the COVID-19 has been conducted by direct field observation along with data from the news of social, print and electronic media. Seventy-three interaction reports were documented in which 12 species and 149 individuals were recorded. The highest interaction was recorded on Fishing Cat (34%). Considering the individual numbers, Asiatic Golden Jackal embodied nearly one-third of total counted individuals and all of them were killed. Most interaction incidents were reported from the rural areas (61.6%) and this varied significantly with other areas ($\chi^2 = 29.25$, $df = 2$, $p < 0.00$). The highest number of interactions were recorded for winter ($n = 34$) and result varied significantly with other seasons ($\chi^2 = 8.2466$, $df = 2$, $p = 0.016$). Based on reported events, three regions (central, northwest, southwest) were identified as major interaction hotspots, where more than two-thirds of incidents occurred. The reasons behind the interactions identified in this study included natural food scarcity, misconception, human interference, misidentification, traditional hunting, unplanned transport system, lack of breeding ground and natural hazards. The mitigation of human-carnivore conflicts necessitates a comprehensive approach that integrates accurate knowledge dissemination, mass awareness campaigns, habitat conservation endeavors, and effective law enforcement measures.

Key words: carnivore, interaction, Fishing Cat, hotspots, pandemic

INTRODUCTION

Globally, human carnivore conflict is increasing due to rapid growth of the human population resulting in natural habitat loss and putting many carnivore mammals on the threatened list (Dar *et al.*, 2009). The order Carnivora is the fifth largest group of mammals and approximately, one-third species of carnivore are categorized as threatened and population trend is decreasing (IUCN, 2023; Menon, 2014).

Bangladesh is a south Asian country, full of rich wildlife diversity because of its geographical location at the junction of the Indo-Himalayas and Indo-China sub-regions (Shome *et al.*, 2021a). A total of 127 extant mammalian species are recorded from Bangladesh which play important roles in the ecology, economy, and culture of the country (Khan, 2015; Khan, 2018). Among the recorded species, 28 are carnivore mammals which are under six families i.e. Viverridae, Felidae, Herpestidae, Canidae, Ursidae, and Mustelidae (Khan, 2018). Being a predator species, their role in the food chain is very important and their absence cause trophic cascade (Akash & Zakir, 2020; Ripple *et al.*, 2014; Suraci *et al.*, 2017). Besides, they play important role as umbrella, keystone and indicator species in the area or ecosystem (Baker & Leberg, 2018; Sarker & Ameen, 1990). Due to anthropogenic activities and indiscriminate killing, their population is declining, and Bangladesh has already lost two species of carnivore mammals (*Hyaena hyaena* and *Melursus ursinus*) (IUCN Bangladesh, 2015). The distribution of carnivore mammals in Bangladesh reveals that most of them are

currently restricted to few areas of the country, although historical records indicate a thorough distribution of carnivore mammals (Akash & Zakir, 2020). According to previous literatures, some carnivore species (e.g. *Felis chaus*, *Prionailurus bengalensis*, *P. viverrinus*, *Herpestes edwardsii*, *H. auropunctatus*, *Canis aureus*, *Paradoxurus hermaphrodites*, *Viverra zibetha*, *Viverricula indica*) are distributed throughout the country but they are facing existential crisis together with other carnivore mammals due to degradation of wildlife habitat, illegal hunting, killing, insufficient enforcement of wildlife law, and outdated policy framework (IUCN Bangladesh, 2015; Khan, 2018; Eva, 2022). Consequently, they are losing their natural habitat and natural food resources which forces them to entry into human habitation in search of prey items. This increases human deaths, injuries, livestock depredation, damage to human property and carnivore deaths and injuries (Rawshan *et al.*, 2012).

COVID-19, a serious threat to human survival, has had some direct and indirect positive effects on our ecosystem and environment. The reduction of noise pollution, greenhouse gas emissions, air pollution, and clean beaches were among the positive effects (Rahman *et al.*, 2021). During the COVID-19 pandemic period, human activities decreased especially in urban area and frequent movement of wildlife was observed throughout the world (Silva-Rodríguez *et al.*, 2021). At the same time, many human-animal conflict incidents occurred and reported in several countries including Bangladesh (e.g. Ghosal & Casey, 2020; Newburger, 2020; Rahman

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et al., 2021). The pandemic had significantly disrupted socioeconomic condition of Bangladesh, with a rising negative influence on the environment. The effects of lockdown measures are likely to hinder or change human-wildlife interaction. This study represents the possible causes of human carnivore conflict; investigates the spatio-temporal conflict pattern, identify the hotspot areas, and recommends some mitigation measures.

MATERIAL AND METHODS

Data collection

We collected data from, direct field observation, online news portals and nature-based Facebook groups of Bangladesh related to human-carnivore interaction during the COVID-19 pandemic. We included reports starting in March 2020 to February 2021 since the COVID-19 pandemic started in March 2020 in Bangladesh. We searched keywords (e.g. species name, carnivore, area,) on Google and Facebook using English and Bengali language (the official and native language of Bangladesh). We used combinations of the keywords to do this such as- 'species name' + 'rescue/dead', 'species name' + 'area name' + 'human' and 'species name' + 'rescued/dead' + 'district name' etc. To avoid repeated observation, we used information such as date and location of the incident to prevent duplicate records in the dataset. Furthermore, we also added our personal field observation in the dataset concerning human-carnivore interaction.

Data sorting

Primarily, we collected a total of 88 interaction reports- 71 were from Facebook, 10 from online news portal and 7 were personal observation which were scrutinized and later finalized to 73 events. For each interaction event, we recorded the following information: 1) carnivore species; (2) season which was divided into monsoon, summer, winter; (3) month; (4) date; (5) exact location of the attack; (6) district; (7) biogeographic region which was denoted according to Khan (2018); (8) location of the attack which was divided into urban area, semi-urban and rural; (9) total number of carnivore individual; (10) number of dead carnivores; (11) number of rescued carnivore; and (12) cause of interaction i.e. the main factor that could have triggered the event. We categorized the interaction reasons into eight scenarios and these eight either caused individually or with the combination of each other. These include- natural food scarcity, lack of breeding ground, natural hazards, misconception, misidentification, human interference, traditional hunting and unplanned transport system. Some reports were found without definite information thus categorized as unknown.

Data analysis

We scrutinized photos published with reports to identify the carnivore species. The scientific names and families along with threatened status of carnivores were prepared following the IUCN Bangladesh (2015). We extracted location data (GPS) using Google Maps from the center of the area if not specified clearly in the report. We produced a map showing interaction hotspots with Kernel density function by ArcMap (version 10.3). We used chi-square test to examine significant difference of the interaction events among areas and seasons. All analyses were done in R version 3.4.4.

RESULTS

Determining the vulnerable species

A total of 73 human-carnivore interaction reports, representing 149 individuals of 12 species were recorded in this study. We found Fishing Cat along covered 34% of the total reports followed by Jungle Cat (19%), Asiatic Golden Jackal (9.5%) and Large Indian Civet (9.5%) (Table 1). Considering individual number, Asiatic Golden Jackal embodied nearly one-third of the total counted individuals and all of them were killed (Table 1). A total of 36 Fishing Cat and 24 Jungle Cat individuals were recorded and of them 58% and 54% were rescued respectively. Leopard Cat was the topmost rescued carnivore and only one out of seven (14%) was killed (Table 1). From human-carnivore interaction reports and the number of individuals (dead and rescued), it is suggested that Fishing Cat, Asiatic Golden Jackal, Jungle Cat and Large Indian Civet are the most exposed carnivore species.

Fishing Cat faced all the eight reasons except natural hazards followed by Jungle Cat (seven). Golden Jackal, Common Palm Civet and Large Indian Civet met four reasons each where natural food scarcity was a common reason for all three species. Golden Jackal and Large Indian Civet are the only two species who encountered natural hazards (Table 1). The motivations behind interaction were not confirmed in 8% of the reports. Among the major reasons, natural food scarcity, misidentification and traditional hunting contributed 38.4% of the total interaction events. The reason, natural food scarcity with other causes such as human interference, misconception, and misidentification furthered 36.9% of the total reports. Details about the reasons with their combination, species affected, and number of reports are provided in the Appendix-I.

Interaction in areas at different seasons

Most interaction incidents were reported from rural areas (61.6%) and this varied significantly with other areas ($\chi^2 = 29.25$, $df = 2$, $p < 0.00$). More than 75% carnivore individuals were encountered from rural areas and 84 were either killed or hunted (Figure 1A). Fishing Cat, Large Indian Civet and Leopard Cat was reported from all areas while Binturong and Indian Grey Mongoose was reported only from rural and Smooth-coated Otter from semi-urban area (Figure 1B). Reports on the top four species were mostly from rural areas (Figure 2A). We reported only a single event from the protected area for Bengal Tiger *Panthera tigris tigris* and it was recorded from Sundarban east wildlife sanctuary.

Winter was the season showing the highest (34) number of interactions following summer (25) and monsoon (14) and varied significantly ($\chi^2 = 8.247$, $df = 2$, $p = 0.016$). The highest number of individual encounters was found for winter season, although death number was the maximum in monsoon (Figure 1C). Among 12 species, five (Leopard Cat, Jungle Cat, Golden Jackal, Fishing Cat, Large Indian Civet) was reported in all seasons; two (Small Indian Mongoose, Common Palm Civet) in summer-winter seasons and one (Small Indian Civet) in monsoon-summer seasons (Figure 1D). Among the top four species, reports on Fishing Cat and Jungle Cat were collected mostly in winter, Golden Jackal in monsoon, and Large Indian Civet in summer (Figure 2B).

Table 1. Number of human-carnivore interaction reports with the reason behind interaction and death-rescued individual number of each species.

Family	Common name	Scientific name	Incident number	Death	Rescue	Reason behind interaction
Felidae	Fishing Cat	<i>Prionailurus viverrinus</i>	25	15	21	A, B, C, D, E, F, G, I
	Jungle Cat	<i>Felis chaus</i>	14	11	13	A, B, C, G, C, E, F
	Leopard Cat	<i>Prionailurus bengalensis</i>	5	1	6	A, D, F
	Bengal Tiger	<i>Panthera tigris tigris</i>	1	1	0	I
Canidae	Asiatic Golden Jackal	<i>Canis aureus</i>	7	48	0	A, B, H, I
Herpestidae	Small Indian Mongoose	<i>Herpestes edwardsii</i>	2	6	0	A, E, F
	Indian Grey Mongoose	<i>Herpestes auropunctatus</i>	1	4	0	E
Mustelidae	Smooth-coated Otter	<i>Lutrogale perspicillata</i>	2	4	0	A, B, C
Viverridae	Large Indian Civet	<i>Viverra zibetha</i>	7	7	3	A, B, C, H
	Small Indian Civet	<i>Viverricula indica</i>	3	3	0	A, E, F
	Common Palm Civet	<i>Paradoxurus hermaphroditus</i>	5	3	2	A, B, G, I
	Binturong	<i>Arctictis binturong</i>	1	1	0	B

Note: A = Natural food scarcity; B = Misconception; C = Human interference; D = Misidentification; E = Traditional hunting; F = Unplanned transport system; G = Lack of breeding ground; H = Natural hazards; I = Unknown.

Human-Carnivore interaction hotspots

Based on reported events, three regions (Central, North-west, Southwest) were major interaction hotspots, > 68% of all incidents occurred in these locations (Figure 3). These three regions also formed a large hotspot and it falls within the Padma-Jamuna river system including Chalan Beel, a wetland connected with 47 rivers covering 26 km². Another small hotspot is formed in the southern region and this region is connected with a network of rivers, wetland and coastal bodies. The number of interaction events varied significantly ($\chi^2 = 28.74$, $df = 6$, $p\text{-value} = <0.00$) in the seven regions.

DISCUSSION

The previous study of Rawshan *et al.* (2012) showed 80 incidents of conflict in 21 years (1990 to 2010) while the present study recorded 73 incidents in one year only. This clearly reveals that human-carnivore interaction was at its peak during the pandemic and a plethora of reasons boosted the process. Migration of human from urban to rural areas, decline in income-generating activities, changes in human behavior and psychological health can be regarded as principal factors among the reasons (Bodrud-Doza *et al.*, 2020; Golar *et al.*, 2020). These causes ultimately resulted in over-harvesting of natural resources, human-human conflict, and human-wildlife conflict (Clark *et al.*, 2014; Inskip *et al.*, 2014, 2016). During the pandemic situation, like many countries Bangladesh gone under lockdown for a long period,

and human movement and activities were limited so wildlife got space for their activities (Islam, 2021; Shome *et al.*, 2021b). But, unfortunately wildlife kill has increased at this time and anthropogenic threats to forests and wildlife increased (Islam, 2020; Rahman *et al.*, 2021) which is also reflected in this study. For example, Rahman *et al.* (2021) showed that 112 wild animals were killed during the COVID-19 pandemic.

Among carnivores, Fishing Cat was observed to face the maximum threats in this study throughout the country. The population of this species is declining globally and nationally due to habitat loss, scarcity of natural food, and indiscriminate killing (Sultana *et al.*, 2022; IUCN Bangladesh, 2015; Chowdhury *et al.*, 2015). The incident number and death number of the present study have increased compared to the previous study of Chowdhury *et al.* (2015). They recorded 82 reports and 30 death records of Fishing Cat in 39 months study while this study found 25 reports and 15 death records of Fishing Cat in only 12 months. This indicates an alarming situation for this species in Bangladesh. We also observed that Fishing Cat is misidentified as Tiger and consequently killing occurs.

The shrinkage or loss of wild habitat for carnivore mammals is a major concern. Habitat loss fortifies food scarcity, loss of feeding and breeding ground, landscape alteration, and disruption in trophic levels (Das *et al.* 2023; van Bommel *et al.* 2020; IUCN Bangladesh, 2015). Besides, insufficient management of anthropogenic food sources such as poultry farm, pet food, bird feeders and waste in homestead areas is known to be

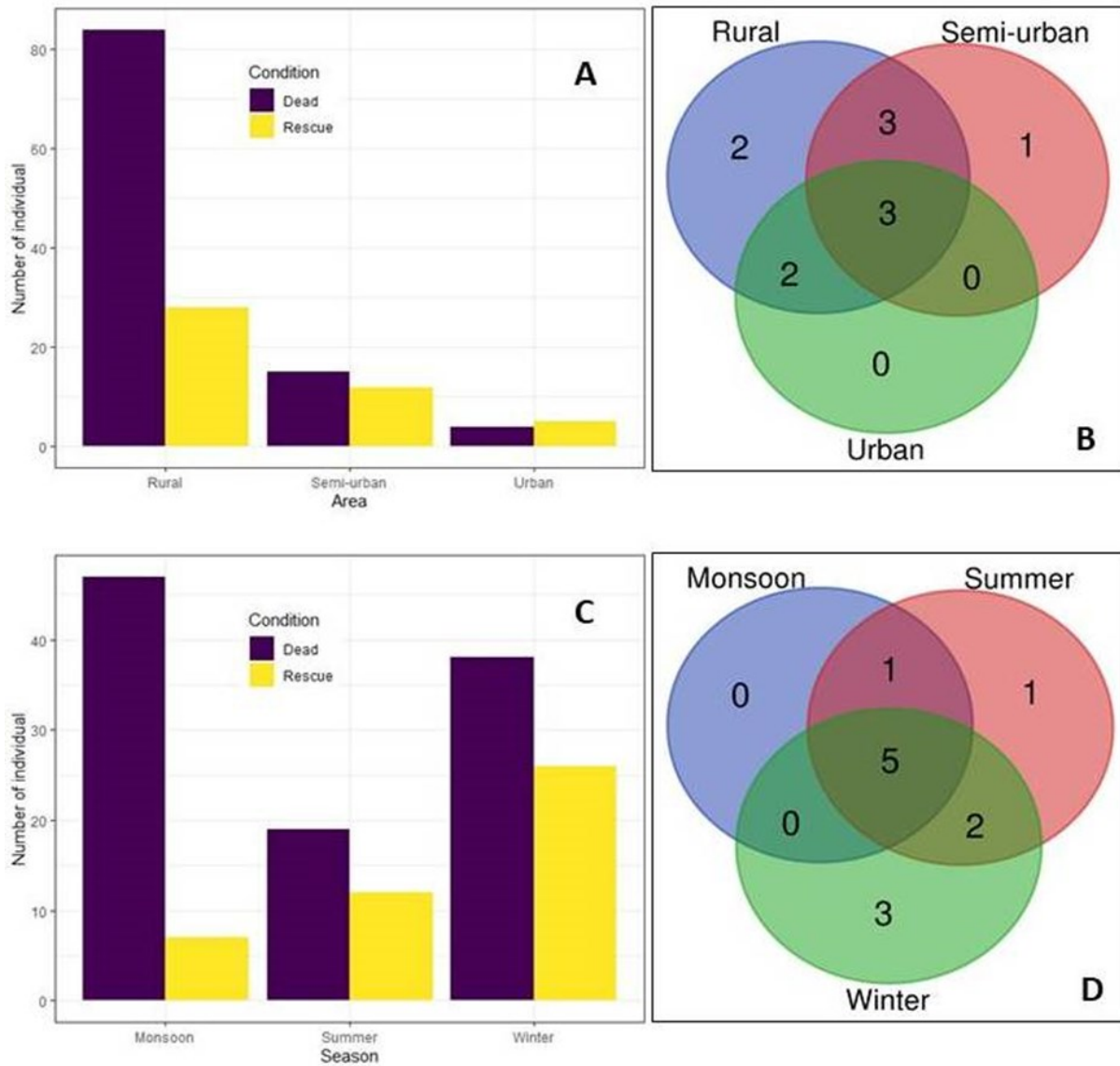


Figure 1. A. Number of death and rescued individual from three different areas; B, Area-wise unique and shared number of species shown in Venn diagram; C, Number of death and rescued individual in three different seasons; D, Season-wise unique and shared number of species shown in Venn diagram.

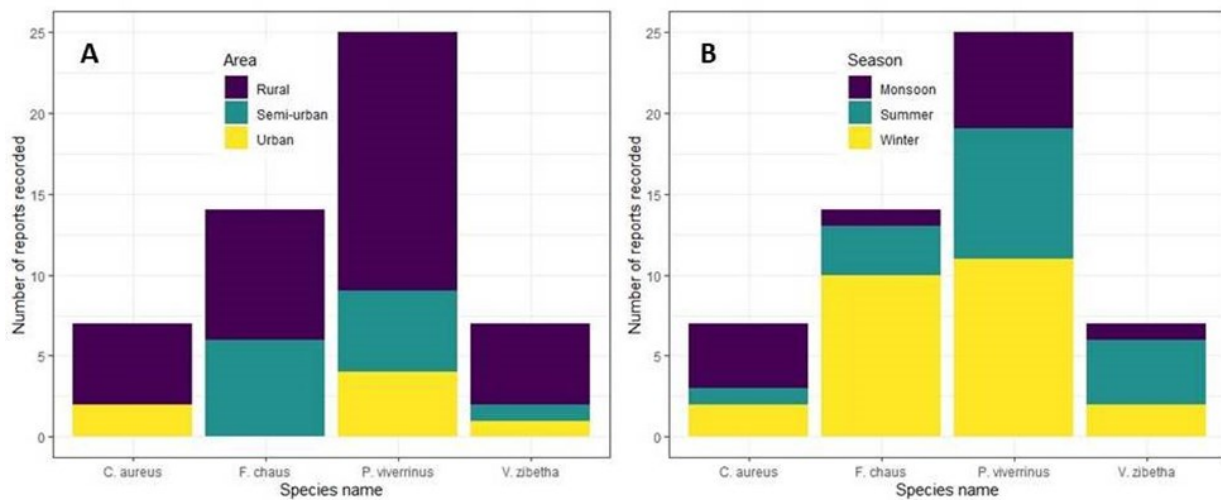


Figure 2. The number of reports on the top four species collected from: A, different areas; B, in different seasons. Human-Carnivore Interaction hotspots

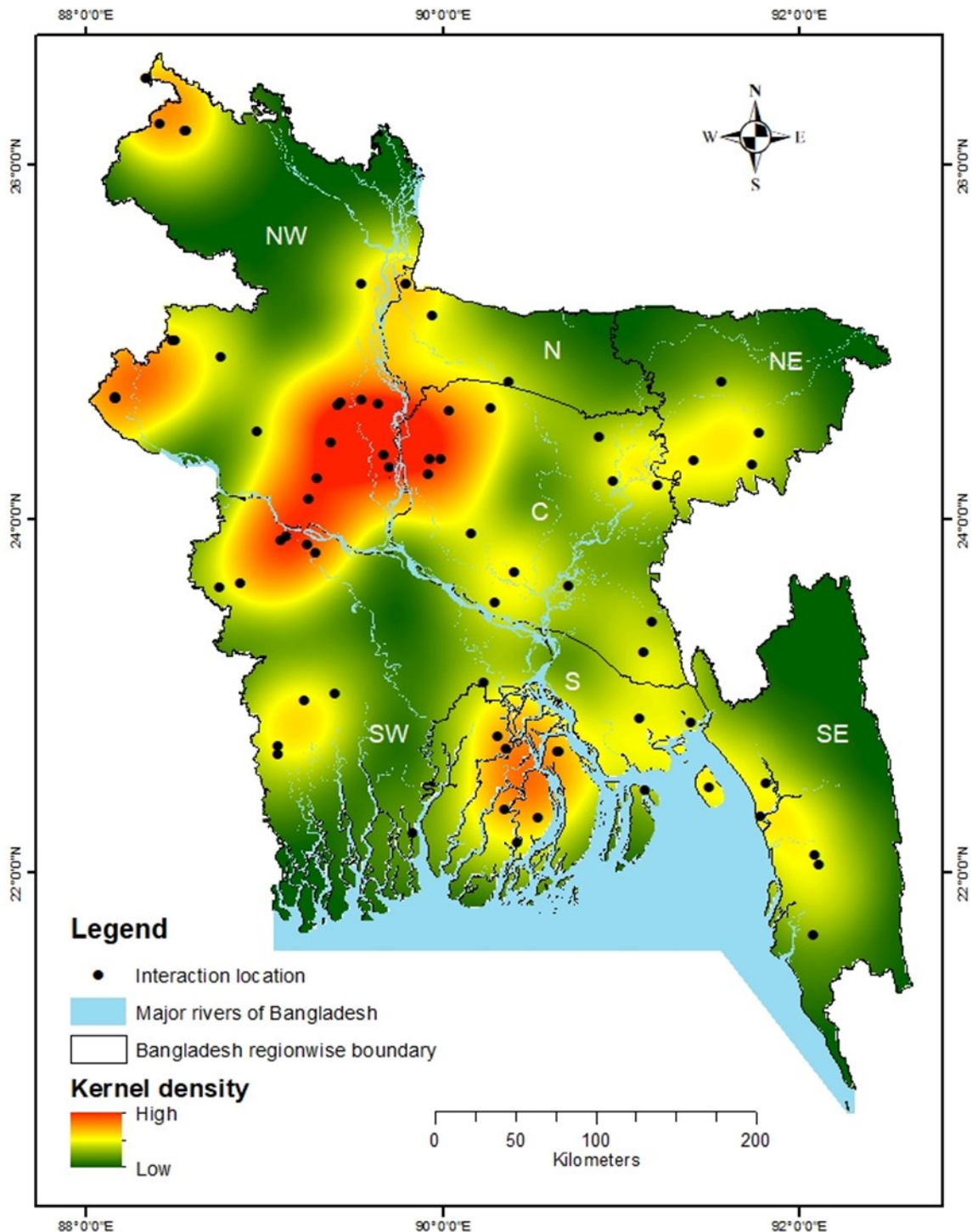


Figure 3. Map (Kernel density) of Bangladesh showing the human-carnivore interaction locations during COVID-19 pandemic.

one of the most common factors behind human-carnivore interaction (Bombieri *et al.*, 2018). The number of poultry and livestock industries has increased over time in Bangladesh (Gazi, 2020). These are easy food sources for the carnivores such as Jungle Cat, Golden Jackal which contributed in rising conflicts number. Urban areas in Bangladesh have been developed without sufficient consideration for wildlife habitat management, resulting in minimal prospects for the survival of species within these urban environments (Jaman *et al.*, 2021). Our research indicates a significantly lower occurrence of interaction events between humans and wildlife in urban areas compared to rural areas. Additionally, rural areas

are characterized by various misconceptions and superstitions regarding wildlife, which contribute to an increased incidence of conflicts and mortality among wildlife populations in those areas. In rural settings, human communities suffer financial losses, such as livestock and poultry depredation, which intensify the human-carnivore conflicts prevalent in these regions (Dar *et al.*, 2009; Linkie *et al.*, 2007; Naughton-Treves, 1998). The hotspots identified in this study suggested that almost all the areas are rural, riparian areas where the life standard is low. The initial national strategies implemented during the onset of the pandemic potentially imposed economic and social burdens on individuals

who depend on ecosystem services derived from river and wetland areas. This circumstance likely had psychological ramifications, compounded by other factors such as flood, joblessness etc. which heightened human-carnivore conflicts in the hotspot areas.

The highest number of interactions was observed during the winter season (Figure 1C). This pattern could be attributed to the scarcity of natural food sources for carnivorous mammals, which compels them to seek out easily accessible food. The reproductive cycle of most carnivores occurs during the winter season in Bangladesh (IUCN Bangladesh, 2015; Khan, 2015; Khan, 2018). During this period, carnivores utilize bushes, thickets, and agricultural lands as suitable habitats for giving birth to their offspring, coinciding with the timing of crop harvesting in Bangladesh. This synchronization of breeding biology with crop production is another potential factor that may contribute to an increased likelihood of human-carnivore conflicts. For example, the number of interaction report for Fishing Cat and Jungle Cat is found higher in winter season (Figure 2B), coinciding with their breeding season (IUCN Bangladesh, 2015; Khan, 2015). However, the mortality rate of carnivorous mammals was found to be higher during the monsoon season. It is important to note that this result was influenced by a specific incident. During the monsoon, as the water level rose, the habitats of Golden Jackals became flooded, leading them to seek food and shelter in nearby human settlements. Regrettably, local people brutally killed 23 individuals in response to this situation.

About 40% (11 species) of carnivore mammalian species are found outside the protected areas of Bangladesh (Khan, 2018). In the central, northwest, and southwestern region, the number of protected areas is very low, and most people are not aware of wildlife conservation outside protected areas (Rabbe *et al.*, 2022). The present result indicates that non-protected areas harbor a good number of carnivore mammalian species, but they are now at risk and facing a crisis (Figure 3). The recent record of *Pardofelis marmorata* from the urban area of Chittagong also supports the assumption (Shome, 2021). More than 30% of the reported events were from the northwestern region, which was the maximum (Figure 3). To protect the existing carnivores of the identified hotspots, mass awareness program, habitat conservation, planned urbanization and industrialization, and enforcement of wildlife law are clearly required.

CONCLUSION

It is true that in today's world, we have access to more information through social, print media, and electronic media compared to previous times. This easy access to information allows us to stay informed about various issues, including wildlife conservation. Social media platforms can play a significant role in spreading information about carnivore conservation and raising awareness about the threats faced by carnivores. They provide a platform for sharing stories, news, and initiatives related to carnivore conservation, which can reach a wide audience and generate public support. In Bangladesh, there are several non-government organizations dedicated to conserving wildlife and addressing the increasing

conflicts faced by carnivores. Some of these organizations include Dhaka University Nature Conservation Club, Deep Ecology and Snake Rescue Organization, Team for Energy and Environmental Research, Voice for Voice Less etc. These organizations should be recognized by the government and more voluntary and non-profit organizations should come forward to mitigate the conflicts.

Conserving natural habitats and planting more native trees are crucial steps in wildlife conservation. The conservation of homestead forests, which are small forests or green spaces around homes, is particularly important in urban areas. Proper urbanization planning should consider the preservation and integration of such green spaces to maintain ecological balance.

To effectively conserve not only carnivores but all types of wildlife, it is important to spread accurate and reliable information among local communities. This can help dispel myths, promote coexistence, and encourage the adoption of wildlife-friendly practices. Creating awareness among people from all walks of life is essential, especially among school-going children. Education and awareness programs can help instill a sense of responsibility and empathy towards animals and nature in the younger generation.

In areas identified as hotspots for human-carnivore interaction, it is crucial to take necessary steps and enforce laws to protect these areas from encroachment, illegal activities, and habitat destruction. Conservation efforts should involve collaboration between government authorities, local communities, and conservation organizations to ensure the effective protection of carnivores. Overall, a comprehensive approach that includes accurate information dissemination, awareness creation, habitat conservation, and law enforcement is necessary for the successful conservation of wildlife, particularly carnivores, in Bangladesh.

DECLARATIONS OF INTEREST

The authors declare no conflict of interest.

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Appendix I: List of reasons (individual and combined) with name of the carnivore species affected and number of reports.

Reasons	Species affected	Species number	No. of report
A	Common Palm Civet, Fishing Cat, Golden Jackal, Jungle Cat, Leopard Cat, Small Indian Civet	6	12
A, B	Common Palm Civet, Fishing Cat, Jungle Cat	3	5
A, C	Fishing Cat, Jungle Cat, Large Indian Civet, Smooth-coated Otter	4	8
A, B, C	Fishing Cat	1	1
A, D	Fishing Cat	1	1
B	Binturong, Large Indian Civet	2	3
B, C	Jungle Cat, Large Indian Civet, Smooth-coated Otter	3	4
C	Golden Jackal, Jungle Cat	2	3
C, D	Fishing Cat	1	1
C, G	Fishing Cat	1	1
C, H	Golden Jackal, Large Indian Civet	2	4
D	Fishing Cat, Jungle Cat, Leopard Cat	3	8
E	Fishing Cat, Indian Grey Mongoose, Jungle Cat, Small Indian Civet, Small Indian Mongoose	5	8
F	Fishing Cat, Jungle Cat, Leopard Cat, Small Indian Civet	4	5
G	Common Palm Civet, Jungle Cat	2	3
I	Bengal Tiger, Common Palm Civet, Fishing Cat, Golden Jackal	4	6

Note: A = Natural food scarcity; B = Misconception; C = Human interference; D = Misidentification; E = Traditional hunting; F = Unplanned transport system; G = Lack of breeding ground; H = Natural hazards; I = Unknown.

