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Research Article

Analysis of carnivore attacks on humans and economic losses in and around Hirpora Wildlife Sanctuary along Pir Panjal Moutain range, Western Himalayas

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Abstract

Human-wildlife conflict arising as a result of interaction between humans and wildlife has evolved as one of the most critical threats to species conservation. Human-wildlife interactions and associations are as old as human civilization. The study presents an analysis of human-wildlife conflict situations in and around Hirpora Wildlife Sanctuary, Kashmir Himalayas for a period of 11 years from 2011-2021. A combination of the questionnaire, focus groups, and semi-structured interviews of key informants was used for data collection. During the surveys, we collected data on 634 injury cases majority (56%) of which were caused by Asiatic black bears followed by Common leopards (44%). The chi-square analysis revealed that bear injuries were overrepresented during 2018-2019, and leopard injuries were overrepresented during 2012-2013 and 2017-2018. Statistically, a significant association was recorded between the gender and age of the victims. Bear-caused conflict incidents were significantly higher during the study period. No significant association was recorded between livestock causalities and wild animals. A significant decreasing trend was observed between the number of injuries and the increasing distance from the forest. Improving mitigation measures such as traditional crop-guarding systems (active and passive guarding strategies, barriers, and combinations of measures), construction of fences and wires, and educating local communities about wildlife behavior will help reduce conflicts and ensure coexistence.

Keywords: Human-wildlife conflict, Hirpora, injuries, Asiatic black bear, common leopard Shopian

Introduction

Human-wildlife conflicts (HWCs) occur when the needs of wildlife and human populations collide, putting both humans and wildlife at risk (Messmer 2000; Treves et al., 2020). Conflicts between humans and wild animals can be defined as an adverse interaction between both parties, leading to death or loss of resources (Messmer 2000, Decker *et al.,* 2002). Conflicts between wildlife populations and their environment are detrimental to both communities and to the livelihoods of humans (WWF, 2005). In addition to attacking people and animals (Löe and Röskaf, 2004; Packer *et al.,* 2005; Jadhav and Barua, 2012), depredating livestock (Thirgood *et al.,* 2005; Banerjee *et al.,* 2013; Bombieri *et al.,* 2019), destroying crops (Pimentel *et al.,* 2005; Perez and Pacheco, 2006; Karanth *et al.,* 2012; Mohammadi *et al.,* 2022), or spreading zoonotic diseases (Daszak *et al.,* 2000; Singh and Gajadhar, 2014), negatively affect local communities.

Globally, human and wildlife competition over space and food is becoming more common (Conover 2002, Hoffman and O'Riain 2011). In many places, human-wildlife conflicts are increasing, as burgeoning human populations move further into previously uninhabited areas, and as some species recolonize parts of their range (Woodroffe *et al.,* 2005; Mohammadi *et al.,* 2021). The Himalayan region of Jammu and Kashmir has suffered an increase in wildlife-related injuries in the last few decades (Sangay and Vernes, 2008, Nabi *et al.,* 2009; Ahmad *et al.* 2012). Due to the increase in human population and increase in resource use, humans are forced to live in close proximity to wild animal habitats, making them vulnerable to wild animal attacks (Mohammadi *et al.,* 2021). The present study was conducted around the Hirpora Wildlife Sanctuary with an aim to analyze the human-wildlife conflict situations and understanding the patterns, cause and magnitude of damage inflicted by wildlife for ensuring coexistence. In order to better understand the drivers of human-carnivore conflict in the region, we investigated the incidence of cattle depredation by carnivores and analyzed environmental and protective variables.

Materials and methods:

Study Area

The present study was carried out in and around Hirpora Wildlife Sanctuary (Figure 1). The Sanctuary covers an area of 341km^2 and is located in the Pir Panjal range about 70 km southwest of Srinagar. It lies in southern Kashmir's Shopian district around 33°39' 55" N latitude and 74°39' 40" E longitude ranging in elevation between 2300-4610 m asl. Forests, pastures, scrubland, and water bodies enhance the beauty of the sanctuary (Ahmad *et al.,* 2015). The slopes are mild to moderately steep

on the eastern side and very steep with many cliffs on the upper northern and western sides. The slopes are moderate on the southern and southeastern sides. This Sanctuary is home to a diverse collection of flora and fauna. Among the main faunal elements of this sanctuary are Pir Panjal Markhor (*Capra falconeri*), Himalayan musk deer (*Moschus leucogaster*), Himalayan black bear (*Ursus thibetanus*), Himlayan brown bear (*Ursus arctos*), red fox (*Vulpes vulpes*), and Tibetan wolf (*Canis lupus*). The floral diversity includes Kail pine (*Pinuswallichiana*), Fir (*Abiespindrow*), Himalayan Birch (*Betulautilis*), Juniper (*Juniperus communis*) and Wild rose (*Rosa macrofolia*).

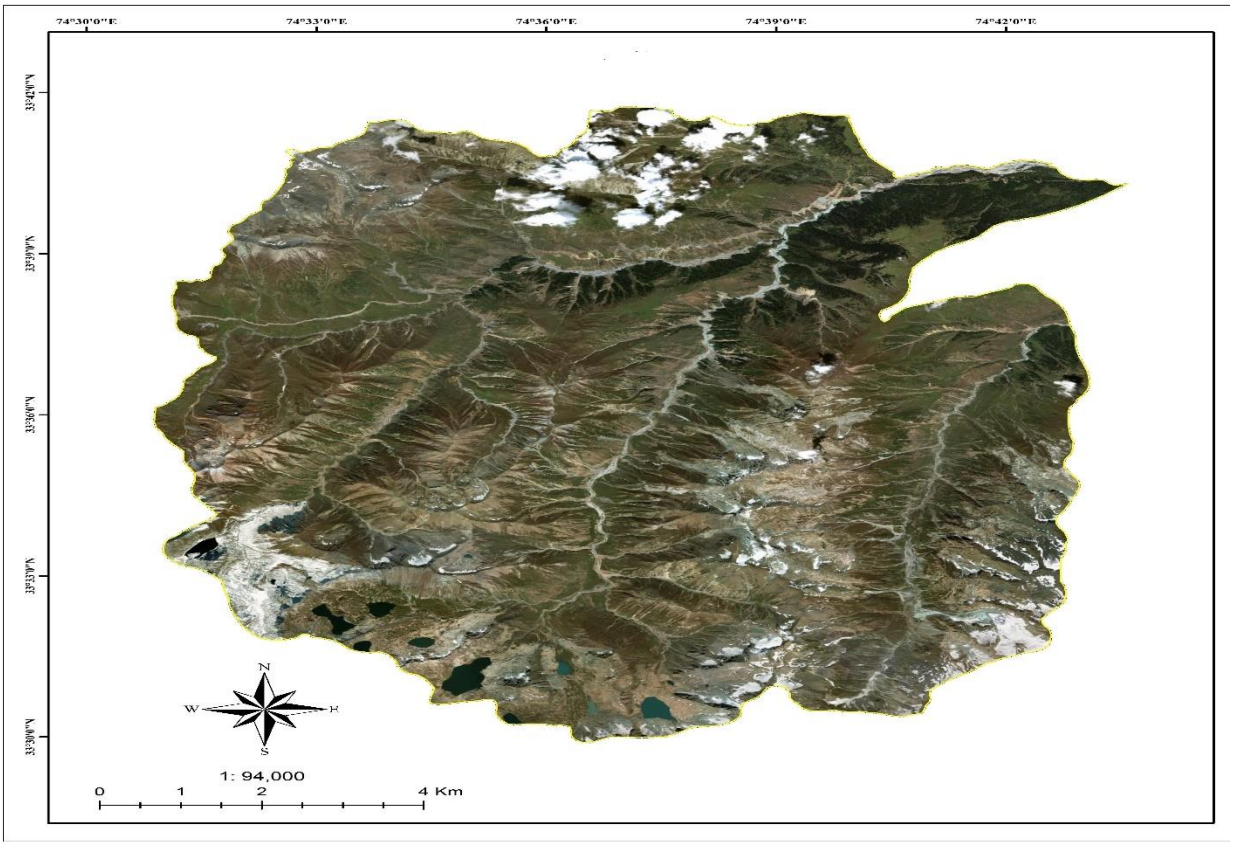

Figure 1. Location of the study area

Data collection

For achieving this objective, information and documentation of case histories of injuries, cattle/crop damages and human casualties by wild animals that have occurred in and around Hirpora Wildlife Sanctuary from 2011-2021 were collected from the published articles (Ahmad *et al.,* 2012; Ahmad *et al.,* 2015; Charoo *et al.,* 2011) and Government reports, Attempts were made to visit and sample all the affected families along elevation gradients across the landscape for collecting both qualitative and

quantitative data through a combination of questionnaire, focus group discussions from a purposely selected group of individuals and semi-structured interviews of victims and key informants including Wildlife officials, field staff and villagers of forest fringe communities. Regular site visits were made for on-spot assessment of the sites, amount of damage caused and conflict situations in the field using open and close-ended questions and the people's perspective of the problem faced, attitude towards wildlife conservation, and strategies to be adopted for resolving the conflict for moving towards coexistence. At every conflict site data were collected on date and year of the attack, age and sex of the animal, group composition of animal, mode and characteristic of attack, habitat in the place of attack, micro-habitat, distance from the place of attack to water sources, human settlement and forest, conflict in various districts and divisions, age and sex of the victims, attack on livestock, presence of leopard and bear. The information obtained from the villagers was verified with the data from the concerned Government wildlife department records.

Data analysis

Data analysis was performed in R programming software 4.0.2 (R Core Team, 2020) using the packages cited within the main text. In the present study, Pearson's Chi-Square test of independence was adopted to evaluate whether there are significant differences among the studied years for the number of injuries by (i) animal type and (ii) based on the body part (abdomen, chest, leg, arm, face, other) involved. The observed counts within each category in combination with the expected counts were compared which were calculated based on the assumption of equal distribution across the different categories to show the over-represented and under-represented categories. The degree of deviation of observed scores from those expected within each category combination was expressed in terms of Pearson's residuals using the R package "*vcd 1.4-8*" (Meyer *et al.,* 2020). In addition, Pearson's Chi-Square test was used to investigate the existence of any significant differences in the number of injuries by the (i) studied animals on different age groups, in different months and on studied livestock, and (ii) livestock depredation within and outside wildlife sanctuary. Once again, Pearson's Chi-Square test of independence was used to study whether there exists any significant difference in the damage caused by wild animals on different crops and livestock among the studied years.

Linear regression models were used to quantify whether there occurs any significant relationship between the year of study and (i) total number of injuries (ii) number of injuries caused by bears (iii) number of injuries caused by leopards (iv) number of injuries on different body parts (abdomen, arm,

chest, leg, face and other) and (v) economic losses by wild animals on different crops using the "*basicTrendline 2.0.5*" R package (Mei and Yu, 2020). In the regression models year was used as a predictor value, while the rest of the above-stated variables were used as response variables independently. Also, for each model, the total variance (R^2) explained by the particular model and the associated statistical significance at $P \leq 0.05$ level (i.e., 5% level of significance) was calculated. Linear regression analysis was used to study whether the number of injuries by wild animals increases with distance from the sanctuary.

Results

During the present study, a total of 634 human-wildlife conflicts and/or injuries spanning 11 years' time period from 2011-2021 were observed. Of the total reported injuries, 357 (ca. 56%) were caused by Asiatic black bear, while the remaining 277 (ca. 44%) were inflected by Common leopard. Most of the bear injuries (72 % and 66%) occurred during 2019-2020 and 2018-2019 respectively, while the highest number of cases of injuries by leopard in and around Hirpora Wildlife Sanctuary were reported during 2018-19 and 2012-2013 respectively (Figure 2). Statistically, the chi-square analysis revealed that the number of injuries caused by bear and leopard differed significantly between the studied years ($\chi^2 = 86.88$, $df = 9$, $p < 0.001$). The highly over-represented bear injuries occurred during 2018-2019 and highly under-represented bear injuries took place during 2012-2013 and 2017-2018. Contrary to this, highly over-represented leopard injuries were observed during 2012-2013 and 2017-2018, while highly under-represented leopard injuries were seen during 2012-2013 and 2018-2019 (Figure 3). Human casualties appear to vary spatially along with the inundation of people visiting forest areas for hunting or collecting nontimber forest produce (NTFP). Among the human incidents, the majority (41%) occurred within a distance of less than 1 kilometer from the wildlife Sanctuary. 9% of human injuries occurred within the 4.1 km to 7 km range. Most incidents (19%) recorded within the 1 km range occurred in 2019-2020, and the least (3%) were recorded in 2015-2016 (Figure 4). A significant difference was seen between the distance and number of human incidents ($\chi^2 = 118.82$, $df = 3$, $p < 0.008$).

Moreover, the different injury types observed differed significantly between the studied years ($\chi^2 = 94.28$, $df = 45$, $p < 0.001$). The highly over-represented were the injuries of chest and leg during 2016-2017, face injuries during 2019-2020, and others during 2018-2019. On the other hand, highly under-represented were the injuries of arm during 2016-2017 and 2019-2020 (Figure 5).

Gender wise, the number of injuries were not equally distributed within different age groups (χ^2 = 132.25, df = 5, $p < 0.001$). Among males, the number of injuries were highly over-represented for the age groups of 56-75 years but highly under-represented in case of 19–30-year age group. In contrast, for females, highly over-represented injuries were seen for 19–30-year age group and highly under-represented injuries were observed for all the age groups between 31-90 years (i.e., 31-55, 56-75 and 76-90) (Figure 6).

From 2011 to 2020, the monthly number of human casualties caused by wild animals varied significantly. Out of the 634 cases, summer (61%) had the most casualties followed by autumn (19%). Black bear attacks were recorded highest in the month of June (12%), however, leopard injuries were recorded highest in July (9%). Statistically, the number of injuries by bear and leopard differed significantly between different months of the year (χ^2 = 34.58, df = 11, $p < 0.001$). The highly over-represented bear injuries were recorded in the month of June during which the leopard injuries were highly under-represented (Figure 8).). Most livestock depredation cases (47%) occurred during the summer months, followed by spring (34%) and autumn (13%). Winter recorded the least amount of livestock depredation (6%) (Figure 9). Summer and spring movements of livestock toward grazing areas and back to villages during winter seem to be correlated with monthly variation in livestock killings. . As livestock move higher during summer, predation increases, which results in a greater number of casualties when livestock are in pastures. A significant difference was seen between the seasons and type of livestock depredation (χ^2 = 33.12, df = 15, p = 0.004).

Black bears were responsible for 59% of livestock depredation, with sheep (17%) and buffaloes (13%) being the most frequently preyed upon by bears. Leopards, however, accounted for 41% of total livestock depredations, with cattle (12%) and sheep (10%) depredations accounting for the majority of the total losses (Figure 10). However the number of injuries by bear and leopard on domestic livestock showed no significant differences (χ^2 = 1.02, df = 4, p = 0.91). Most (58%) of the livestock killings for which locations were recorded occurred outside the Sanctuary in agriculture areas (43%), followed by horticulture (25%) and villages (29%). Fewer (35%) occurred within the sanctuary in open scrub (10%) and forest areas (3%). Moreover, no significant difference was found in the livestock depredation within and outside the wildlife sanctuary (χ^2 = 7.05, df = 4, p = 0.13). The chi-square test also showed no significant difference in the effect of wild animals on the production of crop species among the studied years (χ^2 = 21.95, df = 16, p = 0.14). Similarly, no significant difference was found in the number of injuries on domestic livestock during the study period (χ^2 =

8.51, $df = 8$, $p = 0.39$). However, significant differences ($\chi^2 = 13635$, $df = 10$, $p < 0.001$) were observed in the economic losses caused by wild animals to various crop species during the study period. The highly over-estimated economic losses during 2019 were observed for orchards and walnuts, but highly under-represented for maize, potato and pulses (Figure 11). Similarly, the highly over-estimated economic losses during 2020 were seen for orchards and potato, but highly under-represented for maize, pulses asoybeansean. Further, highly over-represented economic losses occurred for maize and pulses, while highly under-represented economic losses occurred for orchard, potato, and pulses during the year 2021.

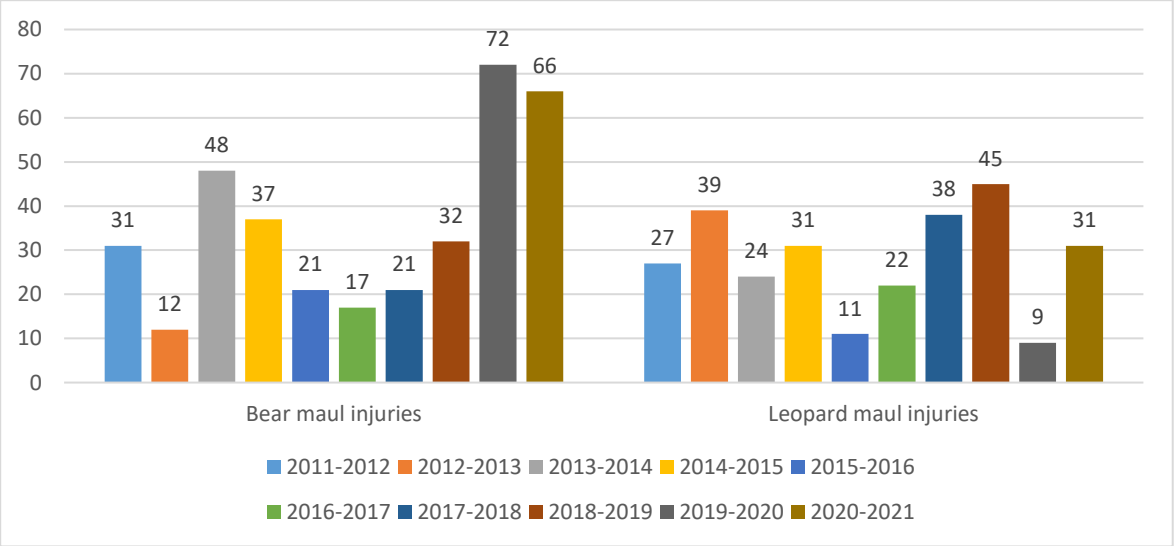

Figure 2. Yearly injuries by (a) bear and (b) leopard for the 11-year time period.

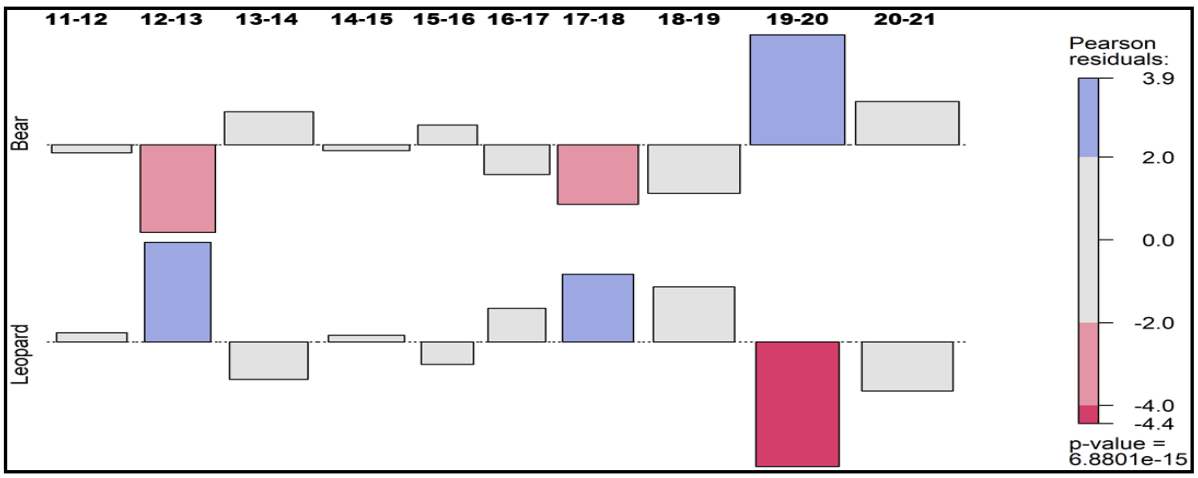

Figure 3. Results of Chi-square test for the number of injuries by animal type for the 11-year time period. The figure presents Pearson's residuals. Positive values denoted higher observed values than expected, while the negative residuals represent lower values than expected. The color gradient corresponds to Pearson's residual scores.

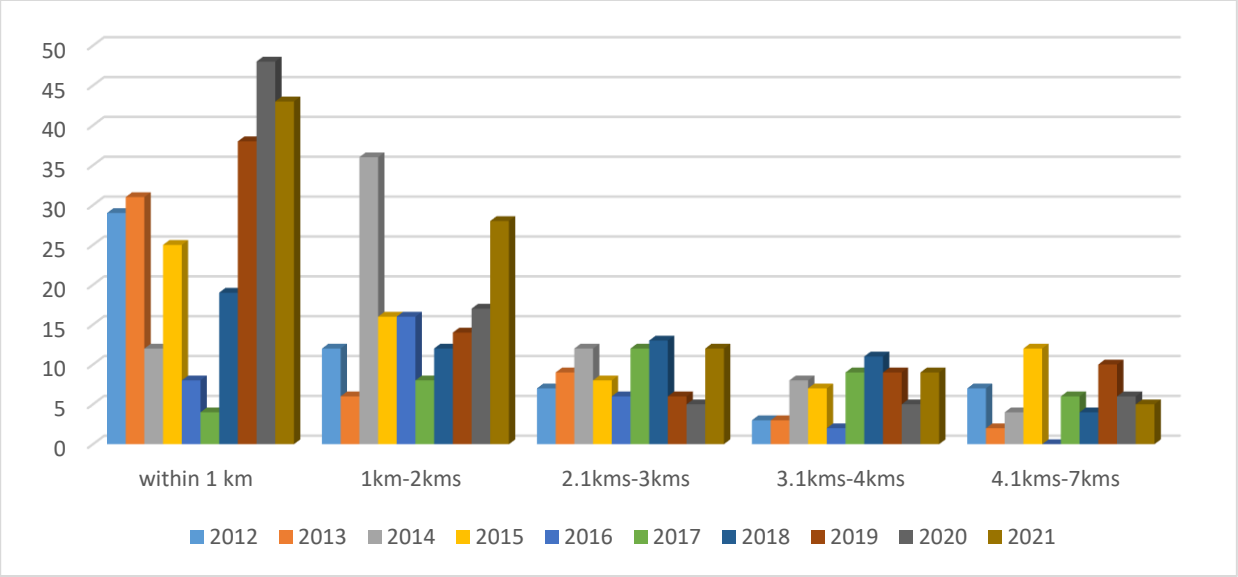

Figure 4. Distance-wise number of injuries from 2011-2020

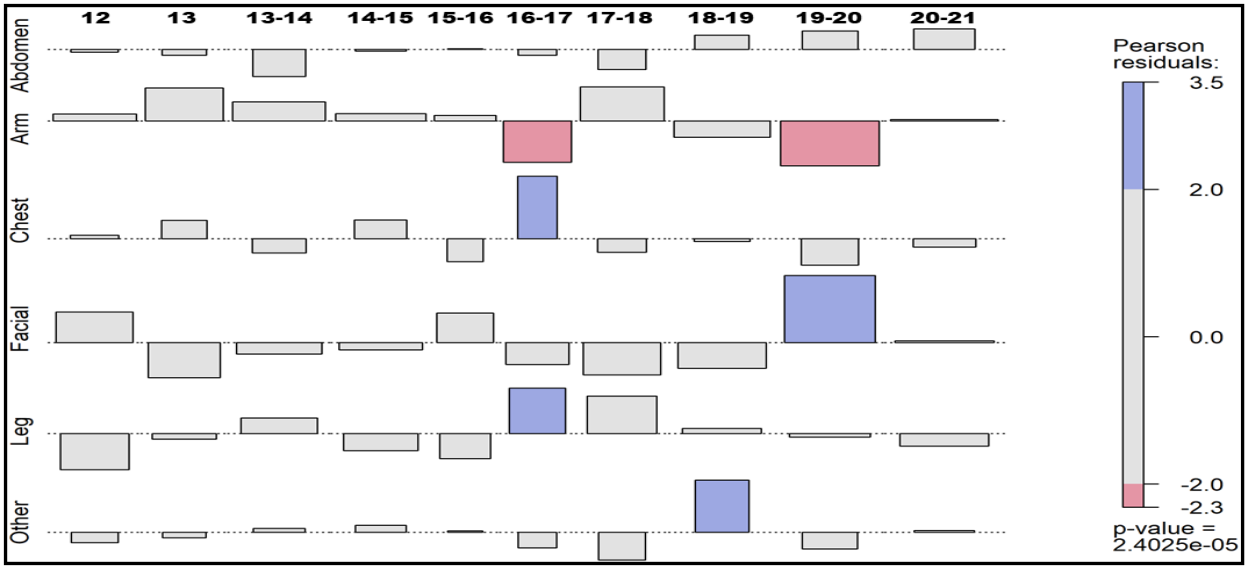

Figure 5. Results of Chi-square test for the number of injuries by body part for the 11-year time period. The figure presents Pearson's residuals.

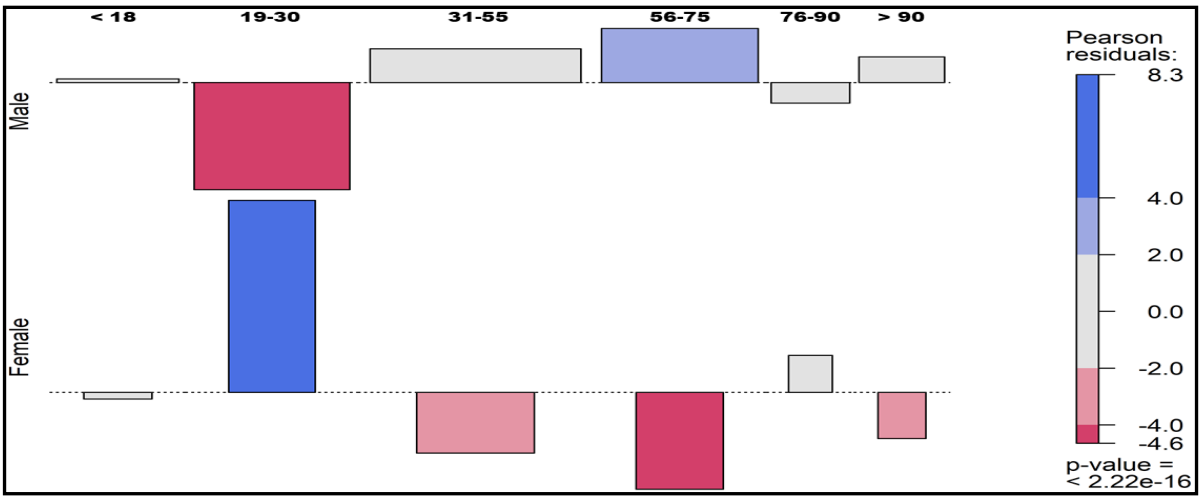

Figure 6. Results of Chi-square test for the number of injuries by gender and age group. The figure presents Pearson's residuals.

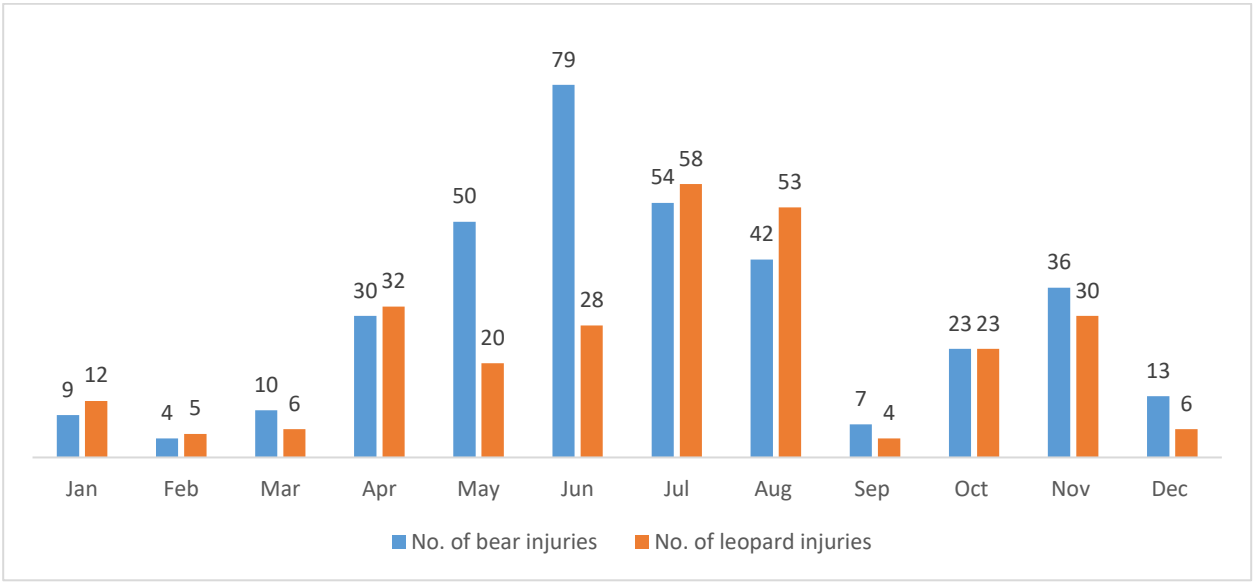

Figure 7. Monthly variations among the number of human injuries by bear and leopard

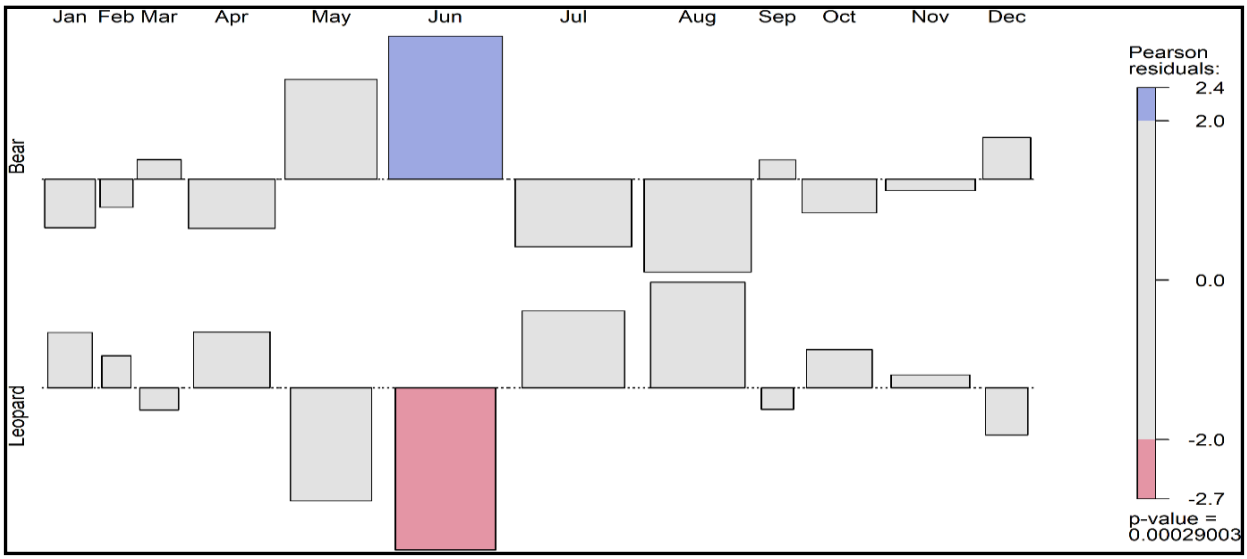

Figure 8. Results of Chi-square test for the number of injuries by animal type in different months. The figure presents Pearson's residuals.

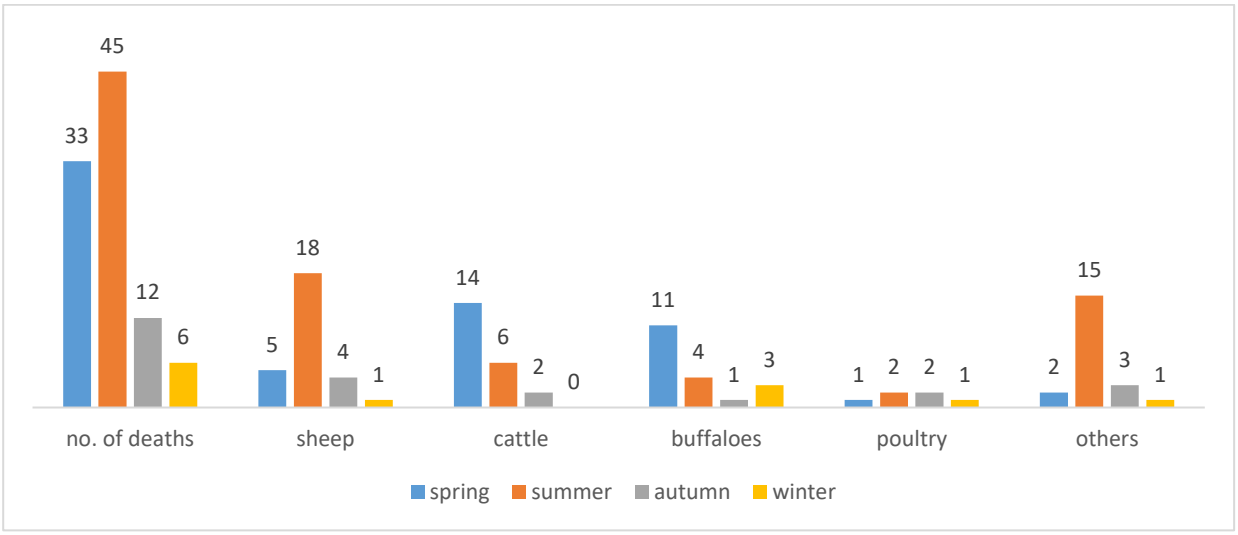

Figure 9. Seasonal variations of livestock depredation

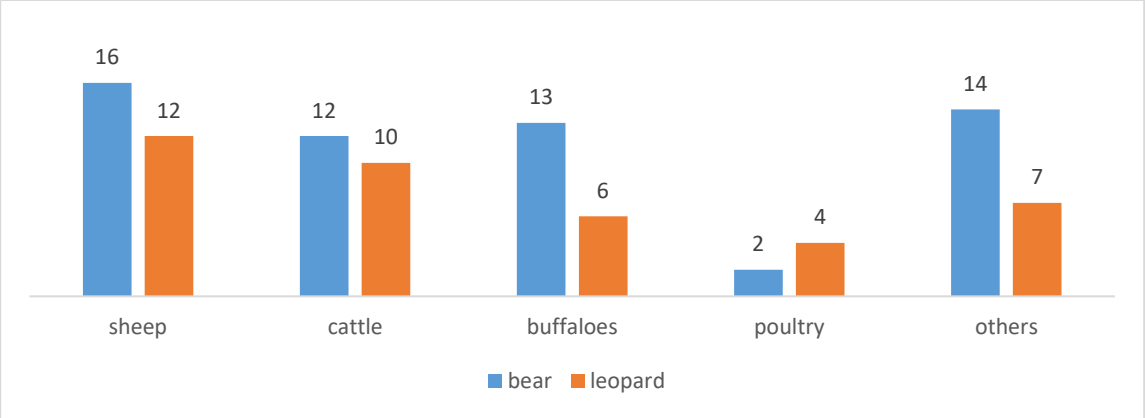

Figure 10. Number of livestock depredations by bear and leopard

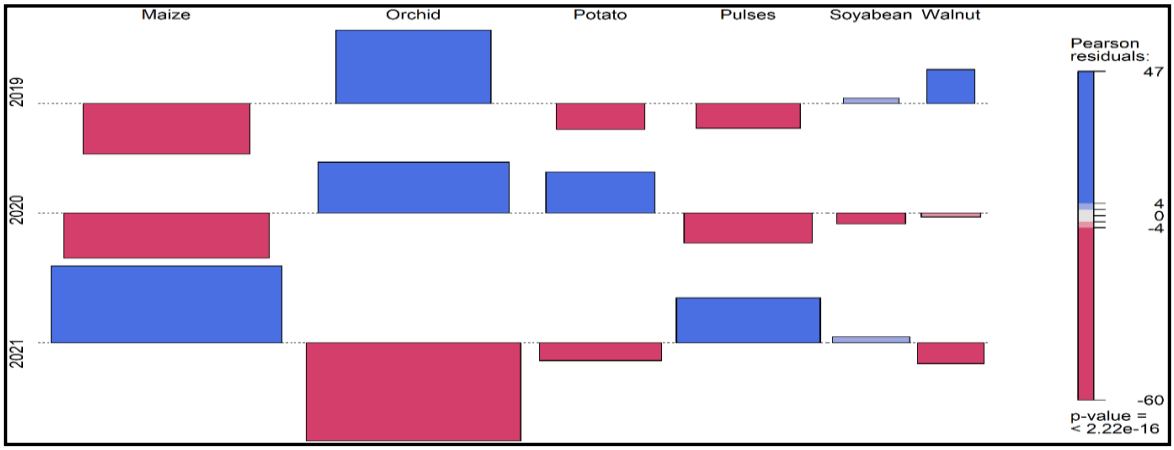

Figure 11. Results of Chi-square test for economic loss on crop plants among the studied years. The figure presents Pearson's residuals.

The linear regression analysis showed that both the total injuries and the injuries caused by bears increased in recent times (Figures 12a-b). However, this increase was statistically non-significant (Figures 12a-b). In contrast, the number of leopard-caused injuries showed a non-significant decrease in recent times (Figure 12c). With respect to the body part involved, there was an increase in the number of injuries for all the studied injury types except injury type with time (i.e., year) except for arm injuries which showed a decrease with time. However, the observed relationship was statistically significant in the case of abdominal injuries only (Figure 13). Further, a positive increase in the economic loss for maize, potato, pulse, and soya bean was observed with time (year), while a decrease in the economic loss was seen in the case of orchard and walnut. However, the observed relationships were statistically non-significant in all the cases (Figure 14). Also, a statistically significant negative relationship was found between the distance from the wildlife sanctuary and the total number of

injuries by wild animals, thereby indicating a decrease in the number of injuries with increasing distance (Figure 15).

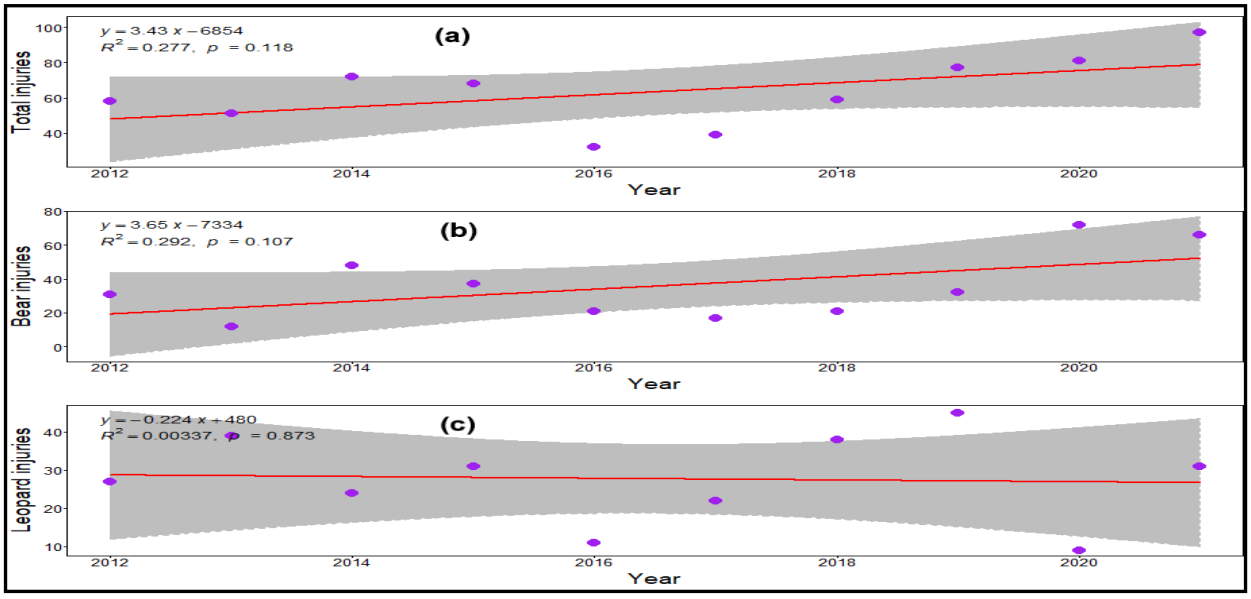

Figure 12. The linear relationship between the study year and (a) the total number of injuries, (b) bear-caused injuries, and (c) leopard-caused injuries. The solid red line represents the best fit line, the shaded grey area 95% confidence intervals, and **the** purple dots the observations.

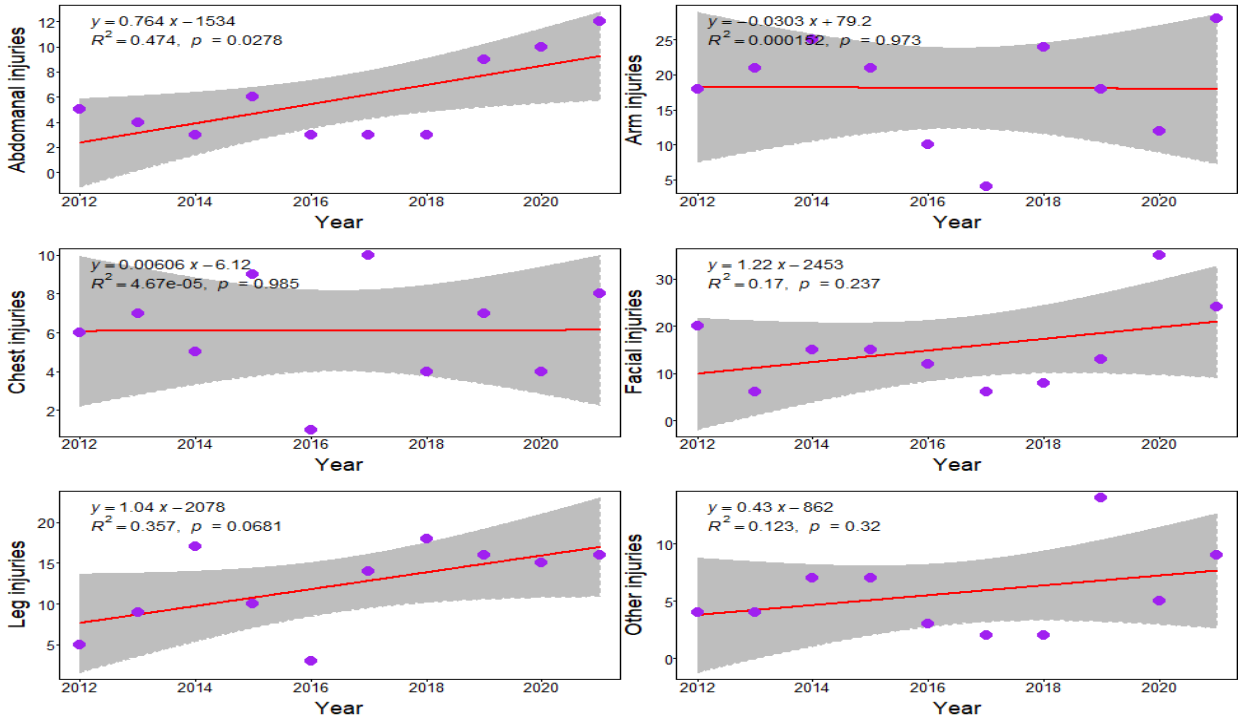

Figure 13. The linear relationship between the study year and injuries of (a) abdomen, (b) arm, (c) chest, (d) face, (e) leg, and (f) other parts.

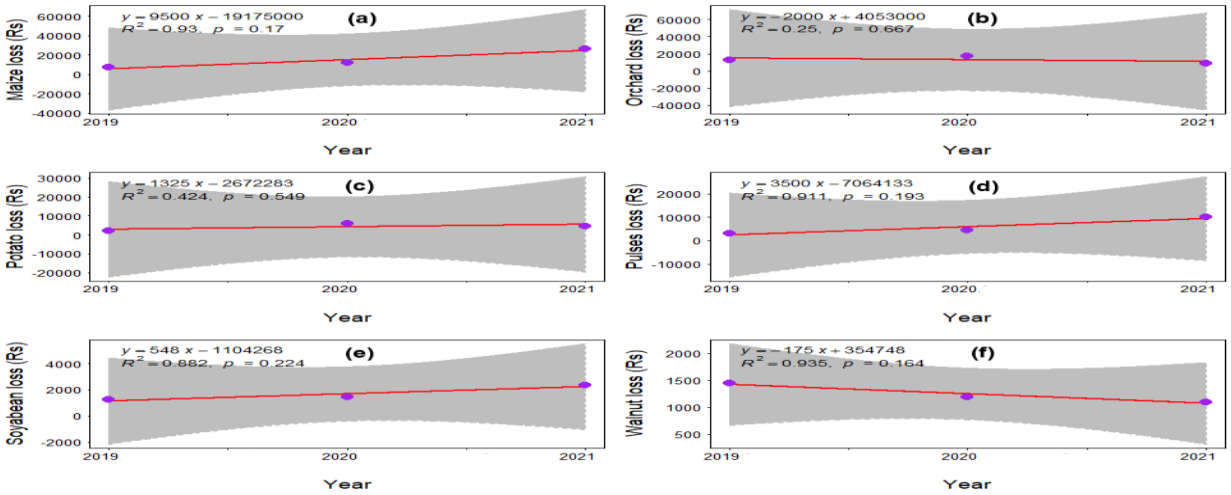

Figure 14: Linear relationship between the study year and economic loss for (a) maize, (b) orchard, (c) potato, (d) pulses, (e) soya bean and (f) walnut.

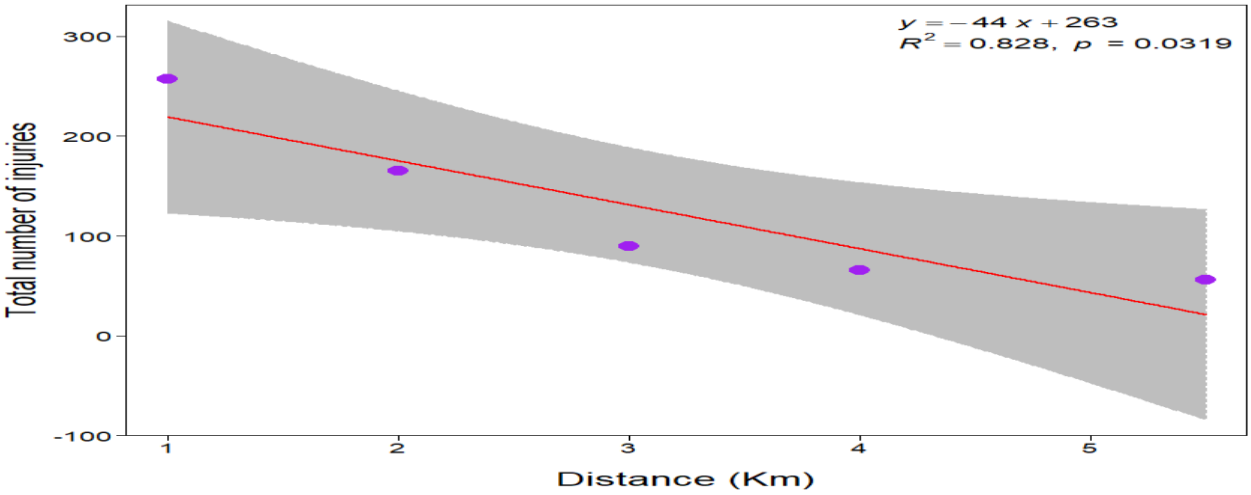

Figure 15. The linear relationship between the distance from the wildlife sanctuary and the total number of injuries by wild animals. The solid red line represents the best fit line, the shaded grey area 95% confidence intervals, and the purple dots the observations.

Discussion

Based on our study, we find a significant increase in the number of attacks over the past decade, probably due to a combination of factors, including population growth and expulsions within the study area, resulting in more habitat overlap. Additionally, there is likely to be an increase in encounters due to the widespread engagement of people in recreational activities in bear habitats. The study indicated that the risk of aggressive wild encounters is very high around the fringe areas of Hirpora Wildlife Sanctuary. Similar relationships have been found in the studies of Sloth Bear in India (Sharp *et al.*, 2017). The majority of the injuries observed in the study were Asiatic bear driven followed by the leopard. The study found that bear maul injuries accounted for 56 % of injuries, followed by

leopard injuries at 43 %. The results are in conformity with the study of Charoo *et al.,* 2011. The results are in line with the results reported in a study by Nabi *et al.,* 2009. In their study bear was recorded as the most common wild animal attacking men followed by tiger and wolf. The majority of the injured persons were adult males with an average age of 31-55 and a smaller number were females between 19-30 years of age.in accordance with this view, the varying ages of the attacked people reflect the main human activities (Bombieri *et al.*, 2019). Similarly, Smith and Herrero (2018) found that adult males were more likely to be attacked by bears in Alaska (83%). They were more likely to be hiking or hunting than women. The majority of the human-wildlife incidents occurred in the summer months followed by autumn. In summer and autumn, the high number of incidents can be attributed to the fact that more people were working in agricultural fields and orchards, or returning from work, during these times. As people live close to park areas, they are at a higher risk of interfacing with carnivores, which could lead to human attacks or wildlife deaths. Most human-wild encounters in our study area were reported within a range of one kilometer from the forest edge. Villages farther from the forest boundary reported fewer conflicts, indicating a spatial clustering of crop damage incidents in our study area. The same findings have been reported in similar studies elsewhere in the world (Woodroffe et al. 2005, Yigrem et al. 2016, Prater, S.H. 1980).

In terms of crop-raiding incidents, maize was found to be the most raided crop and was raided often during the harvesting season followed by orchids. The fringe areas of Hirpora Wildlife Sanctuary were ravaged by wild animals in almost every case. With the current agricultural practices changing from low crops to orchards adjacent to these extensive wildlife habitats (Choudhury *et al.,* 2008) farmers are experiencing increased crop damage, leading to high economic losses. A higher rate of raiding was observed on crops closer to the sanctuary, similar to others near protected areas such as Serengeti National Park, Tanzania (Mwakatobe *et al.,* 2014) and Tadoba-Andhari Tiger Reserve, India (Bayani *et al.,* 2016). In addition, other researchers also noted an increase in conflict in areas close to national parks (Barnes *et al.,* 2005; Sam *et al.,* 2005). According to a study conducted in Rwandan Forest Fragment, wild animals raided maize, potato, beans, cabbage, sweet potatoes, and tomatoes (MC Guinness and Taylor, 2014).

The present study documented a total number of 96 livestock depredation cases in and around the sanctuary. A majority of the cases occurred in 2020, followed by 2021. The size of the prey and the predator was observed to be highly correlated. Sheep were subject to more attacks by bears whereas poultry was targeted by leopards. Our results correlate with the studies of Sharma (1991), and

Studsrød and Wegge (1995). During the summer months, livestock predation in Hirpora Wildlife Sanctuary are most common. Previous studies have also reported the same results (Dar *et al.*, 2009). Depredation was prevalent throughout the study period but peaked in early summer (June-August). Predator attacks peak during the summer, as livestock graze the forest and pasture for a long period (Sangay and Vernes, 2008). Most of the livestock predation was recorded within a range of 1km from the sanctuary. Miller *et al.* (2016) also found that the closer a village is to a forest, the greater the likelihood of conflict. Bears were recorded to be the most serious livestock predator in the current study, followed by leopards. However, human-carnivore conflict studies were conducted in Bhutan (Wang and Macdonald, 2006; Sangay and Vernes 2008), Pakistan (Dar *et al.*, 2009), and India (Chauhan, 2008) have reported leopards are the main livestock predators in mountainous regions.

Conclusion

Human-wildlife conflict in Hirpora wildlife sanctuary has changed unusually over the last thirty years. The study found that most of the black bear attacks were recorded during the year 2018-2019 while as highest leopard injuries were observed during 2012-2013. The results showed that majority of the victims encountered chest and leg injuries followed by facial injuries. In the case of human attacks studies, male victims belonging to the age group 56-75 were highly over-represented as compared to females. Results showed that crop-raiding by wild animals occurred throughout the year, with most of the crop-raiding reported in 2021 followed by 2019. Maximum attacks within a distance of 1km from the forest were recorded during the study period. The number of conflict cases showed a decreasing trend with increasing distance from forests. Most livestock depredations occurred outside the wildlife sanctuary in agricultural and horticultural zones. Bears were found to be the most common predators, followed by leopards.

As a result of human activities like deforestation and habitat degradation, man has forced wild animals to divert to human habituation. Contact with man has given the wild animals an opportunity to raid their fields and orchids. Consequently, there is an increase in human casualties and extensive damage to agricultural and horticulture crops. These studies conclude that the more time people spend in the forest, the more are they vulnerable to conflicts. In order to reduce the conflict, we propose educating local residents to make them aware that while they are alone in farmlands and forests during summer and forests during summer and autumn, they are more likely to be attacked by wildlife; people can prevent wildlife attacks by providing safe paths for wild animals to escape. In addition to this, we recommend burning red chilies in cow dung, a traditional method used by many villages on the

periphery of Dachigam National Park. Wild animals were prevented from entering agricultural fields using this traditional method.

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References

Ahmad, K, Akhtar, N. and Chauhan N.P.S. (2012) Black bear menace, intolerant attitude of people and mitigation strategies in Kashmir valley, India. Proceedings of the 21st International Conference on Bear Research and Management, December 2012, New Delhi.

Ahmad, F., ul Hassan, Z., Farooq, S., & Shah, J. A. (2015). Assessment of land use/land cover change in Hirpora Wildlife Sanctuary, Kashmir. Asian Journal of Earth Sciences, 8(3), 64.

Banerjee K., Jhala Y.V., Chauhan K.S. and Dave C.V. (2013). Living with Lions: The economics of coexistence in the Gir forests, India. PLoS ONE, 8(1): 1–11.

Barnes RFW, Hema EM, Nandjui A, Manford M, Dubiure UF, Danquah E, Boafo Y (2005). Risk of crop raiding elephants around the Kakum Conservation Area, Ghana. Pachyderm 39: 19–25.

Bayani, A., Tiwade, D., Dongre, A., Dongre, A. P., Phatak, R., & Watve, M. (2016). Assessment of crop damage by protected wild mammalian herbivores on the western boundary of Tadoba-Andhari Tiger Reserve (TATR), Central India. PloS one, 11(4), e0153854.fw.

Bombieri, G., Naves, J., Penteriani, V., Selva, N., Fernández-Gil, A., López-Bao, J. V. & Delgado, M. M. (2019). Brown bear attacks on humans: a worldwide perspective. Scientific reports, 9(1), 1-10

Charoo, S. A., Sharma, L. K., & Sathyakumar, S. (2011). Asiatic black bear–human interactions around Dachigam National Park, Kashmir, India. Ursus, 22(2), 106-113.

Chauhan, D. S. (2008). Status and ecology of leopard (Panthera pardus) in relation to prey abundance, land use patterns and conflicts with human in Garhwal Himalayas. Ph. D. Thesis, Forest Research Institute University, India.

Choudhury, S., M. Ali, T. Mudashir, N.S. Ahmad, M.N. Sofi, I. Mughal, U.J. Sharma, A.K. Srivastava, and R. Kaul. (2008). Predator alert - Attacks on humans by leopards and Asiatic black bear in the Kashmir valley - Analysis of case studies and spatial patterns of elevated conflict. Wildlife Trust of India, New Delhi, India

Conover, M. R. (2002). Resolving human–wildlife conflicts: the science of wildlife damage management. Lewis Publishers, Boca Raton, Florida, USA.

Dar, N. I., Minhas, R. A., Zaman, Q., & Linkie, M. (2009). Predicting the patterns, perceptions and causes of human–carnivore conflict in and around Machiara National Park, Pakistan. Biological Conservation, 142(10), 2076-2082.

Daszak P., Cunningham A.A. and Hyatt A.D. (2000). Emerging infectious diseases of wildlife-threats to biodiversity and human health. Science, 287(5452): 443-449.

Decker, D. J., Lauber, T. B., & Siemer, W. F. (2002). Human-wildlife conflict management.

Hoffman, T. S., & O'Riain, M. J. (2011). The spatial ecology of chacma baboons (Papio ursinus) in a human-modified environment. International Journal of Primatology, 32(2), 308-328.

Jadhav, S. and Barua, M. (2012). The elephant vanishes: Impact of human-elephant conflict on people's wellbeing. Health and Place, 18(6): 1356-1365.

Karanth, K.K., Gopalaswamy, A.M., Defries,, R. and Ballal N. (2012). Assessing patterns of human-wildlife conflicts and compensation around a central Indian protected area. PLoS ONE, 7(12):e50433

Löe, J. and Röskaf, E. (2004). Large carnivores and human safety: A review. AMBIO: A J. the Human Environment, 33(6): 283-288.

Mc Guinness, S., & Taylor, D. (2014). Farmers' perceptions and actions to decrease crop raiding by forest-dwelling primates around a Rwandan forest fragment. Human Dimensions of Wildlife, 19(2), 179-190.

Mei, W., and Yu, G. (2020). basicTrendline: Add Trendline and Confidence Interval of Basic Regression Models to Plot. R package version 2.0.5. https://CRAN.R-project.org/package=basicTrendline

Messmer, T. A. (2000). The emergence of human–wildlife conflict management: turning challenges into opportunities. International Biodeterioration & Biodegradation, 45(3-4), 97-102.

Meyer, D., Zeileis, A., and Hornik, K. (2020). vcd: Visualizing Categorical Data. R package version 1.4-8. https://CRAN.R-project.org/package=vcd

Miller, J. R., Y. V. Jhala, and J. Jena (2016). Livestock losses and hotspots of attack from tigers and leopards in Kanha Tiger Reserve, central India. Regional Environmental Change 16:17–29.

Mohammadi, A., Lunnon, C., Moll, R. J., Tan, C. K. W., Hobeali, K., Behnoud, P., ... & Farhadinia, M. S. (2021). Contrasting responses of large carnivores to land use management across an Asian montane landscape in Iran. Biodiversity and Conservation, 30(13), 4023-4037.

Mohammadi, A., Almasieh, K., Wan, H. Y., Nayeri, D., Alambeigi, A., Ransom, J. I., & Cushman, S. A. (2021). Integrating spatial analysis and questionnaire survey to better understand human-onager conflict in Southern Iran. Scientific reports, 11(1), 1-12.

Mohammadi, A., Alambeigi, A., López-Bao, J. V., Taghavi, L., & Kaboli, M. (2022). Living with wolves: Lessons learned from Iran. Conservation Science and Practice, 4(5), e12667.

Mwakatobe, A., Nyahongo, J., Ntalwila, J., & Roskaft, E. (2014). The impact of crop raiding by wild animals in communities surrounding the Serengeti National Park, Tanzania. International journal of biodiversity and conservation, 6(9), 637-646.

Nabi, D. G., Tak, S. R., Kangoo, K. A., & Halwai, M. A. (2009). Increasing incidence of injuries and fatalities inflicted by wild animals in Kashmir. Injury, 40(1), 87-89.

Packer C., Ikanda, D., Kissui, B. and Kushnir, H. (2005). Conservation biology: lion attacks on humans in Tanzania. Nature, 436(7053): 927–928.

Perez E. and Pacheco L.F. (2006). Damage by large mammals to subsistence crops within a protected area in a montane forest of Bolivia. Crop Protect, 25(9): 933–939.

Pimentel D., Zuniga R. and Morrison D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological economics, 52(3): 273–288.

Prater, S.H. (1980). The book of Indian animals. Bombay Natural History Society and Oxford University Press, Bombay, India.

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

Sam, M.K., Danquah, E., Oppong, S.K., Ashie, E.A. (2005). Nature and extent of human-elephant conflict in Bia Conservation Area, Ghana. Pachyderm 38: 49-58.

Sangay, T., & Vernes, K. (2008). Human–wildlife conflict in the Kingdom of Bhutan: patterns of livestock predation by large mammalian carnivores. Biological Conservation, 141(5), 1272-1282.

Sethy, J., & Chauhan, N. S. (2013). Human-Sun Bears Conflict in Mizoram, North East India: Impact and Conservation Management. International Journal of Conservation Science, 4(3).

Sharma, U. R. (1991). A study of park–people interaction in Royal Chitwan National Park, Nepal. Ph. D. Thesis, University of Arizona, USA.

Sharp, T., Swaminathan, S., Arun, A., Smith, T., Satyanarayan, K., & Seshamani, G. (2017). Sloth bear attack behavior and a behavioral approach to safety. Final report to International Association for Bear Research and Management.

Singh B.B. and Gajadhar A.A. (2014). Role of India's wildlife in the emergence and re-emergence of zoonotic pathogens, risk factors and public health implications. ActaTropica, 138: 67-77.

Smith, T. S., & Herrero, S. (2018). Human–bear conflict in Alaska: 1880–2015. Wildlife Society Bulletin, 42(2), 254-263.

Studsrod, J. E. and P. Wegge. (1995). Park- people relationship: The case of damage caused by park animals around the Royal Bardia National Park, Nepal. Environmental Conservation 22(2): 133- 142.

Thirgood, S., Woodroffe, R., & Rabinowitz, A. (2005). The impact of human-wildlife conflict on human lives and livelihoods. Conservation Biology Series-Cambridge-, 9, 13.

Treves, A., & Santiago-Ávila, F. J. (2020). Myths and assumptions about human-wildlife conflict and coexistence. Conservation Biology, 34(4), 811-818.).

Wang, S.W., Macdonald, D.W. (2006). Livestock predation by carnivores in Jigme Singye Wangchuck National Park, Bhutan. Biol. Conserv. 129, 558–565.

Woodroffe, R., S. Thirgood, and A. Rabinowitz. (2005). People and wildlife: conflict or coexis1tence? Conservation Biology 34:497–500.

WWF (2005). Human-wildlife conflict manual. Wildlife Management series. WWF-World Wide Fund for Nature, Southern African Regional Programme Office (SAPRO).

Yigrem, K., T. Wendimagegnehu, and M. Hailu. (2016). Human–herbivore conflict in Sodo community-managed conservation forest, Wolaita Sodo Zuriya district, southern Ethiopia. Journal of Culture, Society and Development 18:7–16.