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Spatio-temporal Pattern of Human Wildlife Conflict in Saiful Mulook National Park and its Vicinity

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ABSTRACT

Human–carnivore conflict is frequently defined as a clash that is the result of interaction among community and wildlife or events by humans or wildlife that has an unpleasant outcome on both. Intimidation caused by carnivore towards injuries to individual, financial defense, damages to crops is increasing or the opinion that wildlife causes threats to human safety, health, food, and property. The current study was conducted from June to November, 2018, at Saiful Mulook National Park Khyber Pakhtunkhwa, Pakistan. For this purpose, 22 villages were selected in and around the park where the population of the wildlife was high. For the study purpose, questionnaire based survey and interview were conducted. In the study area, 300 questionaire were distributed through which the opinion of the respondent was taken by asking 13 different questions like crop damage, livestock depredation, season and months of damage, and people attributes towards the wildlife, etc. The domestic animals killed by the wildlife in the study area were the goats and sheep, (38.98%). The rate of depredation of livestock has been recorded to increase in the early summer season (60%), spring (15%), followed by winter (12%), and autumn is less (13%). Wildlife damage maize crop and majorly attack on the area of crops which are close to the forest in summer.

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KS carried out research work, collected data and organized into a meaningful manuscript under the supervision of MFK and MNA. RAK, SM and NA reviewed the manuscript and helped in table's preparation. ZU prepared the final version of the manuscript and organized all the tables and figures.

Key words
Spatio-temporal pattern, Human-wildlife conflict, National park

INTRODUCTION

Humans and wildlife individuals utilize similar resources which causes close interaction among them. Food resources are the primary and general basis of such conflicts (Charoo *et al*., 2011). Human-wildlife conflict is a defining experience of human subsistence. Their connections result occurs either positively or negatively. For habitat human beings encompass compete with other species, for foodstuff, space, resources to complete their needs for survival on the planet and to become the dominant ecological force (Waters *et al*., 2016; Ullah *et al*., 2021).

Attacks on humans and property damage by wildlife and consequent persecution of wildlife in revenge are commonly referred to as human-wildlife conflict (Redpath *et al*., 2015; Peterson *et al*., 2010). This is a frequent phenomenon especially in the fringe of protected areas and forests (Pant *et al*., 2016; Silwal *et al*., 2017). Prevention or modification of such negative interaction is challenging when multiple endangered species of conservation significance are involved (Acharya *et al*., 2016).

Conflict reduces local tolerance towards carnivores, their conservation and also conservation of other non-conflict species. Furthermore, local people often incorrectly identify culprits that cause most losses to their livelihoods and underplay the role of other threats to their livestock, such as disease (Naughton-Treves, 1998). Increase in human population expansion and related economic activities are risk factor for changing the planet. Increase in population of human being result in shortage of resources and like today the Earth's inhabitants be currently further built-up that rural as not in past time. At limited along with provincial scale, association involving individual inhabitant's size and animals clash is not as much of noticeable (Woodroffe, 2000; Waseem *et al*.,

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2020; Karawita *et al*., 2020; Khatiwada *et al*., 2020; Ullah *et al*., 2021).

Large carnivore populations are declining globally under the pressure of habitat degradation, hunting, disease, and the commercial trade of body parts. Due to the unavailability of food, the carnivore attack the livestock and get food as a result people killed the wildlife (Sillero-Zubiri and Laurenson, 2001; Ullah *et al*., 2021). Thousands of goats and sheep graze in the park in summer influence the natural habitat of carnivores as a result the carnivores attack the livestock of the people. The main aim of the study is to find the view of people about the carnivore and the socio-economic and biological conditions of the study area and suggestions to prevent the loss to the wildlife and natural ecosystem.

The present study aimed at investigating the human-wildlife interactions in and around Saiful Mulook National Park and assessing people's perception of human-wildlife conflicts and interactions in the study area.

MATERIALS AND METHODS

Study area

The Saiful Mulook National Park 34° 52 North, 073° 41 East located in Narran valley covering 4,687 ha area in district Mansehra, Khyber Pakhtunkhwa (Fig. 1). The villages around the National park are Manor Gali, Manor top, Jabri, Richbella, Piran Gali, Naran Batala. The people who depend upon SMNP for earning money in different field are belonging to various villages (Phagal Mhandri, Manor Gali, Batalah, Nerra Bella, Soach) also faces the problems from the wildlife like the killing of Live-stock and crop damages.

Materials

The material used during the study were GPS, binocular, DSLR camera, pen, datasheets, questionnaire, clipboard, GIS map of SMNP and hiking stick.

Questionnaire

To assess the human-carnivore conflict in and around SMNP, to carry out a questionnaire survey in 10 villages having a population of 300 individuals including 50% men 50% women of different ages (Ullah *et al*., 2021). These are 10 villages with a population of 1000 individuals the respondents ask to abound the direct sightings; indirect (sign left by animals on carcass). Question asked on the number and type of livestock killed; village (inside or outside house day, night, time, date, etc.).

Sign survey

Investigation of carnivores signs in Saiful mulook national park was conducted and divide the area into 25 grids (2x2km) using GIS map (Fig. 1) within grid randomly selected 10 survey plot of 50m radii were searched and find signs left by animals and conducted these survey from (July-November 2018) in search of direct and indirect signs, claw marks, scats, tracks left by an animal on the substratum. Observation also includes the dead animals, preyed animals, and takes the reading of place by using GPS (Hackett, 2008; Suwal *et al*., 2020; Ullah *et al*., 2020).

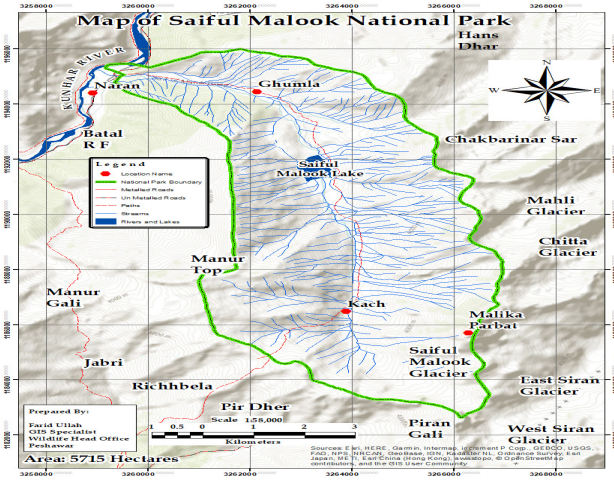

Fig. 1. Map of Saiful Mulook National Park.

RESULTS

Types of livestock killed

In the villages in and around the SMNP questionnaire survey was conducted from June to November 2018 and record was made of the livestock killed by carnivores in different villages (Table I).

The domesticated animals killed by carnivores include goats, sheep, cattle's and others (dog, hen, donkey and horse). The total number of livestock killed in Soach village was recorded highest n=10 in which n=6 were goats and n=4 were others. The percentage of the total killing of domesticated animals in the study area is calculated and estimated. After analyzing the data obtained by the questionnaire, we can state that human-wildlife conflict is increasing with time due to the degradation of habitat. In and around the park area the carnivores are thought to be responsible for killing the livestock which includes black bear (40%), snow leopard (20%), brown bear (10%), wolf (20%). Whereas for the crop damages only black bears were regarded as a major threat (60%) and mostly damages were recorded at night (Table I). Major threats to carnivores in and around the SMNP are habitat loss, tourism, and hunting. Due to these factors an estimated population of

Table I. Livestock killed and crop damaged by carnivores in different villages during June to November 2018.

Villages	Livestock killed					Crop damaged			
	Goat	Sheep	Cattle	Other	Total	Maize	Pea	Bean	Number of damages (%)
Soach	6	0	0	4	10	4	0	5	13.04
Manur gali	0	4	0	3	7	3	3	0	8.69
Batalah	0	2	0	4	6	0	0	0	0
Nera bella	2	1	0	2	5	0	0	0	0
Phagal	3	1	0	4	8	3	0	0	4.34
Manurhtiyan	1	1	2	0	4	0	0	0	0
Mandari Bella	2	0	0	0	2	4	0	0	5.79
Kach	0	2	0	4	6	3	0	5	11.59
Tahrian	0	0	0	0	0	2	3	0	7.24
Kohistan Abad	0	0	0	0	0	0	2	0	2.89
Pumara	2	0	0	0	2	0	4	0	7.24
Dhari	0	0	0	0	0	0	0	2	2.89
Ghumla	0	0	1	1	2	5	2	0	10.14
Baribasti	1	0	1	0	2	0	0	0	0
Jabba	0	0	0	0	0	6	0	0	8.69
Dharian	1	0	1	0	2	4	0	5	13.04
Choti deosi	1	0	1	1	3	0	0	3	4.34
Total	19	11	6	23	59	34	15	20	100
Percentage	32.2	18.64	10.16	38.98	100	49.2	21.73	28.98	

carnivores is less than 20% in and around the park. Inside the villages, most (89%) snow leopard killing occurred at night in winter, and 10% in the daytime during winter, and 20% in the daytime in summer.

Financial valuation of livestock losses/crop damages

The total financial loss arising from livestock deaths during the study period was estimated at Rs. 200,000. 60% of these financial losses were attributed to snow leopard attacks (19.8%), black bear 10% and other predators (4.0%), and accidents (3.5%), e.g., falling off from cliffs or paths. The financial loss due to crop damages is greater as compared to livestock killing. Black bear damages crops (60%). Local perception, attitude, and tolerance towards human-wildlife conflict i.e., n=148 respondents ranked Snow leopard as the most problematic predators that affected them (60.9%) followed by a black bear (20.1%) and wolf (10%), respectively. The majority (93%) of respondents thought that the frequency of snow leopard attacks on livestock had increased since the foundation of roads hotels and visiting of people from the other areas. They suggest that the Wildlife Department should take notice of the loss to wildlife by visitors and hunters in SMNP and its vicinity. The analysis of crop type damages in different villages and their estimated price was calculated. The most damaged crop types are maize, pea and bean and their average price in the local market are respectively 30, 150, and 100 in Pakistani rupees (Table I). In 22 villages the damage to the crops was highest in the Soach village and loss was recorded to the maize and bean is 13.04%. The second highest damage was recorded in Kach village in SMNP to the crop was 11.59% by animals in the nighttime. The wild animal responsible for damaging the crops inside the park are black bears, brown bears, marmot and wild goats (Table II).

The wild animals that were killed and captured include *Capra ibex, Canis lupus*, *Uncia uncia*, *Panthera tigirs*, *Ursus thibetanus*, in different villages mostly by local people. The evidence indicates that most of the wild animals kill in the National Park by a hunter and local people and they trap the young one of animals for selling. People also killed the wildlife as they destroy their crops and become a major threat to their life and livestock. The hunters in winter move to these areas and kill the wild goat and pheasants for meat and recreation. In 22 villages the highest wildlife killing is recorded in Manur Gali village with an elevation of 4598m in the location of N=34 45.885, E=073 42.809 (Table II).

Table II. The wild animals killed and captured in and around SMNP.

Village/site	Elevation meters (GPS location)	Animal killed/captured	Evidences provided by
Kach	3260 (N=34*50.52 E=073*42.08)	Marmot	Wildlife employee
	3270 (N=34*50.85 E=073*42.723)	Marmot	Local people
Ghumla	2957 (N=34*54.261, E=073*41.089)	*Capra ibex*	Wildlife employee
	3250 (N=34*54.28 E=073*41.52)	*Capra ibex*	Wildlife employee
	3252 (N=34*56.02 E=073*41.74)	Marmot	Local people
Manurgali	5680 (N=34*45.82 E=073*40.609)	*Capra ibex*	Shopkeeper
	4530 (N=34*46.02 E=073*40.82)	*Capra ibex*	Local people
	4598 (N=34*45.885 E=073*42.809)	Bear killed	Wildlife employee
Manurhteah	4359 (N=34*42.13 E=073*002)	*Capra ibex*	Nomads
Mhandri	5872 (N=34*61.02 E=073*27.820)	Cub of bear captured	Visitor guide
Mhandri Bella	4530 (N=34*12.34 E=073*23.53)	Bear killed	Shopkeeper
Phagal	3852 (N=34*20.10 E=073*08.110)	Squirrel killed	Local people
Nera Bella	3459 (N=34*42.566 E=073*1.132)	Snow leopard	Wildlife employee
	3442 (N=34*40.423 E=073*16.001)	Wolf	Local people
Chita glacier		Snow leopard dead in 2011	63-year old man

The percentages of livestock killed by the predator in and around the park in the previous five years include goat, sheep, cattle's and other domesticated animals. The number of livestock predation was greater in 2014 and 2017 (Fig. 2). The predators mostly attack the goats and sheep as these graze in the pastures during the summer season.

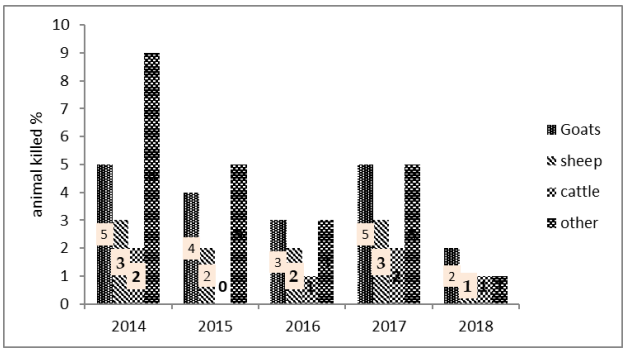

Fig. 2. Year wise killing of animals in the study area.

Temporal pattern of the killing of livestock by wildlife

Attack of carnivores on live stocks annually depends upon the season and place (Fig. 3). In winter the people move toward the lower region along with their live stocks and chances of conflict decreases but the large carnivore also migrate to a lower elevation due to heavy snowfall and in search of food, as a result, the predation of animals occur inside the villages.

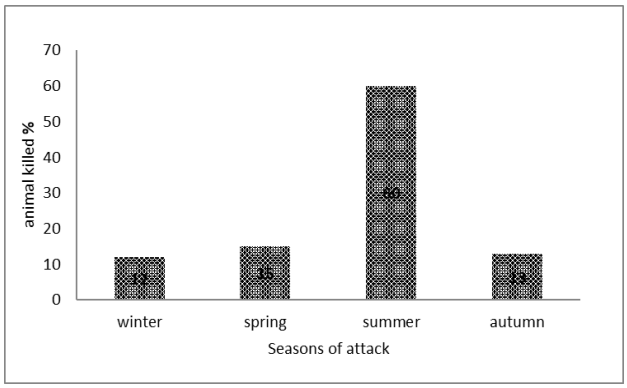

Fig. 3. Season-wise attack of carnivores on the livestock.

Livestock predation is greater in summer (60%) followed by spring (15%), winter (12%), and autumn (13%). However, the difference in livestock predation pattern depends upon the season that in summer people took their livestock to the pastures for grazing and the attack of carnivores is greater on animals. In winter the people move along with livestock to lower elevation due to harsh environment the predation losses are reduced, in autumn livestock is kept in pasture nearest the villages and the chances for livestock losses is decreased.

Therefore, the rate of livestock killing is influenced by seasonal livestock distribution patterns. But due to profound snowfall in winter, the wild prey and snow leopard also move to lower elevation regions. This seasonal migration of wild prey and snow leopard cause livestock

predation in winter also.

Financial evaluation of the damage of crop by animals

Maize, pea and bean are the major crops in the study area black bear mostly affect the maize crop and brown bear affects the pea and bean at high elevation (Table III). The average price of maize in the local market in the study area per Kg is Rs=35 (0.29 $) and the price of pea is Rs=150 (1.25$) and the price of bean Rs=100(0.83).

Table III. Crop damaged by black bear and brown bear.

Village	Crops damage	Damage in kg*	Rs.
Ghumla	Maize	30	1050
Soach	Maize	50	1750
Manur Gali	Maize	40	1400
Batalah	Maize	0	0
Nera Bella	Maize	25	875
Phagal	Maize	35	1225
Manurhtiyan	Maize	50	1750
Total			**8050** (62.58 US$)
Kach	Bean	15	1500
Tahrian	Bean	10	1000
Kohistan Abad	Pea	13	1950
Pumara	Pea	17	2550
Dhari	Bean	20	2000
Ghumla	Bean	5	500
Baribasti	Bean	15	1500
Jabba	Pea	30	4500
Dharian	Pea	25	3750
Total			**19250** (147.132 US$)

* calculated @ Rs 30/kg for maize, Rs 100/kg for bean and Rs 150/kg for pea.

The number of damages of the maize crop was high at Soach village inside the SMNP volume of damage was (50kg) resulting in loss of (Rs=1750) (13.6$) total volume of damage of maize crop by a black bear was 230 kg total in Rs=8050 (62.58$) in the study area most of the damages occurred during the night in summer. The crop damage by the brown bear was pea and bean inside the national park the highest damage to pea in Dharian village (25kg) of (Rs=3750) (28.84) in late summer. The highest damage to beans occurs in Dhari village (20kg) (Rs=2000) (15.38$). The total damage to the pea and bean is 150 kg of price Rs=19250 (147.132$) inside SMNP in 2018.

In the study area where the wild animal cause damage to crops and killing of domesticated animal occurred their GPS location are recorded on GPS meter and map developed in GIS, the map shows four wild animals responsible for the killing of animals within the study area are Black bear and its location of conflict is marked by green color on a map while the conflict caused by snow leopard is marked by yellow circle and conflict of brown bear are marked by blue triangle where the red square on the map indicate the conflict caused by a wolf in the study area (Fig. 4). There is more killing happened by black bear and snow leopard in winter and closer to the area which is near to the forest.

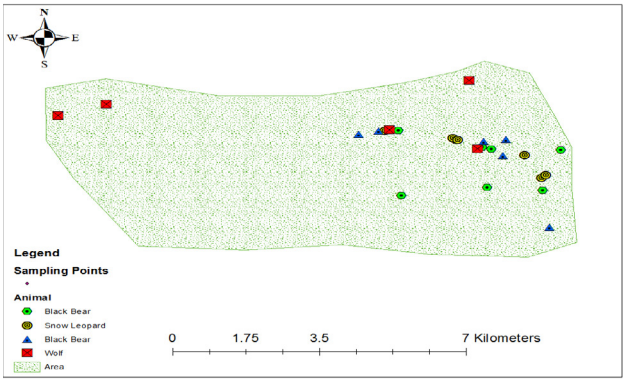

Fig. 4. Map showing the points of conflict with GPS location in the study area.

Sign surveys of different wild animals

During the sign survey in the field different wild animals sign were taken along with the GPS locations on the GPS meter and their elevations was recorded which clue for the presence of wildlife in the SMNP. For this purpose, 30 days survey was conducted with the local guide Mr. Farhan who was a Deputy Range Officer in the National Park, one of the experts for finding the location where the probability of getting a sign was maximum and also identify these signs. Before conducting the field survey, we searched the different sings of wild animals on the internet and find the key which distinguished shape from each other and concerned with co-supervisor how they look like and being differentiated from one another than we conducted the survey.

Different signs of a black bear were collected from the National Park and the selected villages of the study area they were including claw marks, pug marks, and feces (Table IV; Supplementary Fig. 1). Claw marks were found on the soil at the elevation of (2957m) at various locations which were recorded on a GPS meter.

Table IV. Sign survey of black bears, snow leopard, brown bears and wolves in the study area.

Village	GPS location	Elevation (m)	Sign type	Substratum	Date
Black bears					
Ghumla	N=3454.261 E=07341.08	2957	Pug mark	Soil	12/8/18
Ghumla	N=3454.261 E=07341.08	2957	Feces	Snow	12/10/18
Dheri	N=3452.892 E=07341.56	2997	claw mark	Soil	11/8/18
Kach	N=3450.852 E=07342.09	2978	Pug mark	Mud	09/8/18
Kach	N=3450.953 E=07340.02	2973	Feces	Rock	09/8/18
Soach	N=3419.208 E=0720.01	2873	claw mark	Soil	05/7/18
Soach	N=3417.208 E=0721.021	2829	claw mark	Soil	05/7/18
Soach	N=3419.204 E=0720.02	2834	Feces	Grass	04/7/18
Snow leopard					
Ghumla	N=3454.211 E=07341.089	2957	Claw mark	Mud	12/08/018
Ghumla	N=3454.882 E=07341.50	2972	Claw mark	Soil	12/08/018
Pumara	N=3450.260 E=07341.061	2819	Claw mark	Mud	17/08/018
Pumara	N=3451.305 E=07341.93	2854	Claw mark	Soil	17/08/018
Dheri	N=3450.892 E=07341.566	2913	Pug mark	Soil	19/07/018
Kach	N=3452.852 E=07342.072	2973	Claw mark	Snow	12/10/018
Soach	N=3419.206 E=07206.061	2892	Pug mark	Soil	08/08/018
Soach	N=3419.208 E=0725.021	2839	Claw mark	Soil	08/08/018
Tahrian	N=3452.690 E=07341.4	3162	Claw mark	Snow	28/10/018
Tahrian	N=3452.580 E=07341.9	3129	Claw mark	Snow	28/10/018
Brown bears					
Tahrian	N=3452.690 E=07341.9	3152	Claw mark	Snow	
Tahrian	N=3451.590 E=07341.8	3182	Pug mark	Snow	
Dharian	N=3452.431 E=07341.878	2952	Claw mark	Mud	
Ghumla	N=3454.261 E=07341.089	2957	Pug mark	Mud	
Kach	N=3450.852 E=07342.072	3181	Claw mark	Snow	
Wolves					
Kach	N=3452.490 E=07341.4	3158	Pug mark	Snow	
Kach	N=3452.580 E=07343.58	3173	Pug mark	Snow	
Pumara	N=3443.910 E=07342.85	3278	Pug mark	Soil	

While conducting the sign survey we also find the sign of snow leopard at high elevation and identify these signs by matching with the keys. These signs indicate the presence of snow leopard in winter at high elevation in the study area (Table IV). The sign left by animals includes claw marks, and pug mark, on soil and snow.

To investigate the presence of a brown bear in the study area was difficult but the sign recorded during the survey indicates the presence of a brown bear in the park although few signs were recorded due to harsh weather in the study area. Mostly the recorded sign of the animal was on snow as it is the start of winter and these signs are also present at high elevation.

Only at three places the sign of wolf was recorded (Table IV) and is difficult to identify because they resemble the jackal but the only difference is that they are larger and start in a direction as compared to other animals. The sign of animals is present on snow and they are closer to the side of the forest.

DISCUSSION

The possible sites of wildlife in the Saiful-mulook National Park and its surroundings were surveyed to

recognize concerning the human-wildlife interaction for the period of July-November 2018. The whole number of domestic animals kept by respondents in the study area was 5000 for a range of means. The total figures of goats in the national park were highest that is 2500 their percentage is (50%) which is greater than other domestic animals. The total number of sheep was 1000 (20.22 %) cattle 1000 they being (20%) of the total. The percentage of other animals including horses and donkeys is fewer n=500 form (10%). To full fill, the deficiency of animal proteins carnivore attack on the domestic animal's total amount of damage (38% animals) are killed by carnivores in the study area. Charoo *et al*. (2011) revealed common leopards generally well-known for livestock killing which may happen inside the location of the cattle sheds or area surrounded by forest.

The present result reveals that several sheep (18%) and other animals (12%) are killed by snow leopards but they were less in number as compared to goats (32%), reason is that goats were in the farm of herds and easy to capture and kill. Chauhan (2003) reported Carnivore is well-known to hunt sheep in livestock sheds or pasture.

The black bear is more vigorous and kills farm animals following near the beginning of sunrise and behind dusk or when cattle move to their sheds after grazing at evening moment (Charoo *et al*. 2011). The present finding suggested that the killing of livestock happened at pastures, crepuscular time, and during the night when animals doing rest in the open places without any sheds in the field as compared to day time.

A recent finding reveals that mostly crop field's damage by wildlife is those which are near forest the fields which are far from the jungle faced fewer chances of degradation. The present study is supported by (Charoo *et al*. 2011) who reported the information about croplands nearby to the forest and far from villages accidentally attract wildlife due to the huge availability of food.

CONCLUSION

Lack of information regarding the existing status and detailed scientific research on wildlife is deficient which is necessary. In addition, presently no recent research is conducted for getting data about human-wildlife conflict by any association or division in the area. The recent work was conducted to know and record the information about the human-wildlife conflict using questioners to 300 respondents.

After surveying the study area, it confirms the presence of wildlife as conflicts between carnivores and peoples has occurred which resulted in the killing of livestock and rare attack on human and raiding of crops and their sign was also evidence of the presence of these animals in the study area. The other wildlife is killed by either hunters or by local people for recreation, joy, and for obtaining the meat. The hunters also move in harsh winter when snowfall start and they kill the valuable wildlife as the concern employ of wildlife department move to lower elevation area which provides the way to freedom to local peoples and hunter for the killing of wild goat (*Capra ibex*) for fun and their delicious meat.

Supplementary material

There is supplementary material associated with this article. Access the material online at: https://dx.doi.org/10.17582/journal.pjz/20211105221145

Statement of conflict of interest

The authors have declared no conflict of interest.

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