

Distribution Pattern of Grey Wolf (*Canis lupus*) and Human Dimensions of Wolf Conflicts in Marghuzar Valley, Tehsil Babozai, District Swat, Pakistan

Ahmad Ali¹, Muhammad Saad^{1*}, Sultan Muhammad^{1,3}, Tariq Ahmad², Moazzam Nizami¹, Mansoor Hayat^{3,4}, Hasham Ahmad⁵, Kaleem Mehmood^{3,6}, Nusrat Sattar⁷, Khuzin Dinislam⁸, and Muhammad Sadiq Khan³

¹Department of Forestry and Wildlife Management, University of Haripur, Haripur, Khyber Pakhtunkhwa, Pakistan

²College of Wildlife and Protected Area, Northeast Forestry University, Harbin 150040, China

³Institute of Forest Sciences, University of Swat, Main Campus, Charbagh, Khyber Pakhtunkhwa 19120, Pakistan

⁴Key Laboratory of Forest Pathology, School of Forestry, Northeast Forestry University, Harbin 150040, Heilongjiang, People's Republic of China

⁵School of Forestry, Northeast Forestry University, 150040 Harbin, Heilongjiang, China.

⁶College of Forestry, Beijing Forestry University, Beijing 100083, People's Republic of China

⁷Department of Zoology, Wildlife and Fisheries, University of Agriculture, Faisalabad, Pakistan

⁸Department of Chemistry, Bashkir State Medical University, Ufa, Republic of Bashkortostan, 450008, Russia.

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Authors' Contribution

AL, TA, SM, MS, HA, and MH designed the study. AL, KM, and MN Collected field data. TA, MH, NS, SM, and MG interpreted the results and wrote up the research article. TA, SM, KD and MS revised the draft. All of the authors read and approved the manuscript.

Key words

Grey wolf, Distribution, Human-wolf conflict, Marghazar valley, Swat

ABSTRACT

Grey wolf (*Canis lupus*) is distributed in various areas of Pakistan, particularly in the northern regions. The current study was conducted to determine their distribution and the extent of human-wolf conflict in the Marghuzar Valley of the Lower Swat district. Data were collected through an indirect sign survey at 13 sampling sites by observing scats, pugmarks, and dens. The data revealed the presence of the species in ten of the thirteen sampling sites, where a total of seven dens, 32 pugmarks, and 16 scats were also recorded. Additionally, the data also indicated that 12 goats, 14 sheep, 4 four donkeys, and 60 poultry were killed in the area leading to the retaliatory killings of the grey wolf. The highest economic loss was US\$ 1409.94 due to sheep. The lowest loss was US\$ 259.2 that of poultry. The study concluded that the Marghazar Valley is a significant habitat for the grey wolf and should be protected to mitigate the illegal killing of this species. The current study proposed long-term conservation strategies, including awareness and effective law enforcement in the area.

INTRODUCTION

Coyotes, *Canis latrans*, dogs, *Canis familiaris* or *Canis lupus familiaris*, fox, *Vulpes vulpes*, jackals, *Canis*

aureus, and wolf, *Canis lupus* belong to the family Canidae, including thirty-five species (Padilla and Hilton, 2015). The majority of the canids serve as predators, potentially occupying various roles within the food webs of their habitats (Abrams and Cortez, 2015). The grey wolf exhibits a wide distribution throughout Pakistan and comprises two distinct sub-species, the Indian wolf (*Canis lupus pallipes*) and the Tibetan or Himalayan wolf (*Canis lupus chanco*). The Indian wolf specializes in habitats such as plains, desert areas, and riverine forests (Mahajan et al., 2021). In contrast, the Himalayan or Tibetan wolf inhabits the alpine and robust mountains of the northern regions

* Corresponding author: msaad@uoh.edu.pk
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(Khattak, 2022). Wolf plays a critical role as apex predators in shaping ecological communities within the open dry forests of semi-arid landscapes. However, significant loss of habitat due to human population expansion and killing in retaliation to human-wolf conflict has led to a severe population decline across its distribution range (Mahajan *et al.*, 2021).

The grey wolf is categorized as the least concern worldwide according to the IUCN red list of threatened fauna and flora (IUCN, 2018). However, wolf as the endangered in Pakistan (Rehman *et al.*, 2021) and is among the largest species within the Canid family, inhabiting various parts of the country. Reports indicate a decline in the species population across its distribution range, yet information on its ecology in Pakistan is limited (Khan *et al.*, 2020). The species is widely distributed across Pakistan, with overlapping ranges in many areas, including the Hindu Kush Range (Shabbir *et al.*, 2013). The temperate forests of the Western Himalayas, are recognized as a hotspot for biodiversity which is a global priority for biodiversity conservation and protection, and provide habitat to various wildlife, including Wolf (Qamar *et al.*, 2011). The wolf has a broad habitat range, occupying almost all types of habitats. However, it is predominantly found in delicate, barren tracks of hilly regions, vast deserts, and plains, grasslands with low rainfall, scrublands, and pasture lands (Roberts, 1997; Shahi, 1983). The territory of wolf spans from 150 to 300 square kilometers, contingent upon the availability of prey and denning sites within their territory (Jhala, 2003; Habib and Kumar, 2007). The wolf has been eliminated from a significant portion of its historical range in Pakistan, because of depredation and its effect on human livelihood. The movement corridors indicate that the distribution range of the species has expanded in Pakistan's Northern Areas (Kabir *et al.*, 2017). The leading factor affecting the conservation efforts of the wolf at both local and global levels is the depredation of livestock driven by negative perceptions of the wolf (Khan *et al.*, 2019). Human-wildlife conflict, particularly in terrestrial systems, has received increased scientific and management attention (Guerra, 2019). Effectively managing human-wildlife conflict is crucial for the conservation of wildlife, particularly for large carnivores (Olson, 2015). Human-wildlife conflicts are becoming a major concern because they are expanding with time and cause wildlife depletion as well as economic losses to local communities (Ahmad *et al.*, 2023). To effectively manage these conflicts, it is essential to have a comprehensive understanding of locations prone to livestock depredation and the underlying factors that influence such incidents (Iqbal and Ilyas, 2023). Saad *et al.* (2015) identified that the primary dangers to carnivore species arise from the scarcity of prey in their natural habitats and the degradation of habitats due

to human activities. In developing nations, the significant economic burdens of human-wildlife conflicts, where the grey wolf plays a prominent role (Khattak *et al.*, 2022). Scientific studies focusing on the ecology of wolf are rare in the country. The wolf population has also been reported to decline more recently due to persecution, mainly in such a scenario, the main objective of the current research was intended to focus on *C. lupus* distribution, grey wolf habitat preference, and human-wolf conflict in the Marghazar Valley of Swat.

MATERIALS AND METHODS

Study area

The present study was carried out in the Marghazar valley of District Swat situated between 34.6678° N, and 72.3431° E with an elevation range of 1000 to 2800m (Fig. 1). The meteorological study indicates that the average temperature fluctuates annually, reaching up to 32.71°C in June and dropping to 1.32°C in January. The average precipitation from high to lowest value is 143.0mm in July and 20mm in November and December. The relative humidity is 82.58% in August and 54.41% in May. The fauna present in District Swat include Himalayan ibex (*Capra sibirica*), markhor (*Capra falconeri cashmiriensis*), Kashmir musk deer (*Moschus cupreus*), Himalayan brown bear (*Ursus arctos isabellinus*), snow leopard (*Panthera uncia*), Himalayan lynx (*Lynx lynx*), Himalayan palm civet (*Paguma larvata*), red fox (*Vulpes vulpes*), grey goral (*Naemorhedus goral*), and Himalayan weasel (*Mustela sibirica*). The floral types in the area are subtropical chir pine *Pinus roxburghii* forest, temperate, and alpine. The main vegetation includes chir pine *Cedrus deodara*, blue pine or kail *Pinus wallichiana*, *Abies pindrow*, spruce, *Picea smithiana*, ban oak *Quercus incana*, holly oak *Q. sempervirens*, Kao or Indian olive *Olea ferruginea* and walnut *Olea juglans regia* (Ahmad *et al.*, 2015).

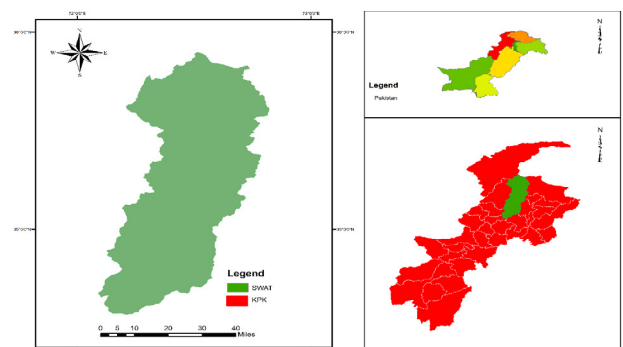


Fig. 1. Map of district Swat locating Marghazar valley.

Study design

The study was conducted from January 2019 to

January 2020. The distribution and presence of the wolf were assessed monthly using the indirect method of sign surveys (Saad *et al.*, 2015; Khan *et al.*, 2020). The signs included dens, scats, and pugmarks surveyed under the principle of transect methodology. Thirteen potential sampling sites were surveyed for data collection. The data survey were repeated for the summer season as well. Geographical coordinates of the positive sites were noted and were utilized to prepare a distribution map of the grey wolf. Similarly, habitat preference was carried out in the study areas with random sampling methods by selecting 7 sites. The quadrat method was used to obtain data on the vegetation structure identifying the plant species and the distribution of specific species in a sample plot. The area was split into 7 stands. In each of the stands, 8 quadrants were systematically placed. Plot size was 10 m x 10 m for the tree layer, 4 m x 4 m for all woody undergrowth to 3 m in height, and 1 m x 1 m for the herb layer (Schemnitz, 1980; Rahman *et al.*, 2024). The density, relative density, frequency, and relative frequency were determined using the following formula.

$$\text{Density} = \text{Total No. of Individual specie} \times \text{plot area} / \text{Total No. of plots sampled}$$

$$\text{Relative density} = \text{Density of species} \times 100 / \text{Total density}$$

$$\text{Frequency} = \text{No. of plots in which species occurs} / \text{Total no of plots sampled}$$

$$\text{Relative Frequency} = \text{Frequency value} \times 100 / \text{Total frequency value of all species}$$

In addition, a questionnaire-based survey was conducted to gather human-wildlife conflict of the grey wolf in the study area while for the distribution map, we used ArcGIS 10.8.2 version (Abbas *et al.*, 2013). During the study period, we completed 147 questionnaires and interviewed 130 people in the local community, including

100 males and 30 females, The ratio of males was more than females because in these areas males are more involved in outdoor activities rather than females. We interviewed elderly women age between 50 to 65 years old were. The participants were orally interviewed because most of the people in this valley are not literate and the data were collected informally in their local language Individuals were chosen based on their existing understanding of the occurrence of wildlife species overall, with a specific emphasis on the grey wolf. Most participants comprised herders, farmers, residents involved in various businesses, school/college teachers, and hunters from the study area. Respondents feedback was documented throughout the surveys using pre-designed questionnaires containing open-ended inquiries (Din *et al.*, 2013; Ahmad *et al.*, 2023).

RESULTS

Indirect signs of Indian grey wolf

We visited 13 sites to collect the indirect signs of the grey wolf from the study area, and 10 sampling sites showed positive signs of the grey wolf. During visits, we collected (55 indirect sign marks 16 scats, and 7 dens while the estimated number of wolves was 9. The total area surveyed was =28.33 km². The estimated density of the grey wolf was (D): $N/A=14/9=1.55$ individuals /km² (Table I). The grey wolf scats were mostly found on the roadsides whereas a moderate number of scats were also found on the tracks and trails, the pug marks of the species were observed in snow and mud along the riverbanks.

Table I. Details of indirect signs of the Indian grey wolf recorded in study area for determining the distribution of the species.

Place name	Lat N	Lon E	Alt	Distance traveled (km)	Dens (n)	Scats (n)	Pug marks (n)	Total signs (n)	Estimated no of wolves
Marghazar	34.667486°	72.343291°	1276m	2	1	3	2	6	1
Kuz Mitrapindo	34.656385°	72.360200°	1751m	1.5	2	2	5	9	2
Mitrapindo	34.651810°	72.362212°	1771m	1	0	1	4	5	0
Kaduno	34.652302°	72.350656°	1425m	1	1	0	1	2	1
Juzo	34.655969°	72.330512°	1923m	2	1	2	10	13	2
Elum Mountain	34.618121°	72.331931°	2737m	1	0	2	2	4	0
Bar Kaduno	34.630910°	72.339341°	2048m	0.5	0	3	2	5	1
Sarbab	34.639213°	72.314980°	1851m	1	1	2	1	4	1
Bar Kandao	34.640429°	72.350844°	1730m	0	0	0	0	0	0
Bar Tortami	34.721650°	72.365278°	1223m	2	1	0	3	4	0
Bakar	34.715769°	72.376089°	1246m	0	0	0	0	0	0
Nizam Mandav	34.705897°	72.369812°	1295m	0	0	0	0	0	0
Nawe Sar	34.708226°	72.385763°	1465m	2	0	1	2	3	1
Total				14	7	16	32	55	9

Probable individuals of grey wolf estimated (based on dens), 9 individuals. Total area surveyed=28.33 km² area. Estimated density of grey wolf (D): $N/A=14/9=1.55$ individuals /km².

GPS coordinates of the grey wolf observed were recorded ArcGIS 10.8.2 Version was used to map the distribution of grey (Fig. 2) grey wolf was distributed in most of the study area, with minor variations both in the summer and winter seasons (Fig. 3). The highest number of pug marks (n=10) existing at the sampling site Juzo followed by Kuz Mitrapindo (n=5). Thus, a total of 9 species were estimated.

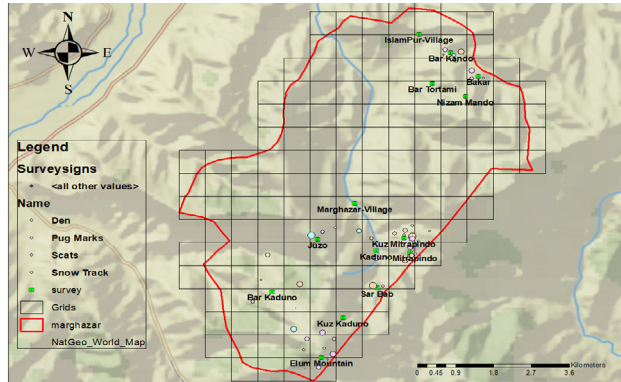


Fig. 2. Map showing indirect signs in the study area where signs are recorded.

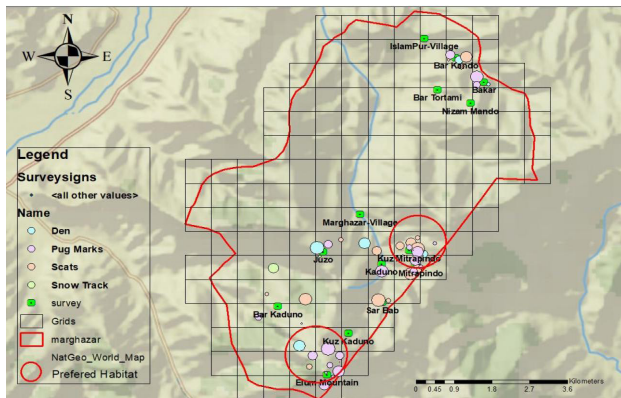


Fig. 3. The distribution map developed indicated that the grey wolf was distributed in most of the study area, both in summer and winter seasons with minor variation.

Tree species present in the preferred habitat of Grey wolf
A vegetative survey of the potential habitat areas was

done to identify the habitat preferences of grey wolves. In their preferred habitat, the dominant tree species were chir pine (relative cover 53.1% relative density 50.1), walnut (relative cover 28.4 % relative density 25.3%), ban oak (relative cover 17.1% relative density 15.4 %), and blue pine (relative cover 11.4 % relative density 9.2 %) (Table II, Fig. 4).

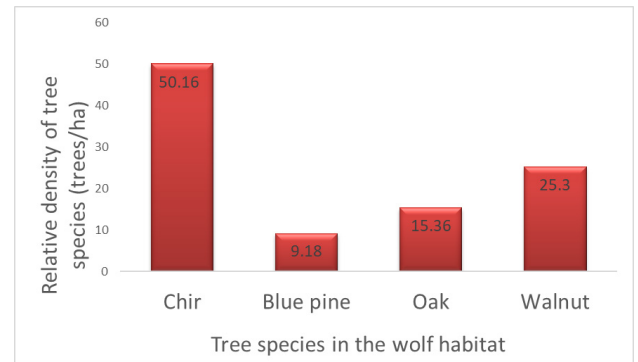


Fig. 4. The bar chart showing relative density of tree species in *Canis lupus* habitat in the study area.

Economic loss to the local community

The local community of Marghazar Valley of District Swat has to bear economic loss due to the attack of a grey wolf on domestic livestock and poultry. Based on the one-year data, the highest economic loss was for sheep, totaling US\$ 1,409.94. This was followed by goats with an economic loss of US\$ 1,079.00. donkeys incurred a loss of US\$ 317.24, and poultry experienced the smallest loss at US \$259.20 (Table II). The rest of the attacks have no such value but grey wolf have also been killed by the local community because they consider grey wolves as their enemy. The data regarding human-wildlife conflict revealed that the main predator attacking livestock was the grey wolf in the study area, (Table III). The factors responsible for the population decline include the lack of prey, population increase, military operations, and retaliatory killings resulting in human-wolf conflict (Table IV). We have also highlighted those areas where the conflict occurred during our study periods (Fig. 5).

Table II. Tree species in the preferred habitat of grey wolf in the study area.

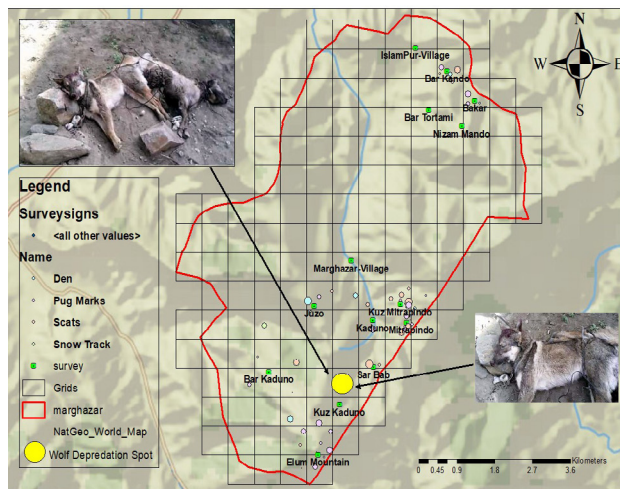
S. No	Common name	Botanical name	Relative cover (%)	Relative density (%)	Density of tree species per hectare
1.	Chir pine	<i>Pinus roxburghii</i>	53.1	50.1	$50.1 \times 1/0.03 = 1672/\text{ha}$
2.	Walnut	<i>Juglans regia</i>	18.4	25.3	$25.3 \times 1/0.03 = 843/\text{ha}$
3.	Oak	<i>Quercus Incana</i>	17.1	15.4	$15.4 \times 1/0.03 = 512/\text{ha}$
4.	Blue pine	<i>Pinus wallichiana</i>	11.4	9.2	$9.2 \times 1/0.03 = 306/\text{ha}$
			100	100	

Table III. Annual loss due to depredation in the number of livestock and domestic poultry in the study area.

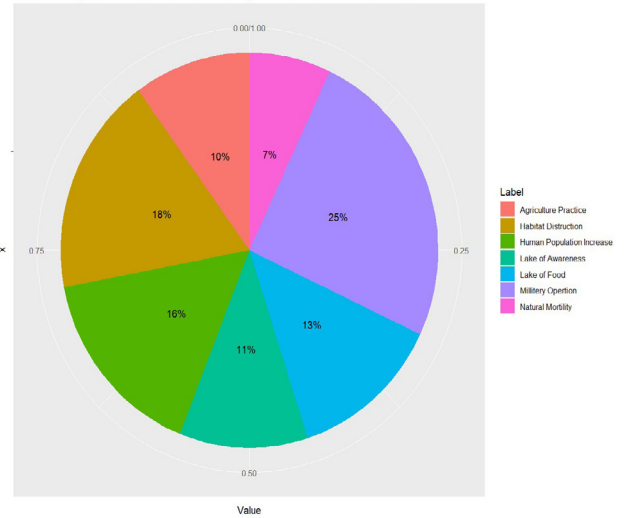
Prey species	Winter (n=20)	Summer (n=14)	Price in USD	Mean %	Total loss in USD
Goat	7	5	89.92	6	12 x 89.92= 1079
Sheep	9	5	100.71	7	14x 100.71= 1409.94
Donkeys	2	2	79.31	2	4x 79.31=317.24
Domestic poultry	38	22	4.32	30	60x = 259.2

Table IV. Factors responsible for the population decline of grey wolf.

S. No	Factors	Frequency
1	Lack of prey	1.3
2	Human wolf conflict	2
3	Human-population increase	2.8
4	Military operation	3.77

**Fig. 5. Map showing wolf killed by local people in Sarbab area.****Public perception about how to control the grey wolf and human-wildlife conflict**

According to the local community, habitat disturbance raised the conflict after the military operation. Results show 25% of military operations followed by habitat destruction (18 %), human population increase (16 %), lack of food (13 %), lack of awareness (11 %), agricultural practices (10 %), and natural mortality (7%) (Fig. 6).

Public Perception About How to Reduce Gray Wolf and Human Wildlife Conflict**Fig. 6. The percentage of different factors that can help to reduce the conflict.****DISCUSSION**

As noted by [Ahmad and Li \(2024\)](#) social media have a serious role in mammal conservation. Facebook currently has the most active users among all social network sites (>2 billion as of September 2017). The objective of the study was to explore the distribution, and analysis of tree species of its habitat and the human-wildlife conflict of grey wolf in Marghazar Valley Tehsil Babozai district Swat. During the study period from 2019 to 2020, the occurrence of dens, scats, and pug marks, of the grey wolf were used to estimate the population following the study conducted by [Saad et al. \(2015\)](#) and [Mahajan et al. \(2021\)](#). The grey wolf was distributed in most of the study area, with minor variations in the summer and winter. The study of [Khan et al. \(2020\)](#) has also revealed the occurrence of a range between 2332 m to 2926 m above mean sea level in the Mahodhand area of district Swat through an indirect survey of signs i.e., pugmark, dens, and scats. The result of the study conducted by [Kabir et al. \(2017\)](#) confirmed the occurrence of the species in Northern areas of Pakistan through movement corridors. In various regions, the species has been eradicated from much of its historical range in Pakistan, mainly due to its impact on livestock and human livelihoods. However, the movement corridors suggest its expansion in Northern areas of Pakistan. The dens of the species were found in steep areas under the boulders in the form of caves in mountainous areas which has also been reported by [Roberts \(1997\)](#). As per the findings of this study, the preferred habitat includes tree species such as chir pine walnut, and ban oak (*Quercus*

incana). Blue pine berberis (*Berberis lyceum*), was the dominant shrub species within these areas and was reported by Jhala (1993). However, these tree and shrub species are not characteristics of the habitat of the grey wolf because of its wide range of habitat from mountainous areas to alpine pastures where the vegetation structure may change (Khattak, 2022). Human-wildlife conflict is becoming more severe for the wolf species due to its wide home range as it was found to attack domestic animals in the study area. Livestock depredation, causing financial loss, may result in the retaliatory killing of endangered predators, as reported by Khan *et al.* (2018). The same fact has also been reported by (Haidar *et al.*, 2023) that grey wolf preying on livestock, leads to a significant conflict between farmers and wildlife in numerous regions worldwide depredation is maximum in the summer season. As per the study by Guerra (2019), there has been a growing scientific and management focus on human-wildlife conflict. The data regarding human-wildlife conflict revealed that grey wolf is the main predator attacking livestock including goats, sheep, and donkeys. As stated by Plumer *et al.* (2018), the grey wolf is frequently accused of preying on sheep and other livestock, resulting in significant and enduring conflicts between farmers and wildlife. These conflicts contribute to negative public perceptions and pose challenges for the conservation of large carnivores. Having a grasp of typical conflict patterns can help formulate management strategies, including decisions on whether to implement lethal or non-lethal controls (Olson *et al.*, 2015). According to Ismaili *et al.* (2024), building ecological corridors for the long-term survival, growth, and migration of adult snow leopard populations in the area is crucial, and it must be done as soon as possible to properly comprehend and manage the factors impacting the selection of snow leopard habitat so our study also suggests that grey wolf also needed ecological corridors. Besides that, since 2008, the distribution of grey wolf in the study area has also been found to be affected by military operations against terrorism. The co-existence of grey wolf in the human area needs clear protection action to be taken for the grey wolf, as well as local people's awareness of wolf conservation, infrastructural construction such as fences, and proper livestock protection.

CONCLUSION

The current study highlights the ecological significance of *Canis lupus* in the diverse and rugged terrains of the Marghuzar region in Lower Swat. Despite its importance, the distribution and intricacies of human-wildlife conflict surrounding this species remain largely unexamined. This research contributes to bridging that

knowledge gap by confirming the presence of *C. lupus* through indirect surveys, including the identification of dens, pug marks, and scats. Our findings indicate that *C. lupus* is involved in livestock depredation, which has fostered a negative perception among local communities. This conflict, compounded by a decrease in natural prey availability and ongoing habitat loss, poses a significant threat to the species' population stability. Consequently, we recommend the implementation of effective conservation measures in the Marghuzar area to mitigate these conflicts and ensure the long-term survival of *C. lupus*.

DECLARATIONS

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Research ethics

The present study was carried out using a self-designed questionnaire, a non-invasive method. No direct handling of animals was involved in this study.

Statement of conflict of interest

The authors have declared no conflict of interest.

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