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A Perspective of the Human–Grey Wolf (*Canis lupus*) Conflicts in Kumrat Valley, Northern Pakistan

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Abstract: In developing countries, long-term conservation goals are hindered by the high economic costs of human–wildlife conflicts. The grey wolf is one of the prominent species indulged in these incidents. We investigated human–wolf conflicts (HWCs) by interviewing 104 respondents from five villages in Kumrat Valley, northern Pakistan. The respondents declared the grey wolf a common and highly dangerous carnivore. The grey wolf was found implicated in livestock predation, inflicting a yearly economic loss of USD 9225 (USD 88.70 per household (with monthly average income of 119 USD)). Our results confirmed that livestock predation was the main reason for the community's hostile attitude (65.38%) and perception of the grey wolf. Concerning occupation, farmers have the most significant negative attitude ($p = 0.040$) towards the grey wolf, yet employees ($p = 0.025$) and students ($p = 0.030$) showed a positive attitude. In addition, the other factors contributing to the negative attitude towards the grey wolf were the grey wolf sightings and livestock predation ($p = 0.016$ and $p = 0.006$), respectively. Based on the findings, we believe that predation compensation and livestock vaccination programs (as done in Gilgit-Baltistan Province of northern Pakistan as a measure of snow leopard conservation, to prevent mass mortalities of livestock due to diseases and in turn safeguarding the predator from retaliatory killing by locals in case of livestock predation) educating the populous can be very promising in minimizing the HWCs in the study area. We also recommend robust and continuous coordination between the local communities and the concerned departments.

Keywords: human–wildlife conflicts; *Canis lupus*; livestock predation; economic losses; Kumrat Valley; northern Pakistan

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1. Introduction

Large carnivores usually occupy the top positions in the food chain—referred to as apex predators. They maintain the ecosystem health by regulating the population of prey species diversity, distribution, and abundance [1], thus assisting species in co-existing at lower trophic levels and increasing biodiversity [2]. The grey wolf (*Canis lupus* Linnaeus, 1758) is an apex predator and the largest member of the family Canidae—distributed through Eurasia and North America [3]. The grey wolf has a broad distribution range in Pakistan, from deserts in the south to the country's highlands in the north [4]. Globally, the grey wolf is listed as the least concern by IUCN [5]; however, it is listed as endangered in Pakistan [6].

Humans' negative interactions with wildlife are widespread worldwide, predominantly with carnivores with large home ranges, such as the grey wolf. Such negative interactions are usually termed human–carnivore conflicts, a significant challenge in conservation biology [7]. Human–carnivore conflicts are a product of several factors, including humans' developmental processes, predation on livestock and game species, spreading diseases, and attacks on humans [8]. All the impacts mentioned above have negative consequences for humans and carnivores, predominantly in communities residing inside or near protected areas [9].

The main reason for conflict between humans and canids is livestock predation [10]. Due to wolf predation on livestock, the pastoral communities suffer massive economic losses, mainly where livestock is their only source of income. At the country level these losses will possibly seem unimportant; however, they result in huge costs for the rural communities. These affected individuals and communities usually belong to poor and low-income classes [11]. Humans usually respond to such losses with the retaliatory killing of the wolves by shooting, trapping, poisoning, destroying dens, and suffocating pups with smoke [2,12]. Mass eradication of canids have been reported from several parts of the world, including the Mexican wolf (*Canis lupus baileyi*) from its natural range [13], extirpation of the African wild dog (*Lycaon pictus*) from 64% of the countries where it historically occurred [14], eradication of grey wolves (*Canis lupus*) from most of the United States and Europe [15], and extinction of the Falkland wolf (*Dusicyon australis*) [16]. In a nutshell, the human–wolf conflicts have lethal effects on animals and ultimately result in the retaliatory killing of grey wolves [17].

Due to excessive livestock predation by the grey wolf, it is believed that the phenomenon of human–wolf conflicts (HWCs) exists heavily in northern Pakistan [3,18–20]. However, unfortunately, there is a severe lack of information on HWCs in the region, despite the widespread importance of this burning issue [21,22]. We believe that, for the robust conservation of grey wolves, it is of great importance to explore the fundamental causes of HWCs. These reasons provided significant motivation for the current study; hence, the first study objective was to evaluate and understand the dynamics and magnitude of HWCs, and the second objective was to suggest mitigation measures for HWCs in the area. We believe that this study is one of its kinds and will provide ample information about HWCs in northern Pakistan.

2. Materials and Methods

2.1. Study Area

Our study site, i.e., Kumrat Valley, lies in the Upper Dir district of Khyber Pakhtunkhwa (KP) province, Pakistan. Kumrat Valley covers 346 km^2 of the greater Hindu Kush Mountains. This valley is bordered by Chitral, Swat, and Dir Lower districts in the north, northeast, and south, respectively. The Panjkora River flows through the valley, and the main settlements are present on both sides of the river (Figure 1).

2.1.1. Climate

A temperate climate prevails in the study with a mean yearly precipitation ranging from 1000 to 1200 mm. The coldest month is December, while June is the hottest month of the year, with average monthly temperatures of 0.3 °C and 25 °C, respectively [23].

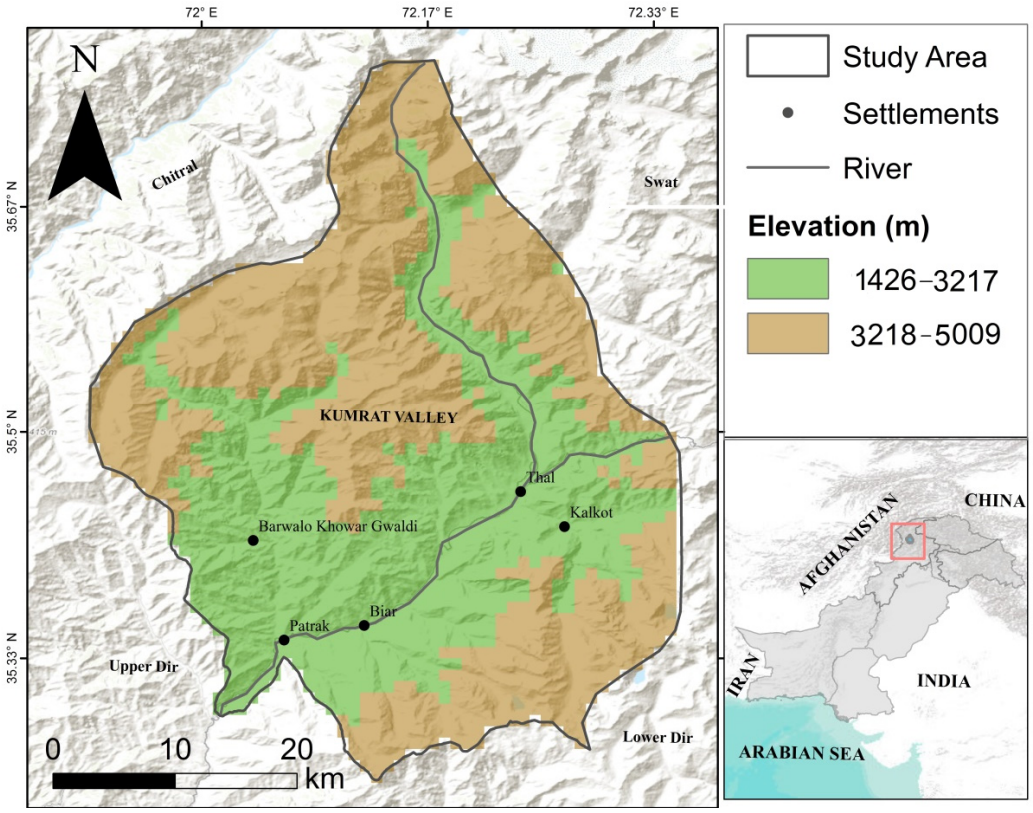

Figure 1. Study area map depicting Kumrat Valley and the surveyed settlements in the current study.

2.1.2. Flora and Fauna

The study areas harbor a diverse array of flora and fauna. The upper areas of the valley are dominated by pine forests, while lower regions are dominated by oak forests [23]. Key mammalian species present in the study area include the grey wolf (*Canis lupus*), Asiatic black bear (*Ursus thibetanus*), yellow-throated marten (*Martes flavigula*), red fox (*Vulpes vulpes*), Kashmir markhor (*Capra falconeri*), and Kashmir musk deer (*Moschus cupreus*) [4].

2.2. Data Collection

To collect data, we used semi-structured questionnaires between February and March 2022. Globally, questionnaire surveys are commonly used for human–wildlife conflict studies to collect information about the presence, perception, and levels of human tolerance towards the wildlife of that particular area [24]. Our questionnaire permitted unrestricted responses to reduce the impact of extremely structured questions [25]. Such an approach was useful in getting complete insights of the respondents about the presence and other activities of the target species in the form of field notes as per their experience. One hundred and four households (0.5% of the total households) were randomly interviewed from five villages including Biar, Kalkot, Thal, Patrak, and Barwalo Khwar. To the best of our knowledge, previous research on the HWC is limited in our study area. To obtain unbiased data on HWC, we selected respondents mostly living in proximity of 3–4 km to the forests.

Furthermore, color printed photographs of a grey wolf were shown to the respondents to get reliable data. None of the respondents in the current study were less than 18 years old [24]. All the respondents in the study were male participants because, in our study area, only males are involved in outdoor activities regarding livestock grazing and agriculture. People from various occupations were interviewed in this study including herders, farmers, teachers, employees, businesses men, local hunters, and other professionals.

Basic demographics of the respondents were recorded in the first part of interview, including age, education level, profession, household size, number of earning members,

possession of agricultural land, and livestock. The second section of the questionnaire was focused on the grey wolf presence (status, sightings, and numbers), respondents' attitudes, perceptions about the grey wolf, and conflicts. Grey wolf status was categorized into common, rare, or absent. We classified the respondents' attitudes towards grey wolves into four categories: increase, decrease, maintain, and eliminate. Likewise, the intensity of grey wolf perceived danger for livestock was categorized into four types: not dangerous, least dangerous, moderately dangerous, and highly dangerous [26]. The respondents were asked to assign a number from zero to two for least dangerous to highly dangerous, respectively. Conflicts with grey wolves were classified into two main categories: livestock predation and attacks on humans. For livestock predation, linked details such as prey type, prey age, prey sex, season, location, and economic loss were recorded. Similarly, in the case of grey wolf attacks on humans, associated details like victim age, sex, and location of the attack were also noted. Moreover, the respondents were asked about the number of wolves killed in the past two years (2020, 2021) in the study area [26].

2.3. Analytical Approach

We used the geographical information system (GIS) ArcMap10.8 to draw the study area map. To calculate species status, livelihood status, and economic losses by wolf, we used descriptive statistics in Microsoft Excel 2013.

We used the Principal Component Analysis (PCA) to check the effects of different factors on livestock predation. PCA transformed the factors into linear combinations called components. For livestock predation, we included seven factors as influencing patterns of livestock predation, i.e., prey type (goat, sheep, cattle), prey age (young, adult), prey sex (male, female), location of attack (forest or non-forest), circumstances (grazing or non-grazing), and season (spring, summer, autumn, winter), as well as livestock when guarded, which were considered as follows:

$$\begin{aligned} PCA_{Livestock\ predation} &= a_{1i}(Prey\ type) + a_{2i}(Prey\ age) + a_{3i}(Prey\ sex) \\ &+ a_{4i}(Location) + a_{5i}(Circumstances) + a_{6i}(Season) \\ &+ a_{7i}(Guarded) \end{aligned} \quad (1)$$

The respective a variables correspond to the loadings presenting the importance of the respective factor in the respective PCA.

To investigate the impact of respondents' education, age, occupation, earning members, household size, agricultural land owned, livestock owned, black bear sightings, attacks on humans, crop damage, and livestock predation on their attitude, we used the generalized linear model (GLM), with logit function, which is simply known as logistic regression model, as given below: [26].

$$\begin{aligned} Attitude = \ & glm(Education + Age + Occupation + Earning.Members \\ & + Agriculture.Land + Household.Size \\ & + Livestock.Owned + Sighted.Grey\ wolf \\ & + Attacks.On.Humans + Livestock.Predation, \\ & family = \text{binomial}) \end{aligned} \quad (2)$$

Based on the Akaike information criterion (AIC), stepwise model selection was performed to obtain an ideal model, keeping only important factors. To check the relationship between the influential factors and response variables, we used the effect plots. In addition, to highlight the influential factors, we used the analysis of variance tables. Significance level was set at $p < 0.05$, and program R version 3.6.3 was used for analysis.

3. Results

3.1. Livelihood System in Kumrat Valley

Raising crops and livestock was the primary source of income in our study area. A total of 1966 livestock were reported by respondents, with an average of 19 heads per

household. Leading livestock were goats (37%) and (sheep 36%). About 22% of the total livestock were cattle, and the remaining 6% were constituted by others (horse, donkey, and mule).

3.2. Sighting Reports and Status of Grey Wolf

Eighty sightings of grey wolf were reported by the respondents in the last two years, (2020–2021), with an average annual sighting of 0.38 per respondent. A large number of the respondents declared the grey wolf as common species, followed by rare and absent (Figure 2).

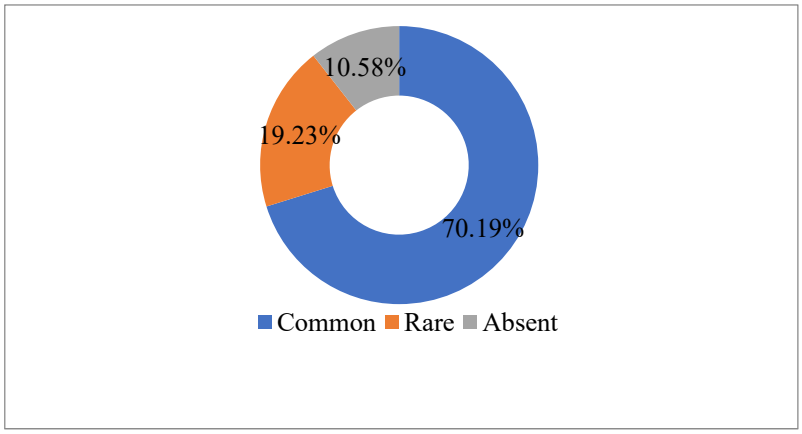

Figure 2. Status of the grey wolf in the study area based on respondents' views. The categories are based on the wolf sightings by respondents and due to the predation of livestock by wolf that respondents suffered with.

3.3. Human–Wolf Conflicts

3.3.1. Livestock Predation and Economic Losses

The respondents of the study area held grey wolves accountable for 84 livestock deaths in the past two years (42 per year). Among livestock, the most common livestock species for the grey wolf were sheep (n = 32), followed by goats and cattle (n = 23 each) and others (n = 6) (Table 1. The reported figure of 84 livestock losses constituted an economic loss of USD 18,450, with a yearly economic loss of USD 9225 (1 USD = 162 PKR) (USD 88.70 per household) (Table 1).

Table 1. Details of livestock predation and suffered economic losses due to the grey wolf in Kumrat Valley (2020, 2021).

Livestock	Unit Price	Livestock Killed	Total Loss USD
Goat	123	23	2829
Sheep	142	32	4544
Cattle	401	23	9223
Others	309	6	1854
Total loss		84	18,450
Annual loss		42	9225
Per hh/year loss		0.40	88.70

hh = household; 1 USD = 162 PKR. The unit price for each kind of livestock was confirmed from Livestock and Dairy Development; Department KP (in personal communication).

3.3.2. Factors Affecting Livestock Predation

The distribution of the seven factors considered in predation-based PCA is presented in Table 2. The PCA loadings extracted for predation are presented as a biplot in Figure 3 for the first two PCA components. The first component, Dim 1, explains 34.2% of the total variation, while the second component, Dim 2, explains 19.2% of the total variation. The

importance of each factor over the PCA is presented by orange color intensity, suggesting that 'location' and 'circumstances' were the most significant factors in livestock predation. Prey sex, prey type, prey age, and guarded have a small role in livestock predation, and aminor contribution was reported for season (Table 2, Figure 3).

Table 2. Factors associated with livestock predation (n = 85) by wolf used in predation-based PCA. Values shown include the number of livestock kills for each level (counts) and the percentages for each factor.

Variable	Value	Count	Fraction
Season	Autumn	1	1.176471
	Spring	11	12.94118
	Summer	43	50.58824
	Winter	30	35.29415
Location	Forest	74	87.05882
	Non-forest	11	12.94118
Prey type	Cattle	24	28.23529
	Goat	32	37.64706
	Other	6	7.058824
	Sheep	23	27.05882
Prey sex	Female	66	77.647061
	Male	19	22.35294
Prey age	Adult	32	37.64706
	Young	53	62.35294
Guarded	Yes	28	32.94118
	No	57	67.05882
Circumstances	Grazing	74	87.05882
	Non-grazing	11	12.941181

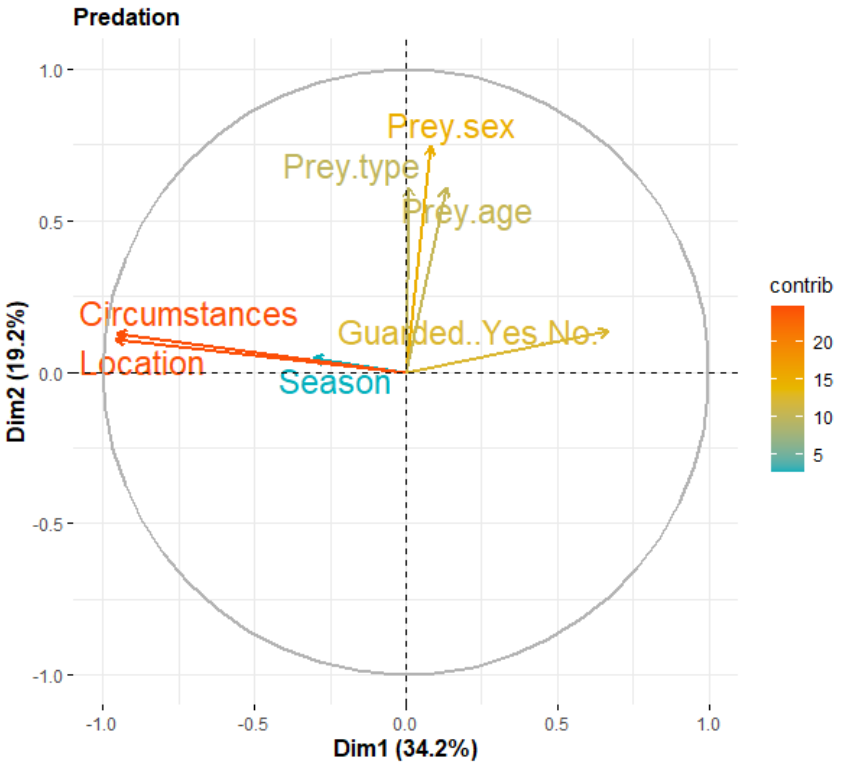

Figure 3. The biplot indicating the importance of predation-related factors extracted by PCA. The importance of each factor on predation is presented by orange color intensity.

3.4. Human Attitude towards the Grey Wolf

Human attitude towards grey wolf has been predominantly negative with 35.58% of the total respondents wishing complete eradication of grey wolf numbers. Nearly 30% and 24% of the respondents either supported reduction of wolf numbers or maintaining the current status (Figure 4). Only a little over 10% of respondents supported an increase of the grey wolf in the region, thereby highlighting the general negative attitude of respondents towards the grey wolf in the region.

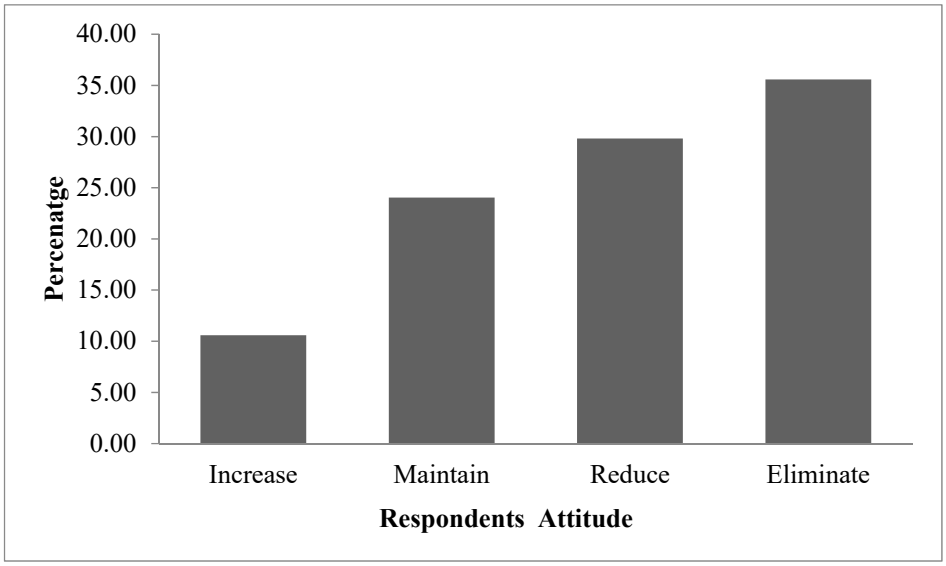

Figure 4. Attitude of respondents towards the grey wolf in Kumrat Valley.

Influences of various socio-economic factors on the attitude of respondents, tested by fitting GLM, are given below (Table 3) [26].

Table 3. Factors associated with attitude towards the wolf (n = 104) are presented. Values shown include the number of respondents for each level (counts) and the percentages for each factor.

Variable	Levels	Count	Fraction
Education	Graduation	14	13.46154
	Illiterate (no formal schooling)	37	35.57692
	Middle	45	43.26923
	Primary	8	7.692308
Age	Older (≥35 years)	38	36.53846
	Younger (<35 years)	66	63.46154
Occupation	Business	14	13.46154
	Employee (any other job)	18	17.30769
	Farmer	32	30.76923
	Labor	20	19.23077
	Student	20	19.23077
Earning Members	High (>1)	30	28.84615
	Low (1)	74	71.15385
Agriculture Land	High (≥5 kanals)	21	20.19231
	Low (<5 kanals)	83	79.80769
Household Size	High (≥7)	73	70.19231
	Low (<7)	31	29.80769

Table 3. *Cont.*

Variable	Levels	Count	Fraction
Livestock Owned	High (≥20)	34	32.69231
	Low (<20)	70	67.30769
Sighted GreyWolf	High > 1	51	49.03846
	Low ≤ 1	53	50.96154
Attacks On Humans	Not reported	104	100
Livestock Predation	No	42	40.38462
	Yes	62	59.61538
Attitude	Negative	69	66.34615
	Positive	35	33.65385
Perception	High	74	71.15385
	Least	3	2.884615
	Moderate	27	25.96154

The best GLM model with an AIC of 90.884 (Table 4, Figure 5) revealed that the respondent's attitude was significantly influenced by occupation, grey wolf sightings, and livestock predation. With business reference, farmers have a negative attitude (p = 0.040). Similarly, the employees (p = 0.025) and students (p = 0.030) have a significant positive attitude toward the grey wolf. The model further revealed that respondents with less sightings of the grey wolf have a considerably more encouraging attitude (p = 0.01) towards grey wolves (Figure 5B). However, the attitude was quite negative (p = 0.006) in the case of respondents who suffered from high livestock predations (Figure 5C).

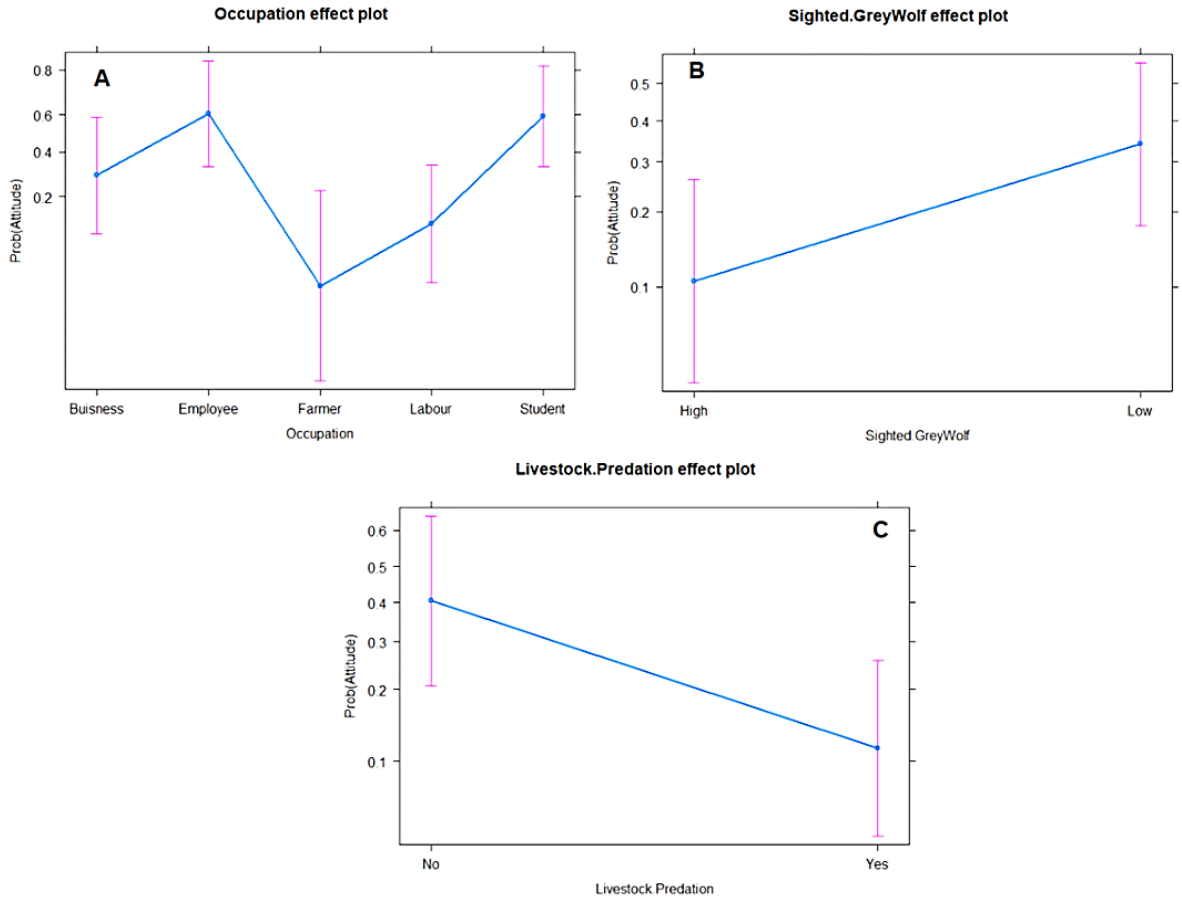

Figure 5. The number of appearances of the influential factors for each level over the chances of the respondents' positive attitude towards the wolf. (**A**) Represents the occupations impacts (**B**) Represents sighted wolf impacts (**C**) Represents livestock predation impacts.

Table 4. The effect of significant socio-economic factors on the attitude of locals towards the wolf. The estimates are the GLM-based effects, which are translated by logs as odds ratio (standard error). The significance of each level compared to a level (called reference level) is presented by *p*-values, which are further supported by z-values.

Factors	Levels	Odds Ratio	Estimate	Std. Error	Z-Value	*p*-Value
(Intercept)		0.503475	−0.68622	0.783446	−0.8759	0.381084
Occupation	Employee	3.864932	1.351944	0.882234	1.532411	0.025421
	Farmer	0.090198	−2.40575	1.230553	−1.95502	0.040581
	Labor	0.349222	−1.05205	0.89098	−1.18078	0.237692
	Student	3.673107	1.301038	0.861507	1.510188	0.030995
Sighted Grey Wolf	Low	4.412519	1.484446	0.617155	2.405305	0.016159
Livestock Predation	Yes	0.189461	−1.66357	0.607188	−2.7398	0.006148

3.5. Perceived Danger

The majority of the respondents (70.2%) considered the grey wolf as extremely dangerous for livestock, while 2.9% of the respondents declared it as the least dangerous (Figure 6).

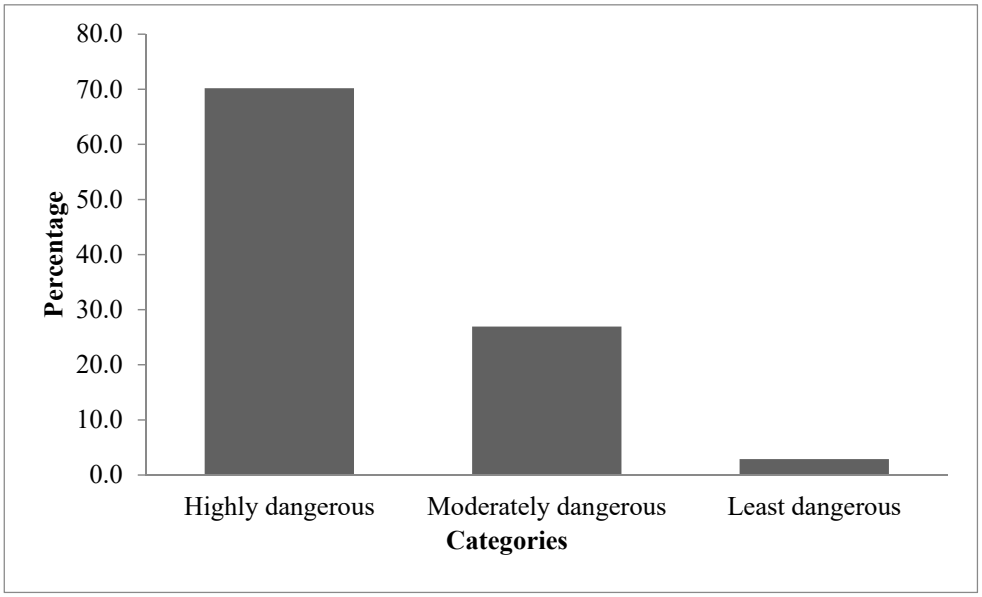

Figure 6. The danger of the grey wolf perceived by respondents in the study area.

4. Discussion

Investigating key drivers of human–wildlife conflicts is essential for designing promising conservation policies [27]. Pieces of information about the local communities' livelihood status can best explain the relations amid poverty and wildlife and it's succeeding long-lasting impacts on conservation. Human–wildlife conflicts can either be urban or rural [28]; however, they appear in a very melancholic fashion in the remote and rural areas where the largest ratio of inhabitants are usually poor. Thus, in areas with such small stakeholders, such events can possibly compromise the community's welfare and stimulate bad views about wildlife, eventually depressing the conservation aims [29].

Carnivores are a fundamental part of the ecosystem [2], yet their involvement in livestock predation is one factor causing their conflicts with humans [9,30]. Livestock predation causes economic loss for rural communities who are mainly dependent on livestock as an integral part of their livelihood [2,24]. In the current study, with a mean herd size of 19, livestock predation by grey wolves caused an economic loss of USD 88.7 per household/year (Table 1). In rural areas of KP province, livestock predation

accredited to wildlife constitutes nearly 4% of pastoral communities' economic losses [24]. The economic loss incurred by the grey wolf reported in the current study is lower than that previously reported by Din et al. [22] (USD 114 per household), Khan et al. [20] (USD 424 per household), and Khan et al. [18] (USD 344 per household) in the adjacent areas of Chitral district, Sheringal Valley of Dir Upper district, and Timergara of Dir Lower district, respectively. An economic loss of USD 299 (average monthly income = 119 USD) per household due to livestock predation by grey wolves was reported from Khanbari Valley in northern Pakistan [3]. However, Ahmad et al. [19] reported an economic loss of USD 21 per household in Musk Deer National Park, Azad Jammu, and Kashmir. Such high livestock predations and subsequent financial losses due to the grey wolf result from an increase in the livestock and a decrease in the natural prey base [31,32], ultimately escalating HWCs. Although the yearly economic loss due to livestock predation by the grey wolf reported in the current study seems very low, given the average household size (9.8) and poverty prevailing in the study area, this is considered a considerable cost to farming families [19,24]. Such economic losses trigger the hostile attitude of communities towards grey wolves and end with retaliatory killings [33]. In the northern province of Gilgit-Baltistan, Pakistan, some 66 to 85 wolves were killed between 2005 and 2006 using firearms in retribution for attacks on livestock [34]. Likewise, a recent retaliatory killing of two grey wolves was reported from the Nowshera district of the KP province [2]. However, fortunately, no such incident was recorded in the current study.

Our results revealed significant variation in predation concerning location and circumstance (Figure 3). Predation was significantly higher in forested areas and during grazing (Table 2). This pattern is because locals regularly use the forests as grazing grounds for their livestock. Similar results regarding grey wolf predation on livestock have been reported from other parts of northern Pakistan [19]. Results obtained from PCA (Figure 3) showed that, although prey sex, prey type, prey age, and guarded have a reasonable role in overall predation, certain differences in these factors reflect the target locking and hunting strategies of grey wolves (Table 2). Comparatively, sheep were much more vulnerable to grey wolves. There is a general trend of small ruminants being more prone to carnivores than large ungulates, owing to their small body size, making it easy to kill and drag them to a safe distance for consumption [35]. Moreover, female and young livestock were much more vulnerable to the grey wolf. Usually, the females and the young are easier targets for carnivores to capture [3,19,24].

In animal husbandry, active defense and herd guarding are of key importance. In the presence of herders, predation is usually lower [36]. In some European countries, wolves' highest livestock predation occurred among unattended and free grazing flocks [37]. Our findings also report a similar trend, supporting the efficiency of active guarding (Table 2).

The predation by wolves leads to a negative attitude, and the results of this study divulged that most respondents nurtured a negative attitude and wanted to eliminate this species. These findings confirmed previous studies in the Hindu Kush range [3,20]. The attitude was shaped by certain factors, including occupation, grey wolf sightings, and respondents' livestock predation. Farmers have a negative attitude in the occupation category, while employees and students have a positive attitude towards wolves. This pattern is quite evident as farmers rear livestock, and their predation by wolves results in this negative attitude related to living in an agro-pastoralist mode of life. At the same time, on the contrary, employees and students in general have no concern with livestock losses as they do not keep livestock and are adapted to the urban lifestyle. The findings of this study disclosed that those respondents who had not sighted a grey wolf had a positive attitude compared to those who had seen one. This exciting aspect is more psychological than ecological, as the wolf is deemed dangerous after physical contact instead of having just an imaginary idea. Similarly, respondents who lost livestock to wolf predation had a negative perception because they were inflicted with heavy economic losses by livestock consumption. This pattern was in agreement with other studies in Pakistan [2,3,19,24].

5. Conclusions

As verified by local respondents, the grey wolf is a common species in Kumrat Valley. The majority of the study participants declared the grey wolf as a highly dangerous carnivore, bearing a negative attitude towards this species. The main driver behind such perceptions and attitudes of locals is the economic losses caused by grey wolf predation on livestock. Thus, most respondents (65.38%) want to reduce or eliminate the grey wolf. We believe that certain compensation schemes and livestock vaccination programs (https://snowleopard.org/update-on-snow-leopard-friendly-vaccination-program-in-pakistan/, accessed on 3 October 2022) can be up and coming to minimize the community's hostile attitude towards the grey wolf. In addition, people should be educated regarding the ecological importance of the grey wolf through meetings with local communities and arranging seminars in educational institutes. Furthermore, we also recommend educating the herders about active guarding of livestock, and concerned departments should also focus on establishing predator-proof corrals for the poor communities.

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