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# Diet Composition of Grey Wolf (*Canis lupus*) Varies Seasonally in Deosai National Park, Gilgit-Baltistan, Pakistan

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## ABSTRACT

Two wolf species reported from Pakistan include the grey wolf (*Canis lupus pallipes*) and the Tibetan wolf (*Canis lupus chanco*). Limited studies have focused on grey wolf ecology in the country, therefore, scientific data on the species' ecological parameters and conservation are scanty. The species is also facing persecution threat in response to depredation on livestock in many parts of the country. We investigated occurrence and diet composition of grey wolf in Deosai National Park, Pakistan to record how much proportion of its diet comprises of livestock, leading to human-wolf conflict. Field surveys were made on monthly basis from July 2018 to December 2019 for data collection. The distribution of the species was determined by surveying the potential habitats and recording its direct and indirect field signs (such as scats, pug marks, prey remains, hairs), while diet composition was investigated by using noninvasive technique of scat analysis. Results showed grey wolf being distributed at an elevation range of 3921 m to 4282 m above sea level (asl) in the park. Scat analysis showed 7 wild and 6 domestic prey species in its diet, with approximately 47 % contribution from livestock and 53 % from wild prey. Most frequently consumed domestic prey were donkey, yalk, goat and sheep, while among wild prey golden marmot (*Marmota caudata*), house mouse (*Mus musculus*), Palm Civet (*Paguma larvata*), Royel's Pika (*Ochotona roylei*) and markhor (*Capra falconeri*) were frequently consumed. Winter diet of grey wolf contained more proportion of livestock (59%) compared to wild prey (41%) whereas its summer diet contained more proportion of wild prey (53%). The grey wolf was found as one of the major predators in the study area mainly attacking donkeys, cows, sheep, and goats.

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**TM and FA designed the study, analyzed the data and wrote the manuscript. SI and MRK collected the field data. MFand NM helped in the laboratory analysis of wolf scats.**

**Key words**
**Grey wolf, Tibetan wolf, Human-wolf conflict, Scat analysis**

## INTRODUCTION

According to IUCN Red List (Boitani *et al*., 2018), the grey wolf (*Canis lupus*) is widely distributed globally, its status is "Least Concern" and its global population is stable. However, in Pakistan, the grey wolf is listed as "Endangered" (Sheikh and Molur, 2004) and its population is reportedly declining, although there are no authentic records about its population estimates in the country.

In Pakistan, Roberts (1997) reported that the grey wolf lives in dens in the Indus plains, excavated by itself usually on the side of sand hills or under tree roots. It occupies natural caves in mountain areas or excavates dens under rocks. The species ascends from the province of Balochistan to Gilgit, Chitral, and Baltistan in the north into Pakistan's mountain regions (Roberts, 1997). It lives in open plains, semi-arid grasslands, scrublands and pastures, and is also distributed throughout the country in numerous protected areas, including Hingol National Park, Hazarganj Chiltan National Park, Cholistan, Lal-Sohanra National Park, Kirthar National Park, and Chumbi Surla Wildlife Sanctuary (probably extirpated from this sanctuary now), Swat and Kalam areas, and South Waziristan (IUCN, 2003; Hamid *et al*., 2019). Today, the grey wolf has become scarce throughout the Indus plains, but occurs in Cholistan and Tharparker, mostly in extensive desert regions (Roberts, 1997).

In Pakistan, only a couple of studies have been conducted in the past focusing on grey wolf occurrence, mainly in the Northern Pakistan. In the Salt Range area of Punjab province, grey wolf population was reported to be occurring in small fragments of scrub forests and with an estimated six individuals across a study area of 88.36 km$^2$ within Lehri Nature Park (Saad *et al*., 2015). Similarly,

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Hamid *et al*. (2019) have reported prey species of grey wolf from Southern Waziristan area. Khan *et al*. (2020) reported an estimated population density of 0.45 wolves /km$^2$ in Mahoodand valley of Kalam, Swat District, and showed that wolf diet in Kalam valley consisted of five domestic and eight wild prey species, major share being from livestock.

In many parts of the country, the grey wolf is in conflict with human and is persecuted using different methods (smoking den sites, poisoning and shooting) in revenge for attack on livestock, as a result of which their populations in Pakistan are reportedly declining (Roberts, 1997). Hamid *et al*. (2019) reported persecution of 28 grey wolves in South Waziristan while Abbass *et al*. (2013) had mentioned killing of more than 80 grey wolves from Gilgit-Baltistan area. These numbers highlight the intensity of human-grey wolf conflict in the country. Keeping in mind the previous background knowledge of the grey wolf occurrence and conflict, the current study aimed at determining distribution of grey wolf, investigating its dietary habits and human-wolf conflict in Deosai National Park, Gilgit-Baltistan, which is one of the very important area of its distribution at higher elevations.

## MATERIALS AND METHODS

*Study area*

The current study was conducted in the Deosai National Park (DNP; 34°58′N 75°24′E), situated at the southeast edge of Gilgit-Baltistan (GB) (Fig. 1). It is a Plateau that falls within extreme northwestern boundaries of the Himalayas close to Central Karakoram at a central geographic location of 35 ° 01'N and 75 ° 40'E. Its average elevation is 4114 m above sea level from the south east of Skardu, in Himalayan Mountains above tree line. It was declared as national park in 1993 and it protects an area of 3000 km$^2$. Administratively DNP falls to the west in the district of Skardu bordering Astor, with spatial extent of 35° North 11' 3.4 "East and 75° 47' 12.29". The plateau has an area of 358,400 ha with undulating surface; gently rolling hills with vast valley plains all around, surrounded on all sides by jagged Rocky Mountains. Chhota Deosai is greener than the main plateau with low altitude and better climatic conditions and keeps the maximum number of nomadic livestock grazing pressure. At elevations between 3500-4000 m the central part of the Deosai National Park is relatively flat (0-10$^o$ slope), while the outer area is steeper (up to 50$^o$) and the highest altitude is 5300 m. The average daily temperature range is -20 C (January to February) to 12˚C (July to August) (Münir *et al*., 2015).

*Study design*

The current study was conducted in Deosai National Park, Gilgit-Baltistan, from July 2018 to September 2019. Field surveys were conducted on monthly basis for data collection. The study was further divided into three sub-studies: distribution of grey wolf in the park, its diet composition and human-wolf conflict in the study area.

*Distribution*

The distribution of the grey wolf was determined by using "signs survey" method following Abbas *et al*. (2013), whereby indirect signs of wolf including its pug marks, den counts, scats, dead specimens, hair samples and prey consumed, were recorded to confirm its occurrence in the study area. Geographical coordinates of the positive locations were recorded by using Global Positioning System (GPS, Garmin eTraxVista) and were used later to develop distribution map of the wolf in the study area.

*Diet composition*

The diet composition of the grey wolf was investigated by analyzing its scat samples. The grey wolf scats were collected from the study area during field surveys wherever encountered. The scats were morphologically identified in the field and distinguished according to their shape, size, and diameter from those of other carnivorous species (Norton *et al*., 1986; Rabinowitz, 1989), sharp ends and several lobes (Edgaonkar and Chellam, 2002). The scats were collected in self-sealing polythene bags along with all relevant information like date, time, locality and were stored in the laboratory till final analysis. Geographical coordinates of the locations where scats were found, were also recorded using Global Positioning System.

*Scat analysis*

The collected scats were first oven (Model: DHG 9030 Thermostatic) dried and stored to avoid damage to their contents by fungus before further processing. After drying, their physical characteristics like weight (g), length (cm) and breadth (cm) were measured in the laboratory using digital Vernier caliper and a weighing balance. During the analysis, scats were soaked in warm water for at least 24 h, and then washed frequently under flowing tap water to eliminate debris and mucus, then screened with a 1 mm mesh size sieve and carefully separated and observed (first by naked eye and then by 10X hand lens) to segregate and recognize fur, feathers, bones, and any other recovered plant material. The segregated contents were put in the sunlight on a paper for drying and recovered food items were segregated into identifiable groups. Undigested target remains like fur (hair) that remains in the scats after washing were used to identify mammalian prey species as described by Mukherjee *et al*. (1994). At least 15 hairs (or all if under 5) were extracted from each feces to prepare light microscopic slides (whole mount and scale

replication). The prepared slides were then compared with the reference hair slides for prey species identification. Similarly, bird target species of the wolf were identified from feathers recovered from the scats. The plant materials recovered such as seeds, were also identified. The animal prey species of grey wolf were further categorized as either wild or domestic prey species.

*Human-wolf interaction*

Data on human-wolf interaction were collected by using self-designed questionnaire by approaching the communities living inside the study area. Data were collected from local people and wildlife staff of the Deosai National Park, Gilgit-Baltistan, from July 2018 to December 2019.

## RESULTS

*Distribution*

In Deosai National Park, grey wolf signs were recorded at 18 different sampling sites surveyed (Table I), mainly a den was recorded in wolf Peak area of the Park, howling of wolves was listened in Sarsangari and Shila areas, while scats of the species were recovered and collected from all eighteen locations. The pug marks of wolf were recorded around Sheosar Lake area, snow tracks of the species were observed at Bara Pani, Marao, Ragichan, Harbachan, Das Nala, Sheosar Lake and Buban Nala sampling sites. Overall, wolf signs were found at elevation ranging from 3921 m asl to 4282 m asl (Fig. 1).

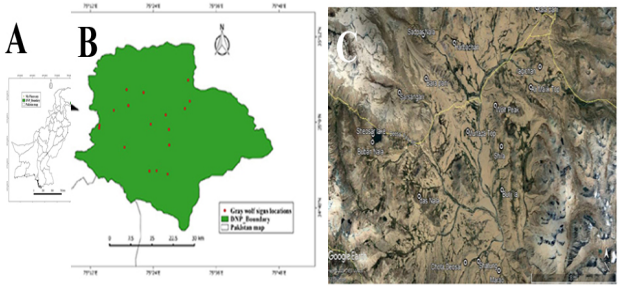


Fig. 1. (A) Map of Pakistan showing location of Deosai National Park, Gilgit-Baltistan, (B) GIS-based map of distributional signs of grey wolf encountered in the Deosai National Park, (C) Google earth map showing locations points where different signs (scats, pug marks, dead body, snow tracks) of grey wolf were recorded.

**Table I. Details of direct and indirect signs of the wolf *Canis lupus* recorded in the Deosai National Park for determining the distribution.**

| Sr. No | Site Name | Latitude (N) | Longitude (N) | Elevation (m) | Dens | Scats | Pug marks | Snow tracks | Howling |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Bara Pani | 35.039109 | 75.320623 | 4282 | × | 2 | × | ✓ | × |
| 2 | Marao | 34.878624 | 75.445711 | 3959 | × | 1 | × | ✓ | × |
| 3 | Barila | 34.870929 | 7.4570230 | 4007 | × | 1 | × | × | × |
| 4 | Shatung | 34.886447 | 75.410548 | 3947 | × | 1 | × | × | × |
| 5 | Chota Deosai | 34.885862 | 75.387795 | 4082 | × | 2 | × | × | × |
| 6 | Burji la | 34.946221 | 75.450954 | 3921 | × | 3 | × | × | × |
| 7 | Ali Malik Top | 35.032151 | 75.500608 | 4009 | × | 1 | × | × | × |
| 8 | Ragichan | 35.049199 | 75.516155 | 4126 | × | 2 | × | ✓ | × |
| 9 | Kala Pani | 35.098326 | 75.510458 | 4238 | × | 1 | × | ✓ | × |
| 10 | Harbachan | 35.069227 | 75.369024 | 4151 | × | 2 | × | ✓ | × |
| 11 | Wolf Peak | 34.995321 | 75.392031 | 3937 | × | 4 | × | × | × |
| 12 | Murtaza Top | 35.016856 | 75.439391 | 4195 | ✓ | 2 | × | × | × |
| 13 | Sarsangari | 35.027740 | 75.274333 | 4179 | × | 2 | × | × | ✓ |
| 14 | Sadpar Nala | 35.075911 | 75.315204 | 4035 | × | 3 | × | × | × |
| 15 | Shila | 34.982623 | 75.449849 | 4085 | × | 2 | × | × | ✓ |
| 16 | Das Nala | 34.941058 | 75.308401 | 4089 | × | 2 | × | ✓ | × |
| 17 | Sheosar Lake | 34.992468 | 75.233321 | 4143 | × | 2 | ✓ | ✓ | × |
| 18 | Buban Nala | 34.986565 | 75.228249 | 4178 | × | 3 | × | ✓ | × |

*Diet composition*

A total of thirty-six scats (N =36) of the wolf collected from the field were measured in the laboratory for their size and dimensions. Morphologically, the scats were found broader at the midpoint but tapered at the two ends. Mean length, breadth and weight of scats were 25.40 ± 1.12 cm, 3.15 ± 0.171 cm, and 32.18 ± 3.52 g, respectively (Fig. 2).

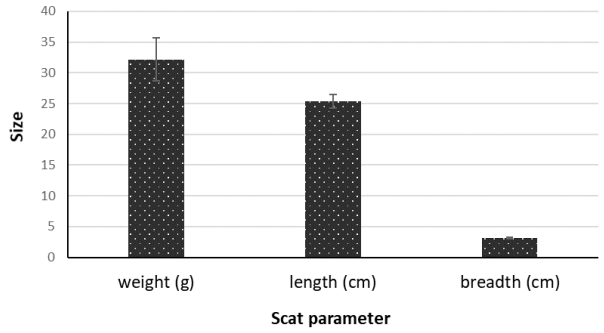


Fig. 2. Average physical measurements of grey wolf scats (mean ± SE) collected from Deosai National Park, Gilgit-Baltistan. N = 36.

*Analysis of scats*

Laboratory analysis of collected scats revealed hairs, bones, seeds, plant matter, and grits etc. (Table II). Most frequently found in the wolf scats were hairs (83.33 %F), followed by bones (22.22 %F). The plant matter, grits, and sand/clay were also recovered in small frequencies. In terms of percent volume (%V) consumption, hairs contributed the maximum (64.10 ± 5.31 %V), followed by bones (10.90 ± 1.93 %V) while seeds and other plant matter collectively contributed 25 % by volume (Table II).

**Table II. Percentage frequency (%F) of occurrence and percentage volume (%V) of recovered food items from scats of grey wolf *Canis lupus* in Deosai National Park. *N = 36 (sample size).**

| Food Item Recovered | % F | % V |
|---|---|---|
| Hairs | 83.33 | 64.10 ± 5.31 |
| Bones | 22.22 | 10.90 ± 1.93 |
| Seeds | 2.78 | 1.28 ± 0.06 |
| Plants matter | 11.11 | 9.62 ± 0.98 |
| Grits | 13.89 | 6.41 ± 1.23 |
| Sand/lay | 13.89 | 4.74 ± 0.56 |
| Unidentified matter | 16.67 | 2.95 ± 0.13 |

*Prey species of grey wolf*

Scat analysis showed ingestion of 13 prey species by wolf in the study area, including 6 domestic and 7 wild species. The domestic prey in wolf diet contributed approximately 53.57 % while the wild prey represented 46.43% of wolf diet (Table III; Figs. 3 and 4). The domestic prey of wolf identified included camel (*Camelus dromedarius),* domestic cow (*Bos taurus)*, donkey (*Equus asinus)*, yalk (*Bos grunniens*), domestic goat (*Capra hircus*) and the sheep (*Ovis aries*). Whereas seven wild prey species in the wolf menu were Himalayan musk deer (*Moschus chrysogaster*), house mouse (*Mus musculus*), Astor markhor (*Capra falconeri falconeri*), golden marmot (*Marmota caudata*), Himalayan ibex (*Capra ibex sibirica*), Asian palm civet (*Paguma larvata*) and Royle's pika (*Ochotona roylei*) (Table III, Figs. 3 and 4).

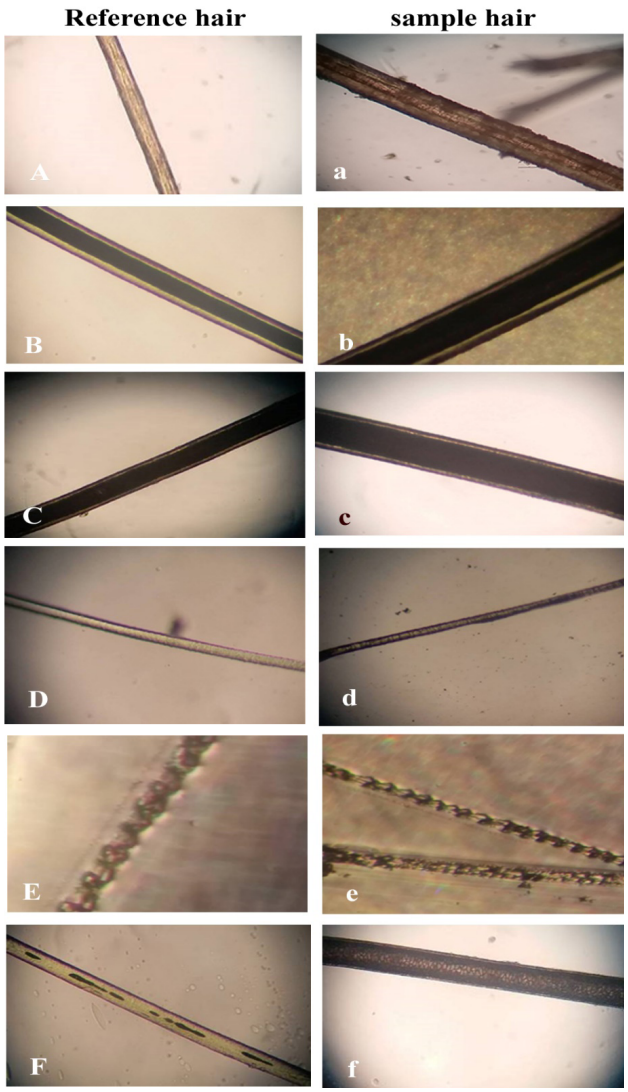


Fig. 3. Hair key of domestic mammalian prey species of grey wolf in Deosai National Park, Gilgit-Baltistan. A) camel, B) domestic cow, C) donkey, D) goat, E) sheep, F) yak.

**Table III. Percent frequency of occurrence (%F), Relative Frequency (RF) and percent volume (%V) of domestic and wild prey species consumed by grey wolf, *Canis lupus*) in Deosai National Park.**

| Prey type | Prey species (Scientific name) | %F | RF | %V |
|---|---|---|---|---|
| Domestic | Camel (*Camelus dromedaries*) | 1 | 1.5 | 2.38 |
| | Domestic cow (*Bos taurus*) | 2 | 3.6 | 5.95 |
| | Donkey (*Equus asinus*) | 11 | 16.8 | 23.81 |
| | Goat (*Capra aegagrus hircus*) | 4 | 6.0 | 4.76 |
| | Sheep (*Ovis aries*) | 3 | 4.8 | 2.38 |
| | Yak (*Bos grunniens*) | 10 | 14.4 | 14.29 |
| | Sub-total | | 47.2 | 53.57 |
| Wild | Himalayan ibex (*Capra ibex sibirica*) | 2 | 2.4 | 2.38 |
| | Himalayan musk deer (*Moschus chrysogaster*) | 2 | 2.4 | 2.38 |
| | House mouse (*Mus musculus*) | 10 | 14.4 | 8.33 |
| | Markhor (*Capra falconeri*) | 3 | 4.8 | 7.14 |
| | Golden marmot (*Marmota caudata*) | 10 | 14.4 | 8.33 |
| | Palm civet (*Paguma larvata*) | 5 | 7.2 | 4.76 |
| | Royle's pika (*Ochotona roylei*) | 5 | 7.2 | 13.1 |
| | Sub-total | | 100 | 46.43 |

*F; frequency; *RF; relative frequency; *V: volume consumption.

Among domestic prey species of grey wolf, the donkey contributed the maximum (16.87%) in its total diet followed by yak (14.4 %), both were most probably scavenged by grey wolf. Goat and sheep contributed approximately 7 % collectively, whereas the camel contributed the least (2.3 %), which could have been scavenged also (Table III; Fig. 3).

On the other hand, among the wild prey eaten by grey wolf, golden marmot and house mouse were most frequently and most heavily consumed, followed by Royle's Pika, and Asian palm civet, and markhor, whereas the Himalayan ibex and Himalayan musk deer contributed the least (Table III; Fig. 4).

*Winter and summer diet of wolf*

Grey wolf diet varied between winter and summer seasons. In winter season the depredation on livestock by grey wolf was higher than in summer season (Fig. 5). Donkey and yak were consumed most frequently and most heavily in winter followed by cow and goat, while sheep were eaten less. Camel was also found consumed only in winter season (most probably scavenged).

The wild prey consumption in wolf diet was found higher in summer season when compared to winter. The prey species including Royle's pika, golden marmot, house mouse, markhor, Himalayan musk deer, Himalayan ibex, all showed higher consumption in summer except the palm civet (Fig. 5).

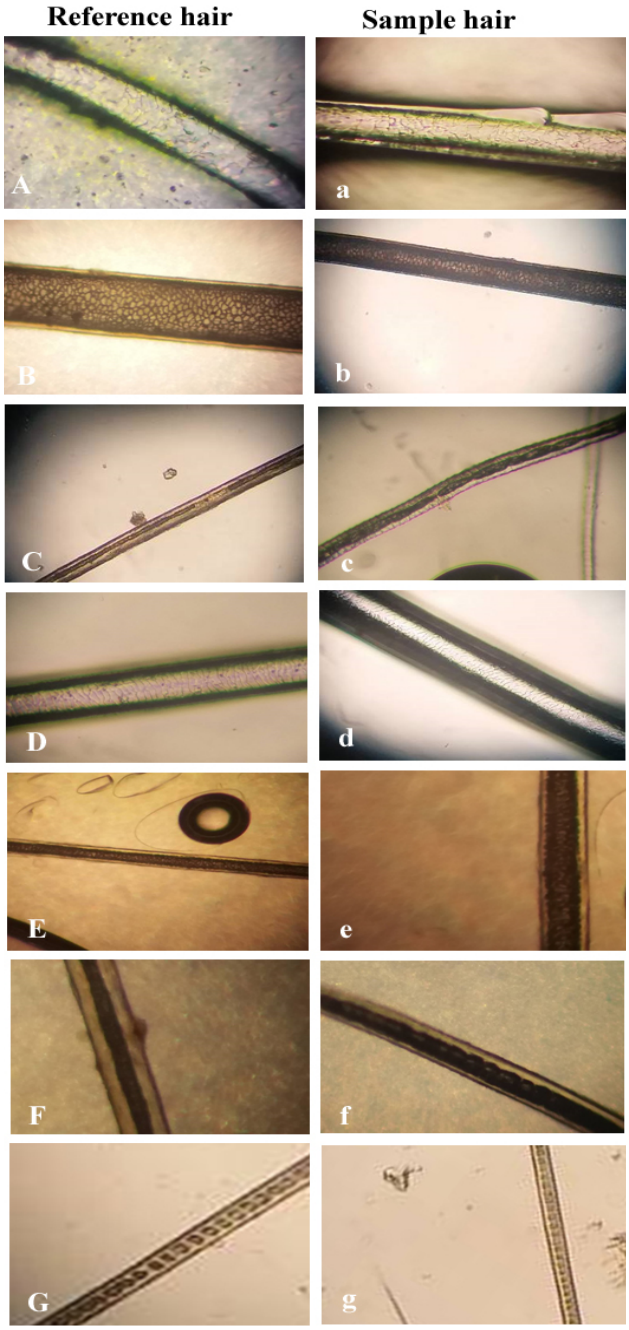


Fig. 4. Hair key of wild mammalian prey species consumed by grey wolf in Deosai National Park, Gilgit-Baltistan. Himalayan ibex, B) Himalayan musk deer, C) house mouse, D) markhor E) golden marmot, F) Asian palm civet, G) Royale's pika.

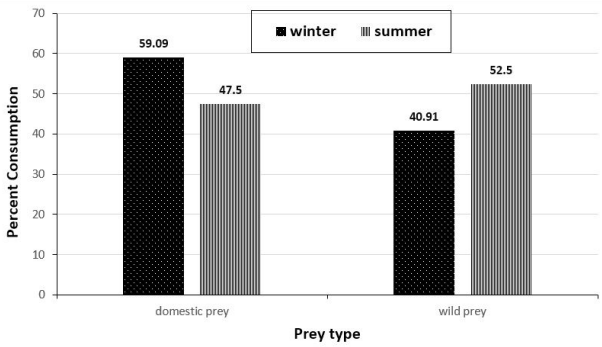


Fig. 5. Winter and summer diet of grey wolf in Deosai National Park, Gilgit-Baltistan.

The statiscal analysis by using independent sample t-test, showed that overall consumption of prey species by grey wolf differed significantly ($p < 0.05$), whereas consumption of wild and domestic prey showed non-significant difference ($p > 0.05$). Similarly, grey wolf depredation on livestock increased non-significantly during winter as compared to summer season.

*Human-grey wolf interaction*

A total of 20 respondents were interviewed to collect information and fill the questionnaires. The little data generated showed that grey wolf was the major predator in the study area. Throughout the study period 3 donkeys, 3 goats, 2 sheep and 1 cow were reported to be killed by grey wolf.

## DISCUSSION

Carnivores are indicative of ecosystem integrity and health (Zielinski and Kucera, 1995) and can potentially affect community and food-web structure of lower trophic levels (Palomares and Caro, 1999). Numerous examples show their critical role in the stability of ecosystem such as wolves in Yellowstone ecology (Ripple and Beschta, 2003). Predation has pivotal role in evolution of ecosystem where species diversity and prey composition, even habitat quality and vegetation community, are the reflection of a carnivore's feeding momentum, at the same time is often viewed that predation makes impact uniformly on evolutionary physiology of an ecosystem even though predators vary in size, their prey choice and hunting behavior. It has been frequently deduced that predation by top carnivores is crucial in the maintenance of biodiversity (Estes *et al*., 2001). Hence predation pattern is of keen importance to conservationists especially when the range of top predators continues to collapse around the world. (Laliberte and Ripple, 2004).

The grey wolf is a good traveler that occurs practically in all habitats, but it is now particularly restricted to distant trails of unproductive hilly regions and vast deserts (Roberts, 1997). Its territory reportedly ranges from 150 to 300 km$^2$ that provides denning sites and prey in its habitat (Jhala, 2003; Habib and Kumar, 2007). In hilly or mountainous regions, the species utilizes natural caves for resting, cubs raising and feeding (Roberts, 1997).

In Pakistan, studies focusing on grey wolf ecology and dietary habits have been scanty in the past. The Deosai National Park is a high-altitude alpine plain (plateau) and national park in the Northern Pakistan region of Gilgit Baltistan. It was established in 1993 to protect the survival of the Himalayan brown bear *Ursus arctos* and its habitat. It is one of the highest protected areas (by elevation) in the country, harboring many important wildlife species including herbivores (Himalayan ibex, Laddakh Urial, golden marmot etc.) and carnivores such as grey wolf, brown bear, snow leopard *Panthera pardus*, red fox *Vulpes vulpes* etc. and more than a hundred species of resident and migratory birds including vultures and falcons. Up till now, the park was focused entirely on studies conserving brown bear and the snow leopard. However, the grey wolf, an apex predator also, did not receive any attention. Owing to the fact that grey wolf is no more reported from many areas of the country where it existed a few decades ago, Deosai National Park deserves studies to investigate grey wolf distribution and its dietary composition to highlight the contribution of the wild and domestic prey species as its food.

Results of the current study confirm occurrence of grey wolf in the Deosai National Park at elevational range between 3921 m to 4282. The species field signs including den, scats, pug marks, snow tracks and howling, were recorded at 18 different sampling sites of the park. Maximum signs found were scats and snow tracks of the species. According to Roberts (1997), the grey wolf can occur in almost any type of habitat, but it usually avoids natural forests and densely populated areas. The species is mainly confined to remotely barren hilly regions and extensive deserts. In mountainous region, it uses the natural caves, it ascends into the mountain's regions of Pakistan from Baluchistan up to Chitral, Gilgit and Baltistan in the north (Roberts, 1997). These studies support its occurrence in Deosai National Park, and its elevational range. Results of the current stud also highlight that grey wolf shows elevational migration during summer and winter seasons, going higher elevation during summer but descending down during winter season, which is logical looking at the topography and environmental conditions where winters are very harsh. Abbas *et al*. (2013) had reported grey wolf in Gilgit-Baltistan, reported about 350 - 400 individuals of

the species distributed over 35,000 km$^2$ of Gilgit-Baltistan, Pakistan, at density of 1.0±1.4/100 km$^2$. During 2005-2006, some 66-87 wolves were killed by villagers in winter by using firearms due to attack on their livestock (no attack reported on human). However, by looking at the results of the current study and the published home range size of the species, it seems less likely that 400 grey wolves could be present in the Gilgit-Baltistan area.

Results of diet investigation have shown that grey wolf in Deosai National Park consumes seven wild and six domestic prey species. Its overall diet comprised of approximately 54% livestock depredation and 46 % wild prey. If we look at its wild prey, it consumes some important wildlife species including trophy animal markhor, endangered Himalayan musk deer, Himalayan ibex, golden marmot, Royel's pika and Asian palm civet, along with house mouse. Out of these most frequently consumed are golden marmot, house mouse, Royale's pika, palm civet, while markhor consumption by grey wolf is also considerable by percent volume. This list of prey species indicates availability of wild prey in its distribution area of Deosai National Park. However, we did not find any evidence of consumption of red fox and Laddakh urial by grey wolf, which are also present in the same area. According to Ciucci and Boitani (1998) and Sidorovich *et al*. (2003), the wolf density in an area is primarily is limited by ungulate availability, and then by rates of wolf population change, in response to human caused mortality. More recently Hamid *et al*. (2019) reported from south Waziristan that wild prey share in grey wolf diet being 48%, with major prey species including rhesus monkey (*Macaca mulatta*), cape hare (*Lepus capensis*), Royel'spika (*Ochotona roylei*), house rat (*Rattus rattus*), red fox and wild boar (*Sus scrofa*). But in our study, rhesus monkey does not occur in Deosai National Park, as well as the wild boar, and grey wolf in our study area did not hunt on red fox and cape hare.

A major portion of grey wolf diet (54 %) in the Deosai National Park comprised of domestic prey which indicates higher proportion of livestock depredation by wolf in the study area. Six domestic species were found in wolf diet in the study area including camel, yak, cow, donkey, goat and sheep. Out of these, first four livestock species seem likely to be scavenged by grey wolf rather than being depredated. However, grey wolf is known to depredate frequently on goats and sheep in some other areas of the country. According to Kabir *et al*. (2017), the grey wolf has been extirpated from most of its historic range in Pakistan primarily due to its impact on livestock and livelihoods. Jhala (2003) reported that grey wolf used many strategies for hunting including stalking activity and rushing or chasing phenomenon. It can hunt prey larger than its body size because of hunting in packs or co-operative hunting strategy. According to Singh and Kumara (2006), grey wolf consumes large ungulates in the areas like arid and semi-arid environments, but also subsisting on small sized livestock species such as goat, sheep and even on other small sized wild prey such as wild hare and rodents. The grey wolf has also been reported to consume insects, birds and fruits of some plants, like *Ziziphus* spp. The Indian grey wolf also preys on donkey and newborn of camel (Jhala, 1993). It also frequently consumes domestic dogs and on outskirts of mountain villages, also prefers practicing cannibalism.

By looking at the summer and winter diet of grey wolf in the Deosai National Park, grey wolf consumed more percentage of wild prey in summer (52.5%) season than in winter. However, grey wolf depredated more on livestock (59%) in winter compared to summer (47.5%). This fact indicates that due to severe winters in the study area, less wild prey was available to grey wolf, as a result it depredated comparatively more on livestock in winter season. The current study continued from July 2018 to December 2019, covering one winter of 2018-19 and months of October, November and December 2019, when there is no livestock grazing because livestock is taken to lower altitudinal grazing lands as Deosai National Park gets snow covered, and during these months only wild animals are available to grey wolf. In Deosai National Park and surrounding areas, during severe winters the local community called "Bakarwal" take their livestock to lower elevations for grazing. However, limited numbers of donkey, yalk, and cow, sheep and goat are still maintained at homes during winter, especially for being used as meat and load carriage purposes. These livestock are left freely in open surrounding areas to feed upon whatever the left-over grasses are available, making these livestock more vulnerable to depredation by grey wolf. In addition, the temporary rooms or sheds constructed poorly for keeping livestock at homes at night are actually open roofed for getting sunshine during winter for the livestock. This fact also makes livestock more vulnerable to wolf attacks during this period of time. Similarly, local community living in Sadpara and Chilm areas that are part of the Deosai, keep livestock at their homes and they mainly depend on their livestock for their living, these are also easy target for wolf depredation. Another important point is that higher altitudes of Deosai National Park get snow covered in the last part of December and then in January months but before these two months, wolf finds its livestock food in the same area. The wolf scats collected from the study area in winter season are mainly before December and January months when livestock are available. Therefore, consumption of more livestock food by grey wolf in winter

season as compared to summer is justified.

Earlier published studies reported that grey wolf depredation on livestock was a major threat for the lives and livelihoods of the local people in the areas having grey wolf around as it has become an obstacle to its conservation (Hosseini-Zavarei *et al*., 2016). The rate of livestock loss was considered high in villages where depredation by grey wolf was more frequent with high wolf population than the less frequent with low wolf population (Xu *et al*., 2015).

## CONCLUSION

The study concludes that Deosai National Park is an important protected area for wolf distribution where the species occurs at elevation ranging from approximately 3900 m to 4300 m. The grey wolf consumes both wild and domestic prey species as its food with more share from livestock. During winter season, grey wolf depredates and kills more domestic prey as a result it can lead to a high level human-grey wolf conflict in the study area.

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*Statement of conflict of interest*

The authors have declared no conflict of interest.

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