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# POPULATION DENSITY AND HABITAT USE OF HIMALAYAN IBEX (CAPRA IBEX SIBIRICA) IN NAGAR VALLEY, GILGIT-BALTISTAN, PAKISTAN

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***Abstract***

*Monitoring of animal populations and their habitat is necessary to conserve, manage or harvest species and to understand their population trend. Present study determined the population size and habitat use of Himalayan Ibex in Nagar Valley of Gilgit-Baltistan. Vantage point count method was applied to estimate population. During winter, 478 Ibex were observed in 25 groups, with mean group size of (19.12 SD= 8.79) and a population density of 0.32 animals/km2, while during spring 456 Ibex were observed in 24 groups with mean group size of (19 SD= 8.65), and with a population density of 0.33 animals/km2. A sex ratio of 1.24 females/male in winter, 1.33 females/male in spring, 1.36 females/young in winter and 1.25 females/young in spring was recorded. A total of 47 plant species were identified in Ibex habitat, dominated by herbaceous species. It prefers precipitous habitat with 60º-70 º slopes angle, and closer to escape terrain between 21m-50m distance (69.23%). It also showed preference for southern aspect (53.8%) with less snow accumulation, the majority of Ibex were observed between 2500m and 3500m (53.8%). Major threats to Ibex in study area include poaching, competition with livestock and weak watch and ward system.*

**Keywords:** *Himalayan ibex; Habitat preference; Population density; Nagar valley*

## Introduction

Wild ungulates form an important part of ecosystem contributing to diversity, biomass and conservation values [1]. They have always been important for man as subsistence source of meat, or money by selling their meat, antlers or horns in the markets [2, 3] or as a source of recreation [4]. Besides this they are also important for maintaining carnivores' density [5] and for the ecosystem by influencing vegetation structure, plant species composition and nutrient cycling [6, 7]. Gilgit-Baltistan host six wild ungulates [8] among them *Himalayan ibex* is the largest specie [9, 10]. It inhabits relatively dry mountains of the inner Himalayas, Karakoram and Hindu Kush, which range between 3660 to 5200m elevations [9]. It is classified as Least Concern globally [11] as well as in Pakistan [12]. Earlier, conservationists were of the opinion that protected areas must be state owned [13] to increase biodiversity. This concept paved the way to marginalized custodians of protected areas and created conflicts [14, 15] with them by losing their interests [16, 17]. On the other hand due to financial constraints and lack of staff, state departments were unable to protect animals from poaching [18] and could potentially compromise the future of these protected areas [19].

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In recent past, wildlife departments and non-governmental organizations in Pakistan started to shift ownership of wild animals to local communities by establishing Community Controlled Hunting Areas (CCHAs) [20]. Since then the *Markhor* and *Himalayan ibex* have become most coveted wildlife species in many CCHAs of Gilgit-Baltistan. The revenue generated by trophy hunting of Himalayan ibex has contributed to the socio-economic uplift of local communities [8]; hence persuading local people to conserve wildlife in their area has resulted in an increased population of wildlife species [21]. However, since the establishment of these CCHAs, very few studies had been conducted to estimate population of *Himalayan ibex* [22, 23] and *Markhor* [24]. Monitoring these ungulates always remains necessary in order to know about their population trend and habitat utilization [25] and to check the effectiveness of conservation interventions [26]. The increasing human population and pastoral activities have declined their population especially in the subcontinent [27]. Therefore, the monitoring of these ungulates has become necessary for their management [28-30]. The present study assessed the population status, habitat utilization and threats to *Himalayan ibex* in Nagar Valley, Gilgit-Baltistan.

## Materials and methods

### *Study Area*

Nagar Valley is situated in the Karakoram Range, between 36°15′45.93″N and 74°43′54.91″E at 1700 to 8000 m elevation with an area of 6134km$^2$ (Fig. 1). The area is characterized by low precipitation (average annual rainfall 144.9mm) with monthly mean minimum temperature of -1ºC and a maximum temperature of 23.3ºC [31]. Plant growth is confined to a short period (April to September). The lower valleys of Nagar (Chalt-Chaprot, Bar, Sikanderabad, Ghulmet, Pisan and Minapin) fall in Mountain Dry Temperate Coniferous forest while upper valleys (Faker to Hisper) in Sub-Alpine zone. Mountains of lower valleys harbor *Cedrus deodara*, *Pinus wallichiana*, *Abies spectabilis*, *Picea smithiana*, *Pinus gerardiana*, *Juniperus spp.*, *Betula utilis, Rosa webbiana, Hippophea rhamnoides* and *Artemisia spp*.

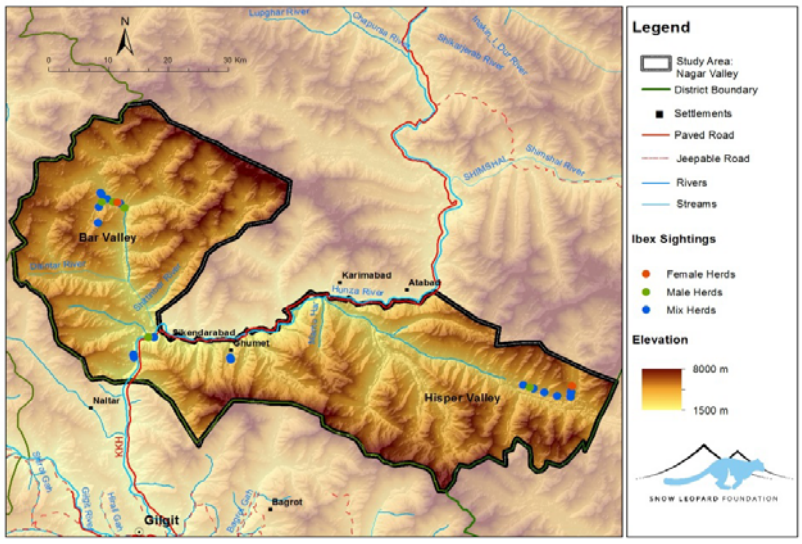


**Fig 1.** Map of the study area: colored dots indicate location of Himalayan ibex herds

The upper valleys are characterized by the highest snowfall (up to three meters) in Northern Areas, but with low rainfall. The prominent plant species of this zone include

*Juniperus spp.*, *Ephedera spp., Artemisia Vibernum, Andropogon spp., Berbris spp, Lonicera* spp. and *Ribes spp.* [32]. Human population of Nagar valley is around 50,000 and WWF [33] reported 35,814 livestock in the valley. Agricultural framing and livestock herding is the main source of income for people of the valley. Trophy hunting of ibex introduced in Bar valley by declaring it CCHA and later on Sikanderabad, Pisan-Minapin and Hisper valleys were also declared as CCHA.

***Methodology***

Study was carried out from November 2010 to May 2011, during rut period and sprouting of new grasses. 'Fixed Point Count Method' [34] was used for estimating Ibex population. Animals were scanned from high vantage points along ridgelines in the morning and late afternoon when animals usually feed, by using binoculars (10-50X) and spotting scope (20–60X). On sighting, Ibex were classified by sex and separated into age classes such as young of the year, yearling (1 ½ years), female (adult), males: Class I (2½ years), Class II (3½ years), Class III (4½ years), Class IV (5½+ years) [9]. Habitat preference of the ibex was determined by recording their presence at various sub-habitats, altitude, aspect, slope angle, and distance to escape terrain. The percentage of each habitat variable was obtained by summing total number of ibex sightings in it and dividing it with the total number of sub-categories in that category. GPS was used to record the locations of ibex sightings. Habitat analysis was carried out through vegetation sampling by using the quadrate method. A total of 92 quadrates were laid down between 1824m and 4300m elevation (34 in Bar Valley between 3119-4013m, 13 in Sikanderabad/Jafferabad between 1824-2335m, 15 in Ghulmet/Minapin between 2388-3085m and 30 in Hisper Valley between 3315-4300m). Using this method plant density, frequency, relative frequency, cover and relative cover were calculated [35].

## Results

***Population size and density***

A total of 478 *Himalayan ibex* were sighted in winter and 456 in spring, counted at four study sites (Table. 1). For both seasons data was collected from the same valleys by scanning *Ibex* from same vantage points.

**Table 1.** Population density of *Himalayan ibex* during winter and spring**.**

| Area | | Young of the year | | Yearling | | Female | | Male Class wise | | | | | | | | | | Density Ibex/km$^2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | I | | II | | III | | IV | | Total | | | |
| Name of study site | Total Area | Winter | Spring | Winter | Spring | Winter | Spring | Winter | Spring | Winter | Spring | Winter | Spring | Winter | Spring | Winter | Spring | Winter | spring |
| Bar | 906 | 25 | 23 | 20 | 15 | 90 | 83 | 06 | 00 | 15 | 12 | 22 | 21 | 28 | 23 | 206 | 177 | 0.23 | 0.22 |
| Sikandarabad | 44 | 17 | 15 | 13 | 13 | 18 | 17 | 00 | 00 | 06 | 06 | 04 | 04 | 11 | 03 | 69 | 58 | 1.57 | 1.32 |
| Ghulmet/ Minapin | 210 | 10 | 10 | 11 | 11 | 24 | 24 | 00 | 00 | 08 | 08 | 07 | 07 | 10 | 10 | 70 | 70 | 0.33 | 0.33 |
| Hisper | 275 | 22 | 25 | 10 | 15 | 62 | 64 | 03 | 04 | 03 | 04 | 13 | 16 | 20 | 23 | 133 | 151 | 0.48 | 0.55 |
| Total | 1435 | 74 | 73 | 54 | 54 | 194 | 188 | 09 | 04 | 32 | 30 | 46 | 48 | 69 | 59 | 478 | 456 | 0.33 | 0.32 |

Valley wise counts were; Bar 206 in winter, 177 in spring, Sikandarabad 69 in winter, 58 in spring, Ghulmet / Minapin 70 both in winter and spring, Hisper 133 in winter and 151 in spring. *Himalayan ibex* population during the winter and spring was not statistically significant at four study sites ($X^2 = 3.77$, DF = 3, $p = 0.28$). Overall season wise density of ibex was 0.33 animals/km$^2$ in winter and 0.32 animals/km$^2$ in spring. The valley wise density was: (a) Bar valley: 0.23 animals/km$^2$ in winter and 0.22 in spring; (b) Sikandarabad: 1.57 animals/km$^2$ in winter and 1.32 in spring; (c) Ghulmat/Minapin: 0.33 animals/km$^2$ both during winter and spring, and (d) Hisper valley: 0.48 animals/km$^2$ in winter and 0.55 in spring.

***Herd size***

During winter, 478 *Himalayan ibex* were sighted in 25 groups with mean group size of 19.12 (SD = 8.79) while during spring 456 animals were sighted in 24 groups with mean group size of 19 (SD = 8.65). During winter about 92.0% sightings were of mix herds, 4% of female herds and 4% of male groups. During spring, it was 70.83% in mixed herds, 12.5% in female herds and 16.66% in male herds.

***Sex Ratio***

During winters there were 1.24 females/male, in spring there were 1.33 females/male, while 1.36 females/young in winters and 1.25 females/young during spring were recorded.

***Habitat Utilization***

Herbaceous vegetation dominates *Himalayan ibex* habitat with 69.38 percent composition followed by shrubs (16.32%), grasses (8.16%) and trees (6.12%). A total of 47 plants species were identified in ibex habitat in the study area (Table 2).

**Table 2.** Plant species in Himalayan Ribex habitat in Nagar Valley.

| S. No | Botanical Names | Relative Density | Relative Frequency | Relative Cover | Important Value Index |
|---|---|---|---|---|---|
| 1 | *Artemisia maritma (H)* | 8.337 | 20.722 | 21.767 | 50.826 |
| 2 | *Juniperus macropoda (T)* | 6.396 | 10.430 | 9.322 | 26.198 |
| 3 | *Betula utilis (T)* | 6.517 | 3.849 | 4.222 | 14.588 |
| 4 | *Poa bulbosa (G)* | 7.361 | 3.547 | 2.473 | 13.381 |
| 5 | *Sophora mollis (S)* | 2.007 | 4.046 | 6.063 | 12.116 |
| 6 | *Poa pratensis (G)* | 5.017 | 3.547 | 2.835 | 11.399 |
| 7 | *Barago spp (H)* | 5.386 | 2.357 | 2.883 | 10.626 |
| 8 | *Rosa webbiana (S)* | 1.319 | 3.129 | 4.580 | 9.028 |
| 9 | *Ailanthus altissima (G)* | 3.383 | 2.382 | 2.823 | 8.588 |
| 10 | *Salix spp (T)* | 2.282 | 3.280 | 2.740 | 8.302 |
| 11 | *Astragalus spp (H)* | 1.394 | 3.325 | 1.993 | 6.712 |
| 12 | *Urtica dioica (H)* | 2.260 | 2.083 | 1.460 | 5.803 |
| 13 | *Tamarix gallica (S)* | 1.391 | 1.936 | 4.469 | 5.796 |
| 14 | *Ranunculus spp. (H)* | 2.205 | 1.315 | 2.100 | 5.62 |
| 15 | *Ephedera intermedia (H)* | 1.266 | 1.936 | 1.38 | 4.582 |
| 16 | *Hippophae rhamnoides (S)* | 1.854 | 1.563 | 2.107 | 5.524 |
| 17 | *Stipagrostis plumose (G)* | 1.911 | 1.315 | 2.100 | 5.328 |
| 18 | *Viola rupestris (H)* | 1.666 | 1.563 | 1.688 | 4.917 |
| 19 | *Juniperus excelsa (T)* | 1.127 | 1.785 | 1.818 | 4.73 |
| 20 | *Juniperous communis (S)* | 0.106 | 1.414 | 2.405 | 3.925 |
| 21 | *Mentha longifera (H)* | 1.301 | 1.041 | 1.374 | 3.716 |
| 22 | *Polygonum spp (H)* | 1.102 | 1.936 | 0.417 | 3.455 |
| 23 | *Orobanche cernua (H)* | 0.441 | 1.315 | 1.470 | 3.226 |
| 24 | *Equisetum arvense (H)* | 1.691 | 0.595 | 0.909 | 3.195 |
| 25 | *Artemisia afra (H)* | 0.349 | 1.787 | 1.053 | 3.189 |
| 26 | *Androsace baltistanica (H)* | 1.315 | 0.595 | 0.909 | 2.819 |
| 27 | *Artemisia dracunculus (H)* | 0.441 | 1.315 | 1.050 | 2.807 |
| 28 | *Carum spp (H)* | 0.877 | 1.190 | 0.6 | 2.667 |
| 29 | *Plantago lanceolata (H)* | 0.225 | 0.968 | 1.215 | 2.408 |
| 30 | *Aster spp (H)* | 1.164 | 1.041 | 0.085 | 2.290 |
| 31 | *Rheum spp (H)* | 0.113 | 1.119 | 1.013 | 2.246 |
| 32 | *Fragaria spp (H)* | 0.288 | 0.970 | 0.886 | 2.144 |
| 33 | *Sambucus nigra (S)* | 0.113 | 1.119 | 0.581 | 1.811 |
| 34 | *Rhodiola spp (H)* | 0.106 | 1.414 | 0.085 | 1.605 |
| 35 | *Ribes alpestre (S)* | 0.075 | 0.746 | 0.724 | 1.545 |
| 36 | *Indigofera spp (H)* | 0.075 | 0.746 | 0.726 | 1.545 |
| 37 | *Berberis lycium (S)* | 0.075 | 0.746 | 0.651 | 1.473 |
| 38 | *Bistorta affinis (H)* | 0.185 | 0.595 | 0.636 | 1.416 |
| 39 | *Onosma spp (H)* | 0.075 | 0.746 | 0.506 | 1.328 |
| 40 | *Dactylorhiza hatagirea (H)* | 0.187 | 0.595 | 0.318 | 1.1 |
| 41 | *Taraxicum officinale (H)* | 0.250 | 0.595 | 0.045 | 0.890 |
| 42 | *Potentilla spp (H)* | 0.037 | 0.373 | 0.484 | 0.844 |
| 43 | *Aquilegia spp. (H)* | 0.037 | 0.373 | 0.361 | 0.771 |
| 44 | *Pedicularis spp. (H)* | 0.037 | 0.373 | 0.289 | 0.699 |
| 45 | *Cochicum spp (H)* | 0.037 | 0.373 | 0.217 | 0.628 |
| 46 | *Rumex spp (H)* | 0.037 | 0.373 | 0.144 | 0.555 |
| 47 | *Geranium spp (H)* | 0.037 | 0.373 | 0.144 | 0.554 |

Dominant tree species were *Juniperus macropoda*, *Betula utilis*, *Salix spp* and *Juniperus excelsa.* Dominant shrubs included; *Sophora mollis*, *Rosa webbiana*, *Tamarix gallica*, *Hippophae rhamnoides*, *Juniperus communis*, *Sambucus nigra*, *Ribes alpestre* and *Berberis spp*. Dominant herb species included *Artemisia maritima*, *Astragalus spp*, *Barago spp, Urtica dioica*, *Ephedera intermedia*, *Viola rupestris* and *Indigofera spp*. *Poa bulbosa*, *Poa pratensis*, *Ailanthus altissima* and *Stipagrostis plumose* were the dominant grasses in *ibex* habitat. *Artemisia maritima* was found in all four study sites with highest IVI value (50.826) (Table 2).

*Himalayan ibex* preferred precipitous habitat (30.7%), a statistically significant difference ($p < 0.05$) was observed in different habitat types (Table 3)**.** Similarly, it showed a preference for 60º-70º slopes angle as more than 50 percent sightings were recorded on moderate slopes. There was a statistically significant difference ($p < 0.05$) between slope angle sub-categories. *Himalayan ibex* were mostly observed closer to escape terrain between 21-50m distance (69.23%), a statistically significant difference being observed in escape terrain sub-categories ($p < 0.05$). As the study was conducted during November to May, *Himalayan ibex* showed preference for southern aspect (53.8%) with less snow accumulation than other aspects. Majority of *Himalayan ibex* were found at an altitude between 2500-3500m (53.8%) (Table 3) and there was no significant difference between altitude uses as ibex moves from low to higher altitude with snow melting.

**Table 3.** Use of different habitat variables by Himalayan Ibex in Nagar Valley

| Type of variable | No of sighting | Percent sighting |
|---|---|---|
| **i) Habitat feature** | | |
| Cliffs/Rocks | 8 | 30.76 |
| Smooth Slopes | 4 | 15.38 |
| Grassland | 3 | 11.53 |
| Barren | 3 | 11.53 |
| Forest | 3 | 11.53 |
| Snow covered | 2 | 7.69 |
| Broken areas | 2 | 7.69 |
| Scree | 1 | 3.84 |
| **ii) Distance to escape terrain (m)** | | |
| Very close to cliff (1-20) | 5 | 19.23 |
| Close to cliff (21-50) | 18 | 69.23 |
| Away from Cliff (51-70) | 3 | 11.53 |
| **iii) Aspect** | | |
| North | 4 | 15.38 |
| South | 14 | 53.84 |
| West | 3 | 11.53 |
| East | 5 | 19.23 |
| **iv) Slope angle (degree)** | | |
| Moderate (60-70) | 13 | 50.0 |
| Steep (71-80) | 3 | 11.53 |
| Very Steep (90) | 10 | 38.46 |
| **v) Altitude Range (m)** | | |
| 1500-2500 | 5 | 19.2 |
| 2500-3000 | 7 | 26.9 |
| 2500-3500 | 7 | 26.9 |
| 3500-4000 | 6 | 23.0 |

## Discussion

The population density of *Ibex* was 0.22 animals/km$^2$ in Bar valley in spring whereas an earlier study reported a density of 0.68 animals/km$^2$ in spring [22]. This fluctuation can be attributed to community conflicts over trophy hunting revenue and subsequent poaching. Low spring densities in Bar and Sikandarabad could be due to either mortality of some individuals due to harsh weather or poaching due to weak watch and ward system [18]. High population density in Hisper Valley in spring could be attributed to the affinity of *Himalayan ibex* for fresh

sprouting [9]. The timberline oscillates between 3600m-3700m in Hisper and animals congregate at low altitudes to feed on fresh sprouting [9, 36] hence it becomes easier to count animals accurately.

*Fox et al.* [37] estimated 91 males, 100 females, 78 young and 33 yearlings of *ibex* in Ladakh where age distribution of males was 43 percent of class III, 34 percent of class II and 23 percent of class I with a density of 0.5 - 0.6 animals/km$^2$. *Schaller et al* [38] reported a density of 0.02 animals/km$^2$ from Mintika and 0.95 animals/km$^2$ to 1.3 animals/km$^2$ for Taxkorgan Nature Reserve. *Namgail* [39] reported during a habitat overlap study a density 0.5 animals/km$^2$ for *ibex* in Ladakh India. Similarly, *Feng et al* [40] found a density of 269.76/100km$^2$ in Tomur National Nature Reserve, Xinjiang, China.

The herd size in the present study (19.12, SD = 8.79 in spring, 19 SD = 8.65in winter) was not so different from the previous observations of *Roberts* [36] who observed herds of ibex ranging from eight to fifty animals in Gilgit and Baltistan region. *Fedosenko and Blank* [41] reported a herd size of up to 30 in Altai Mountains, Russia and up to 70 in Pamir region. *Fox et al* [37] reported the mean group size in Ladakh, India of 11 animals while *Feng et al* [40] recorded 8.43 animals per group, which is low as compared to the present results.

*Himalayan ibex* preferred moderate slopes (angle of 60º to 70º) and steep cliffs (angel of 90º) with around 50 percent and 38 percent observations, respectively. Similar results were also reported in studies from Ladakh, India where *Himalayan ibex* preferred steep rocky areas [36]. However, Bhatnagar [42] reported that *ibex* spent 72 percent of their time on smooth areas as opposed to rugged areas in Ladakh. *Himalayan ibex* preferred areas near cliffs (69.23% sightings) with distance to escape terrain between 20 to 50m on southern aspects between 2500-3500m elevation. Schaller [9] associated the affinity of *Himalayan ibex* for steep rugged terrain with avoidance of predation. *Feng et al* [40] in China reported that ibex exclusively inhabits elevations between 2500-3000 with < 100m means distance from nearest cliff and at slopes between 30º-45º in Northern India *Fox et al* [37] found *Himalayan ibex* at elevations of 4000-4725m.

During the present study around 54 percent of animals were found on southern aspect which had scare vegetation but also less snow cover as compared to northern slopes. Schaller [9] reported that *ibex* use southerly facing slopes due to their better pasture availability in Gilgit. Majority of *ibex* (53.8%) were observed at altitudes between 2500-3500m. *Ibex* descend to low altitudes during rut (late December- early January) and in early spring (March-May) to forage on newly grown grass as low as 2450m [9, 36, 42]. *Artemisia sp* is the common plant reported from *ibex* range by [9, 36, 42]. Any direct competition of livestock with *Himalayan ibex* was not noted during the study except in Sikandarabad where *Himalayan ibex, Markhor* (*Capra f. falconeri*) and livestock were found in close vicinity, but the local herders refused any competition with *ibex* and transmission of diseases to each other. However, there could be still a chance of competition [39], as in Indian Trans-Himalayas many studies have shown competition between livestock and *Himalayan ibex* [43]. *Himalayan ibex* has indirect competition with livestock, as this stays in winter grazing pastures of *Himalayan ibex* during summer and consumes most of the biomass [43]. Fodder collection by local people to stall for winter feeding of their livestock was noted during this study as also reported earlier by various studies [44].

## Conclusions

A viable population of *Himalayan ibex* was recorded in the study area, *ibex* were found to preferred high altitudes and grazes in areas closed to escape terrain. Poaching, competition with livestock, habitat degradation are a direct threat to its survival. Therefore, government departments consult with local communities for better watch and ward system. Recruitment of game watchers, conducting annul *ibex* population census, adopting rotational grazing by community, ban on fodder cutting in core *ibex* habitat and a study on diet overlap of *ibex* with other ungulates are some management options that need to be addressed immediately for sustained survival of viable population of *Himalayan ibex* in the study area.

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