FOREST, WILDLIFE AND PARKS DEPARTMENT
GOVERNMENT OF GILGIT-BALTISTAN

RUT SEASON SURVEY REPORT 2020-21

HIMALAYAN IBEX & BLUE SHEEP

IN GOJAL, GHIZER AND SKARDU, GILGIT-BALTISTAN, PAKISTAN

10 Billion Tree Tsunami 2020
10 Billion Tree Tsunami 2018
FOREST DEPARTMENT Gilgit Baltistan
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Himalayan Ibex (*Capra ibex sibirica*) & Blue Sheep (*Pseudois nayaur*)

IN GOJAL, GHIZER AND SKARDU, GILGIT-BALTISTAN, PAKISTAN

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This report on "The Current Status of Himalayan Ibex (*Capra ibex sibirica*) & Blue Sheep (*Pseudois nayaur*) in Gojal, Ghizer and Skardu, Gilgit Baltistan (2020-2021)" has been developed for Gilgit-Baltistan Forest, Wildlife and Parks Department, with the support of Ministry of Climate Change, IUCN Pakistan, Snow Leopard Foundation and divisional offices of Forest, Wildlife and Parks Department.

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Executive Summary

Mountain areas provide suitable habitat for a number of wildlife species including Himalayan ibex (*Capra ibex sibirica*) which occurs China, India, Afghanistan, Uzbekistan, Tajikistan, Kyrgyzstan and Pakistan. In Pakistan, it is found in Karakoram, Hindu Kush and Himalayan mountain ranges of Gilgit-Baltistan, Kashmir and Chitral. In Azad Jammu Kashmir it is present Neelam Valley. In Gilgit-Baltistan, it is abundant in districts Ghizer, Hunza, Nagar, Gilgit and Skardu, while in Chitral districts its strongholds are around the valleys of Terich Mir, ibex was also reported from Swat and Dir districts. In IUNCN red list it is categorized as least concerned species. The main threats to Ibex are poaching, avalanches, predators, completion with livestock and climate change.

The double observer method (DOM) was employed to estimate the population of ibex, during two conducted in 2020 and 2021. The first survey that was conducted during the winters of 2020 in different Community managed Conservation areas (CMCAs) of Gojal subdivision in district from 7th January to 15th January, 2020. A total of 1487 ibex were sighted with 95%CI ± 997.45) in 75 herds with a mean size of 19.83 ibex/herd. Sex ratios of female to young was (1: 0.39) and female to male (1:0.57) while female to yearling was (1: 0.24) respectively. The population was comprised of 45.05 % adult female, while 4.24% were in Class I, 4.30% in Class II, 5.64% in Class III and 11.83% were in Class IV , young were 17.75% and yearling constitutes 11.16% of the estimated population.

The Second survey was conducted during winters of 2020-21 in different valleys of districts of Ghizer and Skardu. A total of 269 animals including 85 males, 111 adult females, 30 yearlings and 43 young were counted. In SKB area, a total of 67 animals were sighted which included 25 males, 26 adult females and 16 yearlings. Population of Ibex on the basis of sex (female = 41.3 %, Young = 16 %, Male=31.6 % and Yearling were 11.2 %) in district Ghizer and for SKB it was 37%, 39% and 24% male, female and yearling respectively.

However the current recorded biomass of ibex was insufficient for the predators (snow leopard (*Uncia unicia*) and wolf (*Canis lupus*) population in the area. These surveys were first ever effort estimate the population of Himalayan ibex to allocate trophy quotas scientifically i.e., 2 % of the total population or 25% of the trophy animals could be harvested, while keeping the male to female ratio at minimum of 1:6. On the basis of this survey report we proposed 30 trophies taking 2 % of the total population counted or 22 animals taking 25% of the total trophy animals, having consider the male to female ratio of 1:4, we proposed 25 animals can be harvested.

1. INTRODUCTION

Pakistan is home to a great variety of habitats that are spawned over a great altitudinal variation starting with few 100 meters a.s.l in the extreme south and reaches up to 8,611 meters on the top of K2 in the extreme north i.e., , Gilgit-Baltistan.. Gilgit-Baltistan is famous for its unique mountain and associated ecosystems and rich diversity of wild fauna. Many important and threatened large mammals both carnivores and herbivores are thriving in the mountains of Himalaya, Karakorum, Pamir and Hindu Kush, including Astor Markhor (*Capra falconeri falconeri*), Ladakh urial (*Ovis vignei vignei*), Himalayan ibex (*Capra ibex sibirica*), Blue sheep (*Pseudios nayaur*), Marco Polo sheep (*Ovis ammon polii*), and Musk deer (*Moschus chrysogaster*). The carnivores species include Himalayan brown bear (*Ursus arctos isabelinus*), snow leopard (*Panthera uncia*), black bear (*Ursus arctos thibetanus*), grey wolf (*Canis lupus*) Himalayan lynx (*Lynx lynx*) (Zafar et al., 2014).

1.1 Himalayan Ibex

Himalayan ibex is a symbol of arid and rocky mountain of Karakoram, Hindukush and Himalayas of Gilgit-Baltistan (Khan et al., 2016) The males have heavy body, large horns, long bears and females are small body and small horns. Its presence in its natural habitat is essential to maintain healthy ecosystem. Himalayan ibex it is categorized as a least concerned species internationally according to IUCN red list (IUCN, 2020).

The Himalayan ibex is distributed in neighbouring countries of Pakistan, including China (Reading & Shank, 2008), India (Bagchi, Mishra, & Bhatnagar, 2004; Fox, Sinha, & Chundawat, 1992), Afghanistan (Fedosenko & Blank, 2001) and in north-eastern Uzbekistan, Tajikistan, Kyrgyzstan mountains and in northern Pakistan (Ali et al., 2015; Khan et al., 2020; Raza et al., 2015; Ali et al., 2007).

1.2 General Characteristics

Ibex is a sturdy, thick-set goat. The face is short and broad with a long beard in males and a shorter one in females. It lives in precipitous terrain where it requires not speed but power. Hence, they have stocky legs with healthy fore limbs to climb and leap among rocks (Schaller, 1977).

Ibex are sexually dimorphic and their pelage colour varies round the year. In winter adult males are a prominent, dark brown with a white saddle and in some males whitish areas are also present on shoulders, abdomen, legs and thighs. A dark flank stripe is present in some animals. The whitish rump patch is surrounded by light coloured hair that extends down the back of the legs. In contrast, females have grey brown coats with less conspicuous whites on their bodies (Fox et al., 1992; Schaller, 1977).

Ibex develop a dense under-fur of fine wool (pashm) during winter that enables them to withstand extremely low temperatures. Moulting occurs during spring and early summer (May - July) in most parts of its range, after which ibex acquire a paler coat (Fox et al., 1992; Schaller, 1977)Ibex males have scimitar shaped horns with a relatively flat anterior surface, broken by prominent transverse ridges. Horns grow throughout their life, the annual horn increment declining with increasing age (Nievergelt, 1981; Schaller, 1977). Horns grow during spring and summer, and cease growth at the initiation of the rut. Each of the thus formed segments can be identified by a furrow which is most clear on all sides of the horn except the anterior. Usually, 2 ridges or knobs are added each year on male horns.

An adult ibex male roughly weigh 1.5 to 2 times more than an adult female which weigh50 to 60 kg. An adult male stand about 100 cm at the shoulder while an adult female has a shoulder height of about 70 cm (Heptner et al., 1966; Schaller, 1977). The weight of an ibex male head with horns may be ca. 6 to 8 % of its body weight and the horn length is usually about 1.25 to 1.58 times longer than its shoulder height (Schaller, 1977).

Yearling males roughly equal adult females in body size and horn length but differ in having a thicker horn and a darker body. Yearling females are a little over half the size of adult females and have thin, small horns measuring approx. 10 to 15 cm (Heptner et al., 1966).

1.3 Population Structure and Group Size

Females more than two years old were considered as adults. Ibex less than two years old were classed as young. Kids were individuals in their first year and had stubby horns while yearlings were individuals in their second year with females having horn length usually < 5 cm and body size about 3/4th smaller

than adult females. Yearling male horn length was usually < 20 cm, were laterally wide with one or two frontal knobs and body size was close to, but smaller than that of an adult female. They were relatively darker than adult females and yearling females. Kids and yearling males were clearly identifiable, but yearling females and young females were sometimes misclassified. Hence, there is a chance of a slight underestimation of females. Males were recognised into following four categories;

Class	Description
A. Class I (third year):	Horn length approx. 35 cm. Horns short with little curvature. Animal usually did not develop dark brown markings on body during rut and winter
B. Class II (fourth & fifth year):	Horn length approx. 50 to 60 cm. Horns curved slightly backwards and dark brown markings with a distinct silvery 'saddle' that appeared during rut and winter
C. Class III (sixth and seventh year):	Horn length 60 to 70 cm. Horns curve back in a semi-circle and dark black coloration with silvery saddle appeared during rut and winters.
D. Class IV (> seventh year):	Horn length more than 70 cm. Horns shape and body coloration similar to Class III which also curve outward.

1.4 Status and Distribution

Geographical Distribution

Capra ibex has five subspecies i.e., Alpine ibex (*Capra ibex ibex*) occurs in the European Alps, Walia ibex (*Capra ibex walia*) in the highlands of Ethiopia, North Sudan, portions of Egypt, Nubian ibex (*Capra ibex nubiana*), founds in northern parts of Syria,Israel and Kingdom of Saudi Arabia, Spanish ibex occurs in the Caucasus, while the Himalayan ibex (*Capra ibex sibirica*) occurs in the distributed from the European Alps to the north-western Himalayas.

Ecological Distribution

Himalayan ibex live on rugged mountains of cold areas, range between (2500 to 3600m) tree line and occasionally moves to above treeline (5000m) (Schaller, 1977; Prater, 1980), while in its northerly range of the Tien Shan and Altai ranges it lives as low as altitude 500m above sea level and frequently live between 1000m to 2000 m. (Heptner et al., 1966)

Ibex prefers alpine scrub (Champion and Seth, 1968) or dry high steppe vegetation (Schweinfurth, 1957; Puri et al. 1989). These areas are dominated by scattered and open bushland mostly with shrub and herbaceous species i.e., *Artemisia spp*., *Lonicera spp* and *Caragana spp*. Such areas having low relatively annual production of biomass with high vegetation pulse during summer when ibex recapture body condition. They venture into sparsely forested slopes in lower areas of the region seasonally in Gilgit-Baltistan (GB) Pakistan (Schaller, 1977) and Central Asia (Heptner et al., 1966).

Sympatric Species and Predation

In the lower areas of Gilgit-Baltistan, ibex share its habitat with other mountain ungulates like Markhor (*Capra falconeri falconeri*) and Ladakh urial (*Ovis vignei vignei)*. In Karakoram and Pamirs range ibex found with Marco Polo sheep (*Ovis ammon polii*) (Roberts 1977; Schaller, 1977; Petocz, 1978). Alongside the south-west, west and northern marginal of the Tibetan plateau its range overlays with diverse argali subspecies (*Ovis ammon*), and bharal (*Pseudois nayaur*) (Schaller 1977, Schaller et al.,

1987; Mallon 1991; Fox et al., 1992). Snow leopard (*Panthera uncia*) and the Tibetan wolf (*Canis lupus chanko*) are the primary predators of Ibex (Schaller, 1977).

1.5 Habitat Use

Ibex are usually limited to rugged and steep terrain. Their life is closely associated with cliffs, in order to escape from predators, they use cliffs as an advantage (Fox et al., 1992; Schaller, 1977).

Ibex changes its habitat according to different seasons and select different altitudes. Throughout the year, they mostly occur on upper slopes. In peak summer, they go to highest altitudes and descending lowest during spring to take advantage of the new plant growth (Fox et al., 1992; Schaller, 1977).

The winter in the regions which is used by ibex is usually long and severe. During this season, forage is of low quality and is not easy to access through the snow cover and thus makes the period very critical. Ibex cannot move efficiently on snow, thus feeding in deep snow conditions at a considerable cost. Hence, they mainly confine to precipices on southern slopes with less or no snow. The daily movement of ibex is approximately 300 m and they may occasionally travel 3 to 5 km or more in a day, but ibex have strong affinity for tis home range (Fox et al., 1992; Schaller, 1977).

1.6 Feeding Ecology

Ibex is a gregarious species, which chooses living in rugged regions and avoids vast flat areas without cliffs or rocks. The diet of ibex contains mainly grasses and forbs, as well as sprouts, flowers, and fruits of many herb and shrub species (Johnsingh, Stuwe, Rawat, Manjrekar, & Bhatnagar, 1999). Schaller (1977) reported 14 such plant species that were eaten by Ibex. Studies have confirmed that group size and composition have a strong relationship with habitat structure, distribution of food (spatially and temporally), and reproductive characteristics (Barrette, 1991; Raman, 1997).

1.7 Behaviour

Courtship

During the rut season, all females are passive and courting males have to test for oestrus females. Usually, mating is the privilege of the dominant male in a group. A male usually approaches the female in the low stretch from behind, often twisting its head and kicking with its forefoot. The female ignores this gesture initially and may eventually comply to the persistent pursuits by urinating. The male then tests for oestrus by smelling and twisting its lip. A male repeatedly mounts a receptive female, a few seconds each time (Schaller, 1977).

Play

Young often involve in play behaviour which seem to be mostly exaggerated aggressive or sexual behavioural forms. On occasions it also involves running with huge bounds, often with hind legs thrown up in the air and head waving from side to side. Sometimes even adults involve in such behaviour (Schaller, 1977).

Escape Behaviour

Ibex have evolved in the rugged mountainous tracts where they require strength in the forelimbs to climb and jump on steep slopes and cliffs. Cliffs are one place where they can outsmart any land predator and ibex use this to their benefit in escaping predators. Being saltatorial animals, ibex cannot run fast over long distances but can climb steep slopes with ease (Schaller, 1977). Cliffs are hence referred in literature as escape terrain (Fox et al., 1992). Ibex respond to danger, especially large predators by issuing a high-pitched whistle or chirp like a bird before bounding off into escape terrain (Schaller, 1977).

Activity Pattern and Feeding Habits

Ibex mostly feed during early morning and evening, but activity patterns vary seasonally. During the month of November and December ibex had a bimodal pattern with a major activity peak around sunrise and a minor one around sunset. During mid-day, most ibex rested and after sunset they started bedding for the night. After heavy snow fall and drop in temperatures, limited observations by Fox et al. (1992) suggested that ibex had switched to a single mid-day activity peak, often remaining bedded till mid-morning, followed by feeding and bedding again just before sunset (Fox et al., 1992).

1.8 Reproduction and Population Dynamics

Reproduction

Mating period of ibex last for two to three weeks (Heptner et al., 1966). Heptner et al(1966) stated that in the Russian Pamirs, ibex mate in December-January and after a gestation period of 170 to 180 days, usually one and rarely two youngs are born in June-July, similar, pattern of mating and gestation was reported by Schaller (1977) from Pakistan.

The females become mature at the age of 3 years, and parturition synchronize with the fresh sprouting (Heptner et al., 1966). This enables the lactating females to replenish their reserves lost during the lean winter season and rear their young more efficiently (Schaller, 1977).

Ibex females having around 50 kg weight were reported to have young of 3.5 to 4.0 kg (Heptner et al., 1966). Ibex females may cache their young for 2 to 3 days, after which the young follow their mother. A strong mother-young bond exists for about a year

and may temporarily (in female yearlings) or permanently (in male yearlings) break during birth giving (Savinov, 1962; Schaller, 1977).

Longevity

Ibex is the most long lived Caprine as some animals had lived up to 15 years, based on its horn characteristics. However, during their prime years (4 to 10 years), most deaths in (male) ibex occurred with a mean of 8 years. This paradoxical situation is difficult to explain and is probably due to stressful conditions following a period of high activity, i.e., the rut, when males successful in mating have a higher chance of facing malnutrition in the following lean season i.e., winter (Schaller, 1977). Due to ambiguous annual rings, it is difficult to estimate the longevity in females.

Herding Activities

Ibex live in the form of groups and may occur in groups of adult females with young, all male groups and groups with both sexes (Heptner et al., 1966). During the year, adult males and females associate with each other. In summer season, the proportion of males increases in all males' groups. As month of October approaches, males re-join female groups, coinciding with the onset of the rut and stay with or close to the females until early summer (Bagchi et al., 2004; Bhatnagar, 1997; Zahid et al., 2018).

Population Structure

According to various authors, group size and composition of Ibex differs significantly with season, forage availability and population density. Group size ranged from 3 to 50 reported in different studies (Bhatnagar, 1997; Heptner et al., 1966; Schaller, 1977).

1.9 Conservation and Status

The IUNC Red List Data has listed ibex as a least concerned species. Ibex is one of the common ungulate along with bharal in its range (Schaller, 1977 & Fox et al., 1991). Random records on absence – presence and abundance from studies exist for its range and it is very difficult to compare the available studies due to difference in use of methods and the season or time of the study. As per studies conducted by (Schaller, 1977 & Fox et al., 1991), the ibex founds in low to average densities (0.5 to 2.8 ibex per sq. km.) in its range.

Threats such as fragmentation, competition with domestic livestock and illegal hunting and especially diseases have been the main factors responsible for demographic changes in the recent history of this species (Acevedo & Cassinello, 2009).

According to Schaller (1977), much of the ibex range in his study area in Northern Pakistan was overgrazed by livestock, and only 1 to 3 % of the plant species were eaten by ibex. Areas above 4,000 m were relatively free from human disturbance but the forage available there was very sparse due to the dry and harsh climatic conditions. In addition to these threats, mega infrastructural development projects right in the core zones of protected areas, illegal hunting and poaching and human encroachment into its habitat for various reasons are posing a great threat to the population of ibex in the study area.

1.10 Potential Threats to Ibex

Grazing Pressure on ibex feeding grounds

Resident livestock may pose a threat to ibex through transmission of contagious diseases, livestock are taken to pastures that are rich with floral composition to feed them during summers and to collect grasses for staff feeding during winters. The customary laws of the GB reserves rights of certain families or villages for livestock grazing in each nallahs, where ibex often foraged in these pastures during winter.

1.11 Trophy Hunting Programme of Gilgit-Baltistan

Trophy hunting is one of the conservation tools, widely use across the world for managing the wildlife, in trophy hunting males that spent their prime time are harvested to generate revenues. Trophy hunting of Markhor, ibex and Blue sheep in several valleys was initiated by Forest, Parks and Wildlife Department of Gilgit-Baltistan in collaboration with IUCN and WWF-Pakistan in early nineties to promote community based conservation of the dwindling ungulate species in Gilgit-Baltistan. From the revenue generated, Eighty (80) percent goes to the communities who spend this money on rural uplift and conservation related projects. It has been admired at both national and international level.

Pakistan is actively promoting community based wild resources management as a conservation tool, to ensure that the financial benefits derived from trophy hunting go directly to local communities. In some cases, trophy hunting of less threatened species has contributed to the recovery and conservation of threatened and endangered species (Lindsey et al., 2007a).

Trophy Hunting of Himalayan Ibex

Nawaz et al (2016) report that some 261 ibex were hunted between 2000 and 2014in Gilgit-Baltistan and were of the view that the trophy hunting programme has a positive effect on ibex and other wild

ungulates in northern Pakistan. However, there are many concerns from the conservationists and animal right groups about the available information on current ibex population size and the trophy hunting programme. Thus, viability of the population of the target species needs to be determined for streamlining the trophy hunting programme of Gilgit-Baltistan.

1.12 Blue Sheep

The Blue sheep (*Pseudois nayaur*), or Bharal, is endemic to the Tibetan Plateau and its adjacent mountain ranges. This sheep is apparently look like a sheep but physiologically it is more related to goats. The Blue sheep has a short, lustrous, brownish grey to greyish blue coat that provides excellent camouflage for the animal among the blue shale, rocks, and brown grasses of Tibet's open hillsides. The tip of the Sheep's muzzle, the belly, the inside and backs of the legs, and the rump patch are white. There is also a white spot on the knees and above the hooves.

The front of the neck, the chest, and the fronts of the legs are dark grey in females and black in males. A grey or black stripe divides the darker upper parts of the Blue sheep's body from the lighter under parts. The male's neck is swollen during the rut.

Both male and female Blue sheep have ridged horns. The horns of males are relatively short but massive, curving up and out from the top of the animal's head, then backwards, and curling at the tip. The horns of males measured about 24 centimetres (9.4 inches) in circumference, in males of at least six years of age, and may grow to be as long as 84 cm (33 inches).

Habitat and Distribution

The blue sheep is an alpine ungulate characterized by its sociability, resides on the Tibetan Plateau and the bordering massif through South Asia i.e. Bhutan, Nepal, China, India and Pakistan, Possibly in Tajikistan (Harris, 2003; Namgail et al., 2004). They live in groups ranging from 10-50, but sometimes the herd size may reach up to 200 individuals (Schaller, 1977; Wegge, 1979; Wilson, 1984; Fox et al., 1986). The distribution range of the blue sheep occurs at an elevation of 4550-5480 m (Chetri and Pokhare, 2005). In Pakistan, the blue sheep is endemic to the northern most province Gilgit-Baltistan (Roberts, 1997; Ablimit et al., 2011; Khan et al., 2012), as it is confined to the Khunjerab National Park (KNP) (Namgail et al., 2004) and neighbouring parts of the upper Hunza i.e. Shimshal which perhaps represents the western most population of the sheep in the Karakorum Range (Wegge, 1988).

The Blue sheep inhabits treeless slopes and alpine meadows and shrub zones above the timberline. The sheep prefers relatively gentle hillsides covered with grasses and sedges, but usually remains within 200 metres (650 feet) of cliffs up which it can climb to escape from predators.

The Dwarf Blue sheep inhabits the steep, arid, lower slopes of the Yangtze River Valley, at elevations from 2,600 to 3,200 metres (8,500 to 10,500 feet). The Dwarf Blue sheep occurs in and to the north, south, and west of Bathang (Batang) county in Kham (Sichuan province). The common Blue sheep also lives in this region, but remains in alpine meadows at higher altitudes than the Dwarf Blue sheep; approximately 1,000 metres (3,300 feet) of forest zone separate the two species.

Behaviour and Reproduction

The Blue sheep is highly a crepuscular animal, and briefly around midday. The sheep typically lives in herds. Herds may consist of all males, all females, females with young and yearlings, or females and males both adult and young. During the summer, males separate from females in some areas of the Sheep's habitat range.

The Blue sheep reaches sexual maturity between at the age of 2 years, but most males do not get a chance to mate because of dominant males out power the young males.. The mating and birth seasons of the sheep vary across the animal's habitat range. In general, the Blue sheep mates during the winter and gives birth in the summer. Reproductive success depends upon weather conditions and level of nutrition. The Blue sheep's gestation period is 160 days. Each pregnant female gives birth to one offspring. Offspring are weaned for about six months of age.

The Blue sheep's life span is 11 to 15 years. The sheep's natural predators include snow leopards, wolves, and common leopards. The Blue sheep is the snow leopard's crucial prey on the Tibetan Plateau. Blue sheep escapes when senses a potential predator in its vicinity. Their excellent camouflage often results in them being overlooked as part of the landscape.

Current Status

The Blue sheep is categorized as Least Concerned on the Red List Data Book of IUCN the total population size of the Blue sheep is estimated at between 47,000 and 414,000. The Dwarf Blue sheep is categorized as Endangered in the 2003 IUCN Red List of Threatened Species and is protected under the laws of Sichuan province. In 1997, there were estimated to be 200 Dwarf Blue sheep remaining.

1.13 Aim and Objectives of the Current Study

The current study was aimed at assessing the current status of Himalayan ibex in Community Controlled Hunting Areas (CCHAs) of Gojal, in District Hunza of Gilgit-Baltistan using a Double Observer Method (DOM) with the goal of determining, whether Himalayan ibex and Blue sheep numbers are viable enough to support and continue the trophy hunting programme in the area.

Key parameters examined, included estimation of population size as well as ratios of females to young, females to yearling and females to males and young proportion in the population with the following set of objectives:

i. To briefly describe mountain ungulates in general and Himalayan ibex and Blue sheep in particular;

ii. To estimate population size of Himalayan ibex in Gojal, Ghizer and Skardu community conservation areas;
iii. To identify the population structure of Himalayan ibex; and
iv. To assess, if the extant population of Himalayan ibex is viable enough for the continuation of trophy hunting programme in the study area.
v. Additionally, part of this survey also provides information about viable number of Blue sheep quota in Gilgit Baltistan based on scientific surveys.

2. MATERIAL AND METHOD

2.1 Location and Topography

The survey area was located in the Gilgit-Baltistan in the Districts of Hunza (Tehsil Gojal), Ghizer and Skardu. Gilgit-Baltistan, previously known as Northern areas of Pakistan, has unique climate and topography. It lies between latitudes 34–37°N and longitudes 72–77°E and is bordered to the north by western China and northern Afghanistan (Joshi et al., 2013). The Karakorum, Hindu Kush and Himalaya ranges knot in the centre of GB and diverge in different directions. The Karakorum and Hindu Kush have north-western and southwestern orientations, respectively. The east-west oriented Himalayas occupy southern parts of GB. The Himalayas receive more abundant precipitation during the summer and winter monsoon. They are therefore greener, supporting Himalayan dry temperate mountain forest, sub-alpine and alpine forest (Champion, Seth, & Khattak, 1965). The Karakoram and the western Himalayas are the main mountain ranges, the Pamir Mountains lie to the north and the Hindu Kush to the west. Outside the polar range the Gilgit-Baltistan has second largest glacier i.e., Biafo-Hisper (109 km) and five of the world's 14 peaks above 8,000 ml.

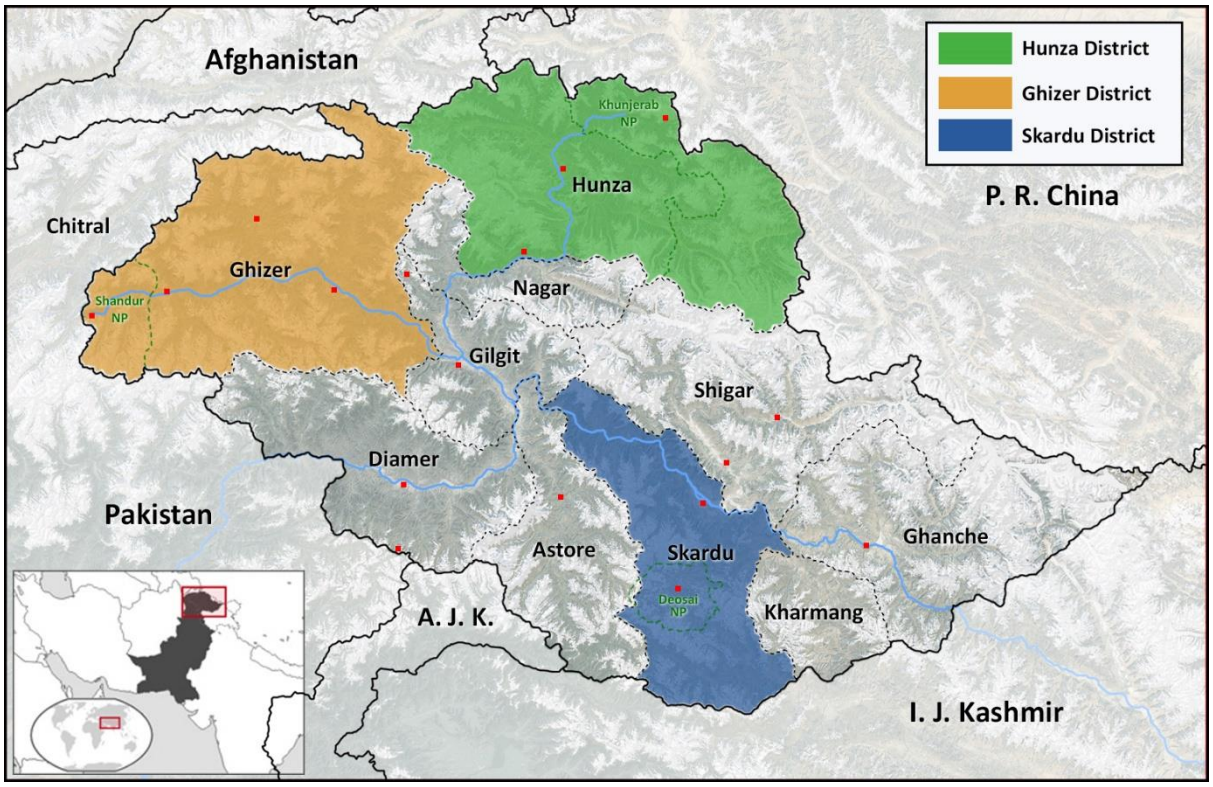

Figure 1: Location Map of Survey Areas

Yak and goats are the main animals grazing in the area. Local herders supplement their life in the lowland areas by subsistence farming and migrate their yaks seasonally between low altitude winter pastures and summer pastures in the alpine region.

The human population of Gilgit Baltistan according to 2017 census by AKRSP was 883,799 (AKRSP). The human population is surveyed districts, i.e., districts Hunza, Ghizer and Skardu were 68,589, 131,278 and 139,564 respectively.

Climate and Seasons:

The Gilgit climatic condition varies from region to region, surrounding mountains ranges creates sharp variation in weather. The eastern part has the moist zone of the western Himalayas, but goes towards Karakoram and Hindu Kush the climate dries considerably.

With the high elevation (above 2,000 masl) and rugged terrain, the climate is quite harsh and characterized by a long and cold winter, high solar radiation, and low precipitation. The maximum and minimum mean daily temperatures fluctuate between 42°C and -20 °C at many locations.

Gilgit is hot during the day in summer yet cold at night and valleys like Astore, Khalpu, Yasin, Hunza and Nagar where the temperature is cold even during the summer. At an altitude of 1,500 meters Gilgit has a desert climate with warm summers and cold winters. Precipitation figures are low all year round. During the winter precipitation often falls in the form of snow or hail. Overall, the climate is semi-arid in most parts of the Karakorum Range (Joshi et al., 2013).

2.2 Methodology

Double Observer Method

The double-observer survey method was initially developed for the estimation of the detection probabilities of the aerial surveys of the different wildlife species (Cook and Jacobson, 1979) and later on modified by (Magnusson et al., 1978) to allow for observer difference in the ability to detect the targeted species. Caughley (1974) is based on the principles of capture mark-recapture theory (Forsyth and Hickling, 1997). This method generally involves two observers scanning for and counting animals simultaneously, while ensuring that they do not signal or cue each other about the sighting of animals groups. The two observers are conducting the survey as independent surveyors. Hence, an individual group of ungulates becomes the unit that is being “marked” and “recaptured” in double-observer

technique. (Suryawanshi et al., 2012; Tumursukh et al., 2016; Ahmad et al., 2020; Khattak et al., 2019) used this method for estimating the Himalayan ibex and other mountain ungulates population in the mountain areas of the Asia.

The current survey was conducted in the month of January 2020 in 7 valleys of the Gojal Conservancies. The survey areas were divided into small blocks assuming the occupied area of one block is less than the daily movement of the Himalayan ibex. The survey blocks with either a temporal or spatial separation between them were scanned by the two independent observers (OB-1 and OB-2). Whereas the survey in Ghizer and Skardu Districts was carried out during winter of 2020-21 (26 Dec 2020 -14 January 2021).

For temporal separation, both observers adopted the same route along the survey block, but observer OB-2 began, scanning the block 20 min after observer OB-1. For spatial separation, both observers began trekking the block at the same time, but took different routes within the survey block as previously did by (Tumursukh et al., 2016).

As documented by (Roberts, 1997), the scans were carried out during the dawn (6:00 a.m. - 10:00 a.m.) and dusk (3:00 p.m. - 5:00 p.m.) to coincide with the crepuscular activity of the species. Ibex were observed using binoculars and spotting scopes and coordinates were taken using the GPS.

Groups of ibex were classified on the basis of age and sex, when there were more than one animal in each group. Further, habitat, time, and coordinates were used to differentiate among the groups seen in two adjacent areas. Upon sighting of an ibex herd, they were first counted and demographically classified on the basis of their horns and body size as previously documented by (Schaller, 1977) into the following categories: Young (<1year), Yearling (>1 < 2 years), and Adult Female (>2), Males: Class I (>3years), Class II (>4years), Class III (>5year), and Class IV (>6years).

At the end of the day both observers matched their data and similar groups were identified on the basis of herd size, demographic categories, habitat types and location. Groups that were deemed identical and groups that were deemed different were then classified. Any occurrences of double counts were removed from the dataset as did by (Masood, 2011).

2.3 Analytical Approach

The estimated population, detection probabilities, mean group size and variance in the group size were calculated by using formulas following (Forsyth and Hickling, 1997).

Estimated Number of Groups

$$G=(B+S1+1)(B+S2+1)/B+1-1 \quad (1)$$

Where,

S1 = number of group sighted by observer 1
S2 = number of group sighted by observer 2
B = number of animal group sighted by both observers
N = population estimated (rather than the number of individual)

Estimated Population Size

Population size estimated as the number of group in the population multiplied by the mean group size (Choquenot, 1990)

$$\check{N}=\hat{G}\hat{u} \quad (2)$$

Where,

$\check{N}$ = estimated population as the product of estimated number of group $\hat{G}$ and mean group size

The variance of estimated population, Var ($\check{N}$) is the variance of the product of independent random variables (Goodman, 1960).

Variance in Estimated Population

$$Var(\check{N})=\hat{G}^2Var(\hat{u})+\hat{u}^2var(\hat{G})-Var(\hat{G})Var(\hat{u}) \quad (3)$$

Where,

$$Var(\hat{G})=S1S2(S1+B1+1)(S2+B+1)/(B+1)2(B+2) \quad (4)$$

S1 = number of group sighted by observer 1
S2 = number of group sighted by observer 2
B = number of animal group sighted by both observers

Confidence Interval

Confidence intervals were calculated for each population estimated in each conservancy using the following formula (Forsyth and Hickling, 1997):

$$\check{N}\pm z\ \alpha/2^{se}\ (\check{N}) \quad (5)$$

Estimating Density

The density was estimated by divided total number animals by the surveyed area (Suryawanshi et al., 2012)

$$D=(\text{Total number of animals sighted})/(\text{surveyed area}) \quad (6)$$

Detection Probability

We used multinomial regression to determine the detection probability of observers with three possibilities for each herd in the study area:

i. herd sighted by observer OB-1 only,
ii. herd sighted by OB-2 only and/or
iii. Sighted by both observers (Unique sighting).

On the basis of "Walt test" (Yan and Su, 2009), the significance variable was selected for our model and according to p-value criteria removed the insignificant variables from the model.

3. RESULT

3.1 Status of Himalayan Ibex in Gojal Conservancy

During winter survey, a total of 1487 ibex were counted across all Gojal conservancy (Ainabad, Shishkat, Gulmit, Passu, Ghulkin, Hussaini, Khyber and KVO). The estimated population of Himalayan ibex using DOM in the study area is (N=2716: Mean 19.83 ± SE 2.38, Var(Ñ)= 252448.30, Variance in mean group 2.72, Variance in estimated number of groups is 534.75, 95% Confidence is 997.45) (Table 1).

Table 1: Himalayan Ibex in Gojal Statistical Test Results

Statistic test	Group size	Male				Female	Young	Yearling
		Class I	Class II	Class III	Class IV			
	1487	63	64	84	176	670	264	166
Mean	19.83	0.84	0.85	1.15	2.37	8.93	3.56	2.21
S.D	20.59	1.83	1.46	1.71	3.28	10.83	3.97	3.18
SE	2.37	0.21	0.16	0.20	0.38	1.25	0.46	0.36

The detection probability of both observerswas quite low and there was not any significant variation in the detection probability of Oberver-1 and Observer-2. The detection probability recorded for Observer-1 was 0.311, while for Observer-2 it was 0.318. Observer-1, sighted a total of (30 groups/herds, while Observor-2 sighted 31 groups/herds, while 14 groups/herds were sighted by both Observers, mean group size was (Ĝ=137). The density calculated on the basis of current survey was (D=1.55) ibex/km2 (Table 2).

Table 2: Double Observer Based CMR results of Himalayan Ibex in Gojal

Estimates parameters	
# groups sighted by both observers	14
# groups sighted by observer one only	30
# groups sighted by observer two only	31
Estimated number of groups	137.00
Mean Group size	19.83
Estimated population	**2716**
Variance in mean group size	2.32
Variance in estimated number of Groups	534.75
Variance in estimated population	252448.30
95% Confidence interval	**997.45**
Detection probability Observer 1	0.311
Detection probability Observer 2	0.318

The total counted or observed individuals of Himalayan ibex in the study area were (n= 1487). Out of the total counted individuals, females constituted (45.05 %), male Class I represented (4.24%), male Class II (4.30%), male Class III (5.64%), male Class IV (11.83%), young (17.75%) and yearling represented about (11.16%) (Table 3).

Table 3: Total Counts of Himalayan ibex in Gojal Conservancy

Total count	
Overall total	1487
Observer one total	1074
Observer two total	959

Distribution of Himalayan ibex in CCHAs of Gojal Conservancy is shown in (Figure 2), which showed a female dominant population, while male and young population was almost the same.

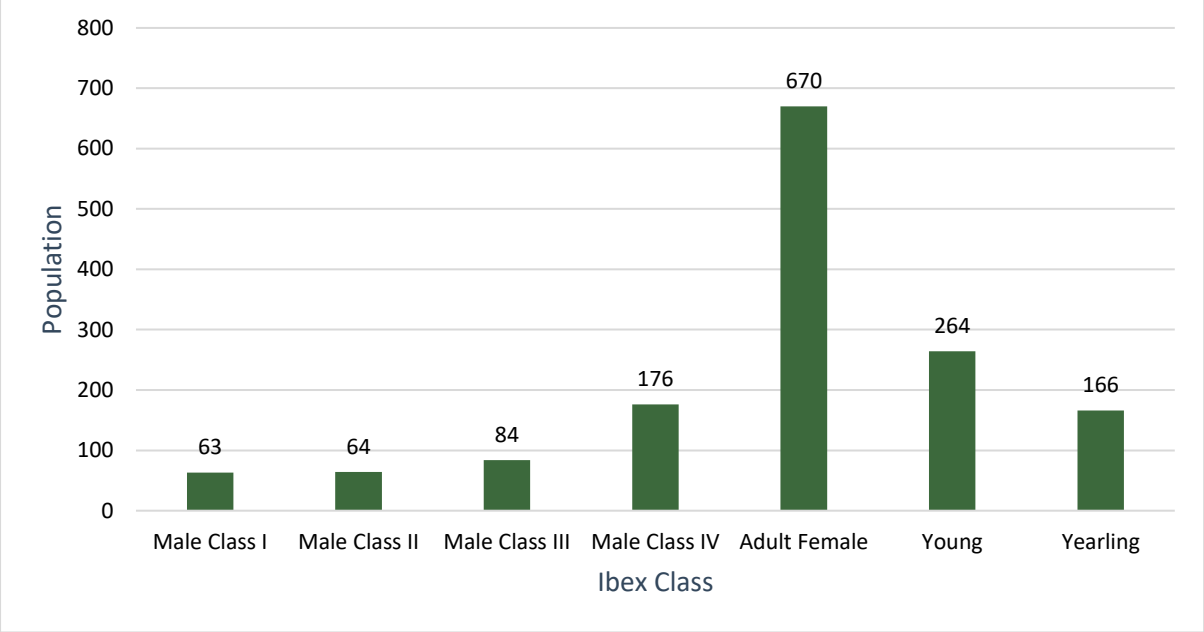

Figure 2: Class-Wise Population of Ibex in Gojal Conservancy

Table 4: Sex Ratio: Female to Male, Female to Yearling and Female to Young

Overall Ratio	Female: Male	Female: Yearling	Female: Young
Gojal CCHAs (Hussani, Shishkat, Ghulmit, Ghulkin, Khaybar Passu and KVOs consist of (Murkhun, Glapan, Jamalabad, Nazimabad, Sost, Sartiz and Gircha)	1:0.57	1: 0.24	1:0.39

Khyber Village

In Khyber, overall292 animals were sighted, out of which, male individuals were 56 (19.18%), females were 135 (46.22%), young were 49 (16.8%) and Yearlings were 52 (17.80%). The mean herd size calculated was for Khyber is (24.33 ± 7.85).

Passu

In Passu Valley, a total of 198 animals were sighted, out of which males constitutes 53 (26.77%), females were 94 (47.47%), young were 36 (18.18%) and yearlings were 15 (7.58), with the mean herd population size (12.37 ± 2.36).

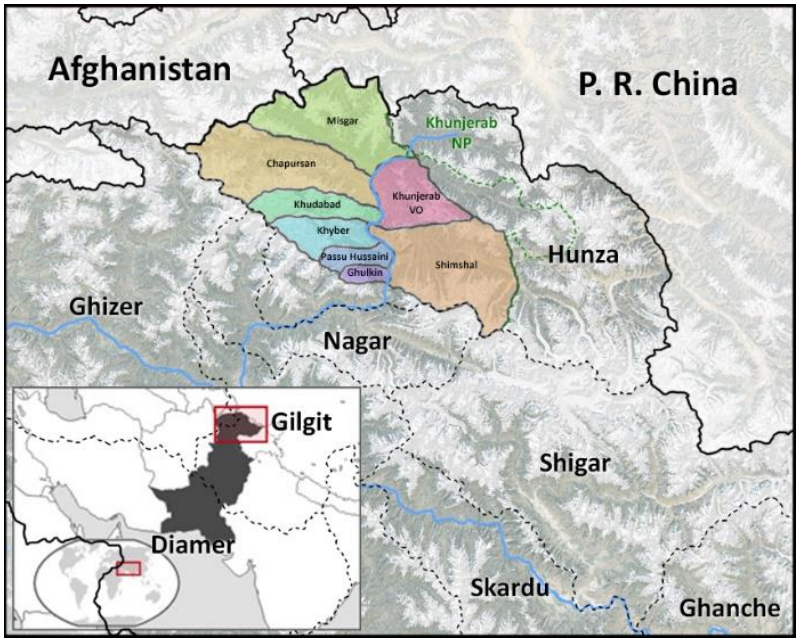

Figure 3: Map of Study Area in Gojal

Khunjerab Villagers Organisation (KVO)

In KVO, a total of 182 animals were sighted. Out of the total, males were 37 (20.33), females were 92 (50.55%), young were 37 (20.33), yearlings were 16 (8.79). The mean herd size is (13 ± 3.46).

Ghulkin

In Ghulkin a total of 275 animals were sighted, out of which males were 105 (38.18%), females were 89 (32.36), young were 49 (17.82), yearlings were 32 (11.64). Mean herd size recorded for Ghulkin was (19.64 ± 4.56).

Ghulmit, Shishkat and Ainabad

In Ghulmit, Shishkat and Ainabad a total of 131 animals were sighted, out of which males were 40 (30.53%), females were 51 (38.94%), young were 19 (14.50%) and yearlings were 21 (16.03%). Mean herd size recorded in these valleys was (16.37 ± 7.82).

Hussaini

In Hussaini Valley, a total 409 animals were sighted. Out of the total counts, males were 96 (23.47%), females were 209 (51.11%), young were 72 (17.60) and yearling were 32 (7.82). Mean herd size recorded for Hussaini Valley was (37.18 ± 8.15).

3.2 Status of Himalayan Ibex in Ghizer and Skardu

The survey was carried out during winter (26 Dec 2020 - 14 January 2021). A total of 269 animals including 85 males, 111 adult females, 30 yearlings and 43 Youngs were counted from different valleys during the survey in district Ghizer. In Skardu area, a total of 67 animals were sighted which included 25 males, 26 adult females and 16 yearlings. The demography of estimated population is showed in (Table 5) and (Figure 5).

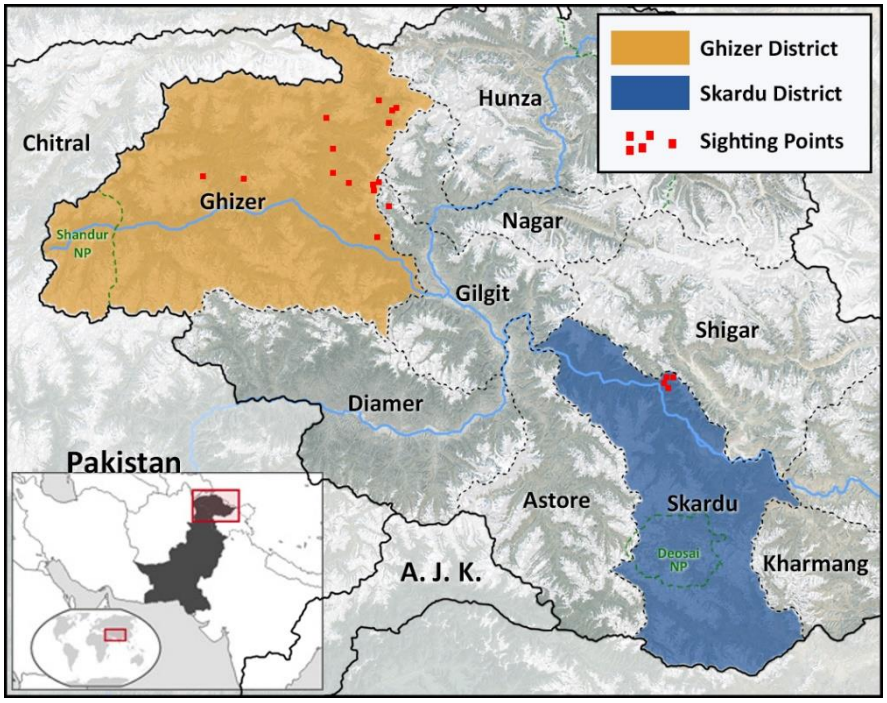

Figure 4: Map of Ibex Sighting Points in Ghizer and Skardu

Table 5: Himalayan Ibex Survey Results for Ghizer District

	Group size	Male				Female	Young	Yearling
		Class I	Class II	Class III	Class IV			
Count	269	18	13	19	35	111	43	30
Percentage	100.00	6.69	4.83	7.06	13.01	41.26	15.99	11.15

Table 6: Himalayan Ibex Survey Results for Skardu District

	Group size	Male				Female	Young	Yearling
		Class I	Class II	Class III	Class IV			
Count	67	1	3	12	9	26		16
Percentage	100.00	1.49	4.48	17.91	13.43	38.81	0.00	23.88

Figure 5: Class-Wise Population of Ibex in District Ghizer

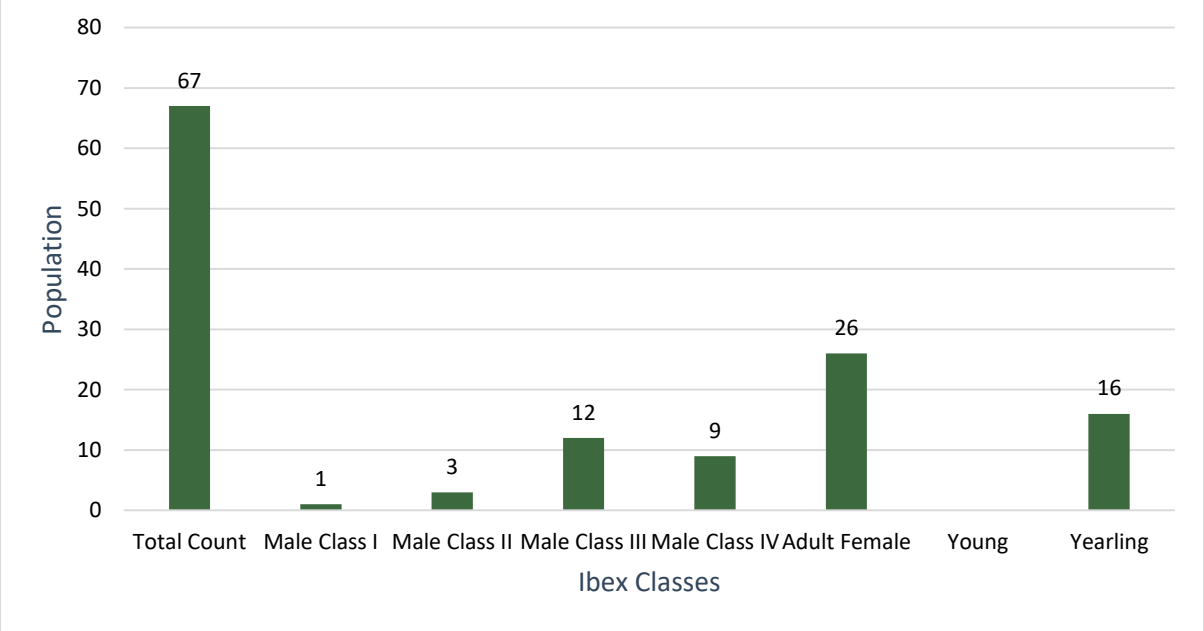

Figure 6: Class-Wise Population of Ibex in District Skardu

Population of ibex on the basis of sex (female = 41.3 %, Young = 16 %, Male=31.6 % and Yearling was 11.2 %) in district Ghizer and for Skardu it was 37%, 39% and 24% male, female and yearling respectively.

3.3 Status of Blue Sheep in Gilgit-Baltistan

Blue Sheep Lambing Survey in Shimshal

A total of 307 individuals of Blue sheep were sighted in 24 herds of different sizes at different locations in different watersheds i.e., Ganj Dur, Yazgill and Maidur of Shimshal Valley. The overall male population was classified into four classes, i.e., class I, class II, class III, and class IV on the basis of horn size and age. Adult females and their young were categorized as separate classes (Table 7). The estimated population was 541± 397.33 (95% Confidence Interval). The detection probability of observer 1 was higher than that of observer 2 i.e., 0.286 and 0.250, respectively.

Table 7: Population Structure of Blue Sheep in Shimshal Valley

	Total	Male				Female	Young
		Class I	Class II	Class III	Class IV		
Count	308	21	16	8	69	98	95
Percentage	100.00	6.82	5.19	2.60	22.40	31.82	30.84

The compositions of entire recorded herds were heterogeneous. The herd composition ratio of sex and age is given in Figure 7.

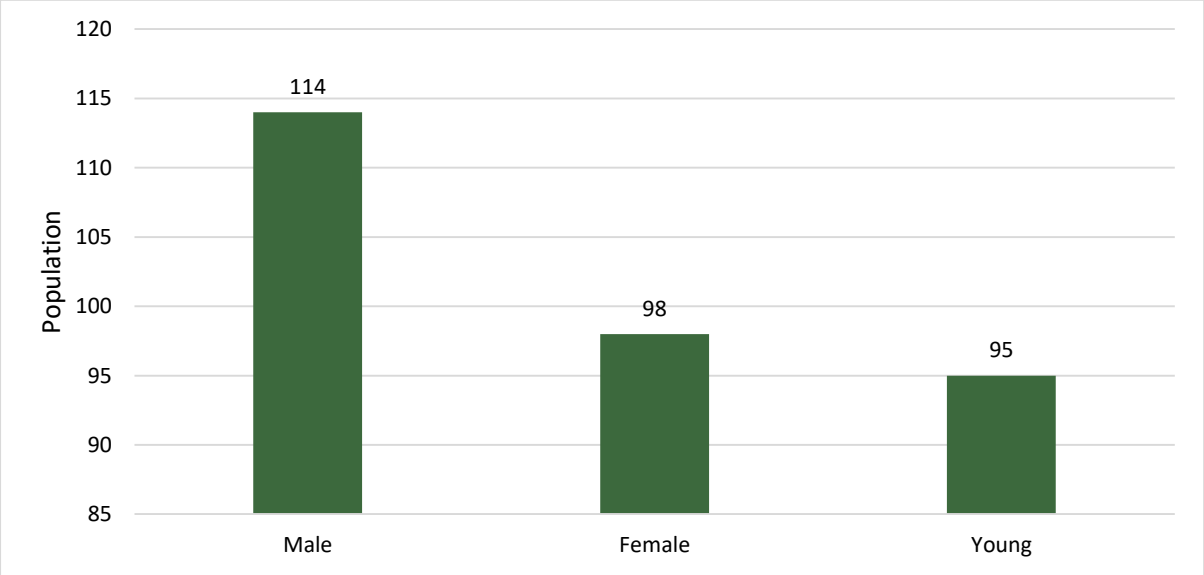

Figure 7: Sex-wise Composition of Blue Sheep Herds Observed in Shimshal Valley

The male populations of Class 1, class II, Class III and Class IV were 21, 16, 8 and 69 respectively (Figure 8).

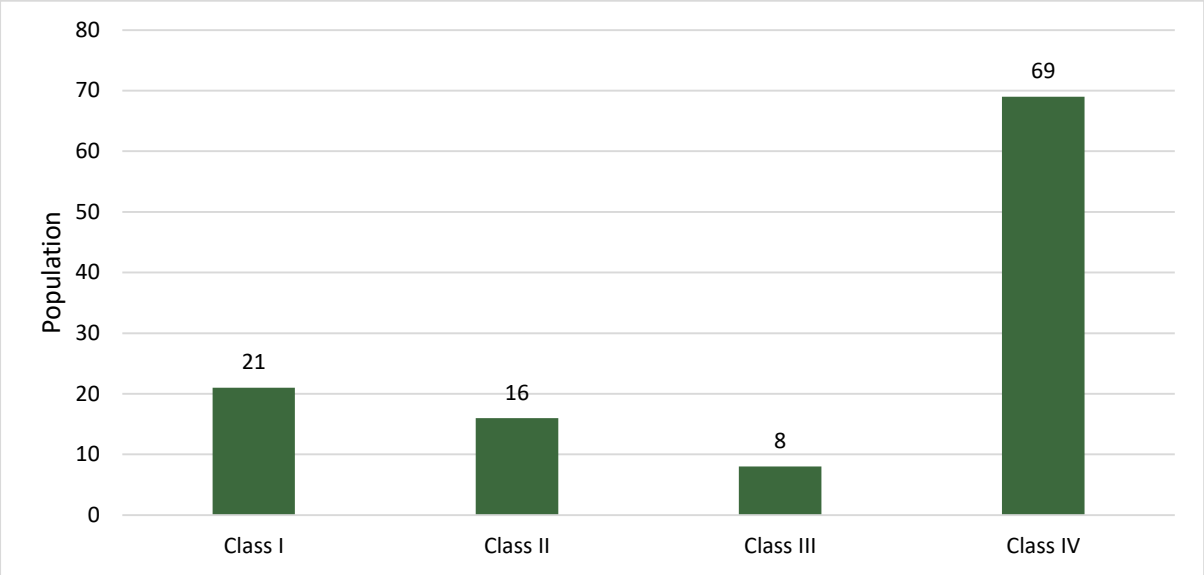

Figure 8: Population of Male Blue Sheep According to Different Assigned Classes in Shimshal

Blue Sheep Winter Survey in Shimshal

A total of 625 individuals of Blue sheep were sighted in 24 herds of different sizes at different locations in different watersheds (Ganj Dur, Yazgill, Mai Dur) of Shimshal Valley. The overall male population was classified into four classes, i.e., class I, class II, class III, and class IV on the basis of horn size and age. Adult females and their young were categorized as separate classes (Table 8). The estimated population was 625± 45.61 (95% Confidence Interval). The detection probability of observer 1 was higher than that of observer 2 and recorded as 1.000 and 0.250, respectively.

Table 8: Population Structure of Blue Sheep in Shimshal Valley during Winter

	Total	Male				Female	Young
		Class I	Class II	Class III	Class IV		
Count	625	28	38	80	102	215	162
Percentage	100.00	4.48	6.08	12.80	16.32	34.40	25.92

The compositions of entire recorded herds were heterogeneous. The herd composition ratio of sex and age is given in Figure 9. The male populations of Class 1, class II, Class III and Class IV were 28, 38, 80 and 102 respectively (Figure 9).

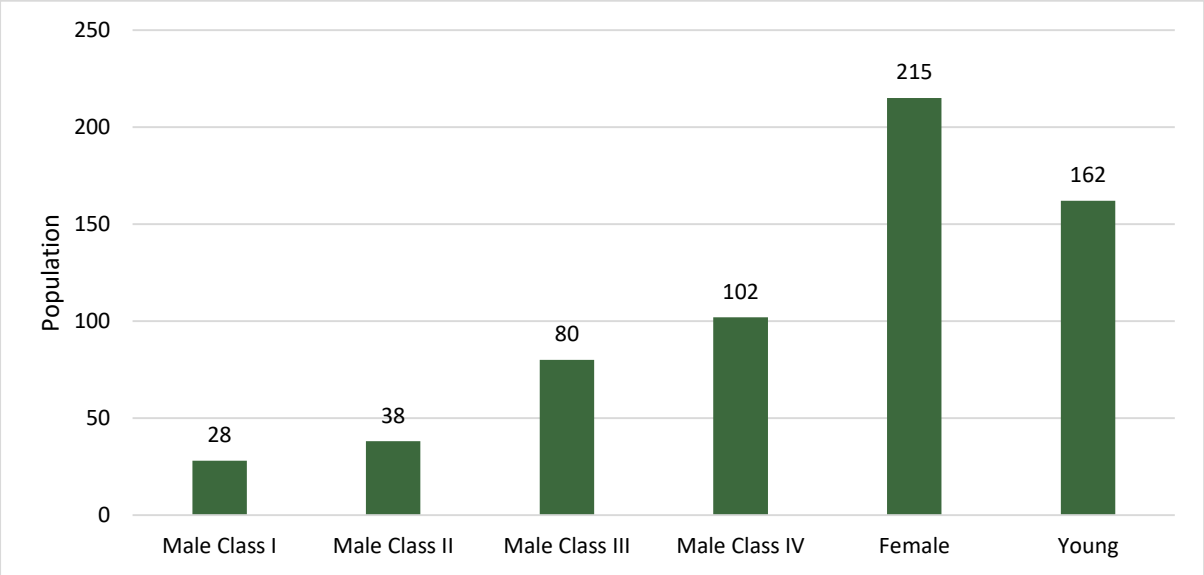

Figure 9: Population Structure of Blue Sheep in Shimshal Valley during Winter

Blue Sheep Winter Survey in KVO

A total population of 69 individuals of Blue sheep was recorded in 2 herds of different sizes at two different locations of KVO. The overall male population was classified into four classes, i.e., class I, class II, class III, and class IV on the basis of horn size and age. Adult females and their young were categorized as separate classes (Table 9). The estimated population was 69± 61.54 (95% Confidence Interval).

Table 9: Population structure of Blue Sheep in KVO

	Total	Male				Female	Young
		Class I	Class II	Class III	Class IV		
Count	69	5	9	5	4	26	20
Percentage	100.00	7.25	13.04	7.25	5.80	37.68	28.99

The compositions of entire recorded herds were heterogeneous. The herd composition ratio of sex and age is given in Figure 10.

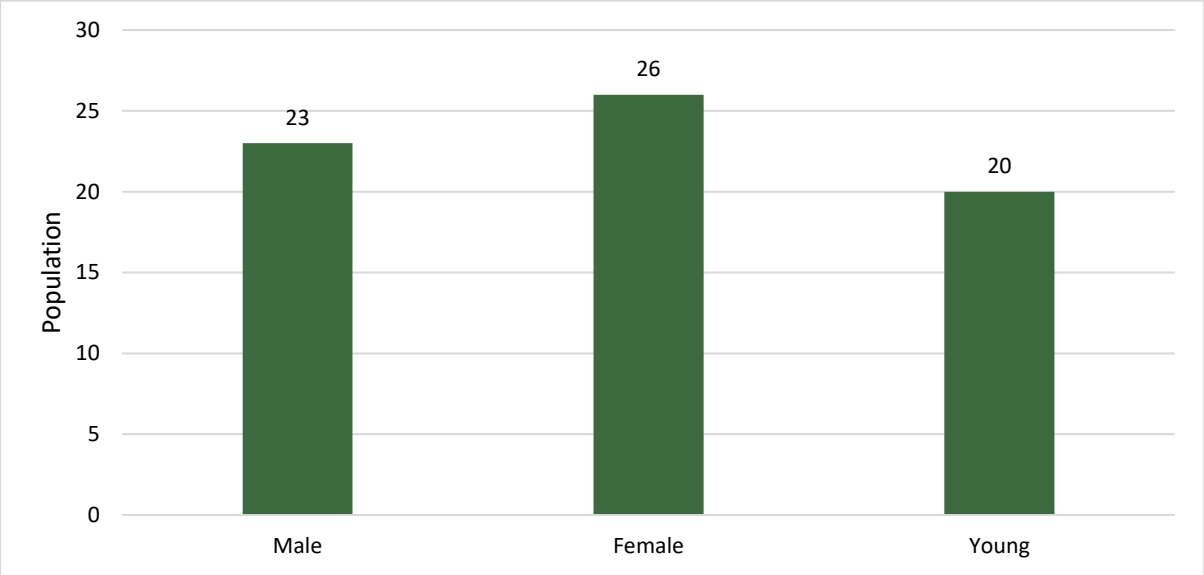

Figure 10: Sex-wise Composition of Blue Sheep Herds Observed in KVO

The male populations of Class 1, class II, Class III and Class IV were 5, 9, 5 and 4 respectively (Figure 11).

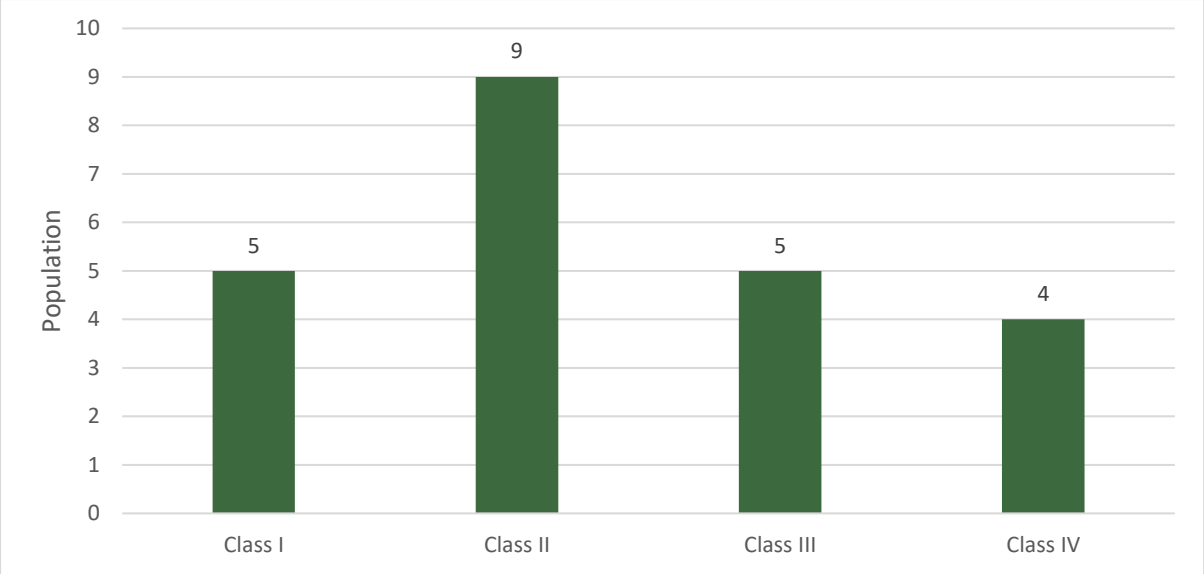

Figure 11: Population of male Blue Sheep according to different assigned classes in KVO

4. DISCUSSION

Estimating wild ungulates population is difficult because of the rough terrains they inhabit in rugged mountainous environments, which requires a considerable logistical and financial support which is actually difficult to manage and hence a real constraint (Singh and Milner-Gulland, 2011), which often make this not possible to execute a robust monitoring survey, but many new methods are developed that requires a low costs, one such method is a double observer based Capture Mark Recapture technique developed by (Suryawanshi et al., 2012). DOM is an appropriate method to meet the challenges in monitoring species in rugged mountains like that of Gilgit-Baltistan and has been successfully used in the Himalayas in the Indian side by (Suryawanshi et al., 2012), in Mongolia by (Tumursukh et al., 2016) and in Pakistan by (Ali et al., 2019; Khattak et al., 2019) Therefore, during current study, we employed this statistically robust and recently developed method in Gojal area of Gilgit-Baltistan, Pakistan.

The current efforts for documenting population of Himalayan ibex in Gojal area indicates that the Hussaini Valley has the highest number of individuals (n=409 individuals) followed by (n= 292 individuals) in Khyber, (n=275 ibex) in Ghulkin, (n=192 Individuals) in Passu, (n=182 individuals) in KVO and (n=131 individuals) in Ghulmit, Shishkat and Ainabad respectively.

The detection probability of both the observers recorded in the study area is quite low (Obs1=0.311 & Obs2=0.318) possibly due to the ruggedness of the study area. The detection probability in the previous studies conducted by (Ahmed et al., 2020 & Khan et al., 2020) was quite high with detection probabilities for Obs1 in KNP, Gojal watershed, Sockterabad conservancies were recorded to be 0.944, 0.538 and 0.333 respectively and for Obs2 the detection probabilities were 0.607, 0.12, and 0.038 respectively. Lower detection probability for Obs2 versus Obs1 was noted by (Tumursukh et al., 2016) for Mongolia due to behaviour of ibex, as the species is sensitive to human presence (Suryawanshi et al., 2012). The estimated population of the current study (N=2716), which is relatively high as compared to (N=2020 individuals) recorded by (Ahmed et al., 2020) in the same study area.

The density (D=1.55 ibex/km2) of ibex estimated in the current study is quite similar to that calculated for Gojal (D=1.4 ibex/km²) by (Ahmed et al., 2020). While the density recorded by. Khan (2012) was quite low (D= 0.4–0.7 ibex/km2) in Khunjerab and in Central Karakoram National Park (CKNP). The sex ratios of ibex recorded in the current study, i.e., Female to Male (1: 0.57), Female- Yearling (1: 0.24) and Female - Young (1: 0.39) is slightly different to that observed by Zafar et al. (2014) in CKNP area where the ratio of female to male was 1:1, female to yearling 1:0.52, and female to young 1:0.7 in 2011 and in 2012 the ratios were recorded as 1:0.87, 1:0.58, and 1:0.77, while in 2013 they recorded ratios of 1:1.3, 1:0.47, and 1:0.84 respectively.

These slight differences in the sex ratio between different studies in similar and different area may be due to factors such as food quality and availability, climatic conditions, habitat and human interference. The mean herd size during the current study (19.83 ± 2.37 (range1-93) is quite similar to that recorded (19.3 ± 3 (range3– 88) by (Ahmed et al., 2020) in Gojal watershed. The findings of our current study are somewhat resembled in all aspects of the study.

The findings of the current study shows that the population of Himalayan ibex is stable in Gojal conservancy and the trophy hunting programme can be continued with regular monitoring of the species and implementation of the guidelines developed by IUCN Pakistan in collaboration with Parks and Wildlife Circle to streamline the "Trophy Hunting Programme of Gilgit-Baltistan". On the basis of current study findings, we suggest 25 hunts in the area (Ainabad, Shishkat, Gulmit, Passu, Ghulkin, Hussaini, Khyber and KVO) in which we have considered the sustainability of the ibex population, which means the suggested quota constitutes, less than 2 % of the total population or 25% of the trophy animals and male to female ratio is also higher than the minimum ratio required to ensure sustainability of the species, i.e., male to female ration should be 1:6 at minimum. As per our records, 2 % of the total population becomes 29.74≡30 trophy animals, while 25% of the total trophy animals become 22 trophy animals and male to female ratio is 1:4, which can be considered as a viable ratio thus supports our recommendations.

A total of 35 catchments and sub catchment were surveyed for Himalayan ibex in two districts of Gilgit Baltistan, i.e., District Ghizer and District Skardu. A total of 336 animals were sighted from 35 points at different location. A maximum ibex were sighted in Qurambar area with a number of 25 individuals from one sighting point followed by Broth and Immit area with a maximum number of 20 and 17 Ibex respectively in district Ghizer.

Their distribution was confined in this range during winter season due to acute shortage of food as a result of snow accumulation in their habitat, hence compelled to move from the upper areas to nearby human settlements. The statement also supports findings of (Fedosenko & Blank, 2001) that ibex shifts to lower elevations up to 2000 m during winter season in mountainous regions and prefer to move in less snow covered areas into a larger group (Grignolio, Rossi, Bassano, Parrini, & Apollonio, 2004). The extent of occurrence of ibex population in winter season was more prominent at mid altitude (3400-3600 masl) due to availability of food and less interference of human beings. In the distribution of ibex, depth of snow cover is an important factor and sometimes it is the only reason of their absence in some surrounding areas and mountains. The movement of ibex have strong influence by snow cover in alpine areas (Grignolio et al., 2004; Raza et al., 2015). The trophy ibex was more confined to the higher altitude (>3600 m) as compared to other age groups of the population. This might be due to their adaptability having larger body size to access food by digging with their hooves and horns than that of smaller ibex even in heavy snow by foraging up to 30-40 cm depth of snow (Raza et al., 2015).

The overall estimated Blue sheep population during the summer and winter was 1166, this was higher than the population estimated by (Khattak et al., 2019) e.g., 834 at density of 0.6 at density of 0.6 sheep/km^2, the obvious reason for this different is the time as (Khattak et al., 2019), conducted the survey in 2014 during the month of October.

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