Forest, Wildlife and Parks Department
Government of Gilgit-Baltistan

ASTOR MARKHOR & LADAKH URIAL

IN GILGIT-BALTISTAN

2021-22

RUT SEASON SURVEY REPORT

PARKS & WILDLIFE Gilgit Baltistan

FOREST DEPARTMENT Gilgit Baltistan

10 Billion Tree Tsunami 2018

SNOW LEOPARD FOUNDATION

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RUT SEASON SURVEY REPORT 2021-22

ASTOR MARKHOR (*Capra falconeri*) & LADAKH URIAL (*Ovis vignei*)

IN GILGIT-BALTISTAN, PAKISTAN

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EXECUTIVE SUMMARY

The current study was conducted in the range of markhor (*Capra falconeri falconeri*) and Ladakh urial (*Ovis vignei vignei*) across Gilgit-Baltistan (GB) during the rut seasons (20th November to 15th December for Ladakh urial and 12th to 31 December for markhor) to document the population dynamics of both the species. Forest, Parks and Wildlife Department of Gilgit-Baltistan has been practicing sustainable trophy harvesting programme of markhor, blue sheep (*Pseudois nayaur*), and Himalayan ibex last two decades in to reward the mountain communities for their, conservation, and management efforts for wildlife in their own area. This trophy harvesting programme requires robust estimates of ungulates population and demographic structure for their effective conservation, planning, management, and regulation of trophy harvesting programme. Therefore, during current study population estimates and demographic structures of Astor markhor and Ladakh urial were assessed, in addition to calculation of trophy size animals in the study area to recommend trophy harvesting quotas under Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provisions for Gilgit Baltistan. We used two different sampling methods i.e., point count method for markhor and double observer method for Ladakh urial. The reason for using varied assessment techniques was, that markhor being offered as a trophy is being under continuous vigilance of the field staff of Parks and Wildlife, GB as well the communities and most of the herds are under the surveillance during rut, therefore, demographic structure is pre-known, so the double observer methods doesn't fit during the rut season. The total counts for markhor were found to be (N1=1319) individuals, out of which 477 individuals were females, 193 yearlings, 218 young, 197 sub-adult males, 155 adult males and 79 trophy males, which shows a healthy demographic structure across the range. The mean group size was calculated as 16 ±2.71 (CI: 95%). The standard deviation was found to be 12.37 and variance was calculated as 153 in the sample. Bunji was found to be the highest stronghold markhor population with 351 individuals, followed by Danyore-Juglote conservancy with 158 individuals, SKB conservancy with 128 and Sai-Damote conservancy with 105 individuals. Out of the total trophy size individuals found across GB, the highest numbers (n=19) of

trophy animals were recorded in Bunji, followed by Danyore-Juglote with 11 individuals, Sai-Damote and SKB with 6 trophy size animals each.

The estimated population of Ladakh urial during the current study in 5 potential valleys is (N2=158) individuals across its range in GB. Out of total population, 69 were females, 13 yearlings, 27 young and 19 males. The upper confidence interval was found to be 233 (CI: 97.5%) and the lower confidence interval was calculated as 133 (CI: 2.5%) while the mean herd size was calculated as 12.8 ±3.83 (CI: 95%). The standard deviation from mean group size was found to be 6.49 and variance in population was calculated to be 42.14. The detection probability of observer 1 and observer 2 were slightly different with observer 1's detection probability calculated as 0.78 and observer 2's detection probability of 0.59. As, this was the first ever effort to document the wide population of Ladakh urial in GB, therefore it is recommended to conduct both lambing and rut season surveys of Ladakh urial every year in itspresent and historic range in GB for its better conservation and management. Furthermore, to formally bring Ladakh urial into conservation mainstream, especially for ownership by respective communities it is also recommended to initiate a premium trophy harvesting programme (allow only 1 trophy per year for which a base price should start from 150,000 USD) of Ladakh urial in GB. Based on current study findings, it is further recommended that in the upcoming trophy harvesting season 2022/23, trophies can be offered in Bunji, Danyore-Juglote, SKB, Damote, DMT, Kargah, Minawar and Doyan conservancies. The department may also initiate and arrange guided wildlife sighting tours for academia and interested tourist groups to hotspot habitats like Bunji, Doyan, Jutial, SKB and other such areas where wildlife can be easily spotted.

1. INTRODUCTION

Mountain ungulates play essential role in balancing ecosystems by influencing nutrient cycle and vegetation cover (Bagchi and Ritchie, 2010). They constitute a major prey base for carnivores living in mountains and are critical determinants of large carnivore populations, including the Vulnerable snow leopard (*Panthera uncia*) (Suryawanshi et al. 2017). Due to their harsh mountainous habitats and associated challenges in surveying, there is less information regarding mountain ungulate populations and their trends (Singh and Milner-Gulland 2011). At the same time, the robust estimates of animal's populations are very essential for effective management planning, conservation and regulation of these species (Eggert et al. 2003; Noon et al. 2012) because imprecise population estimates can cause lots of error in defining population status and goals of conservation which restrict the capability to determine the effectiveness of management interventions (Wiest et al. 2019). Apart from population size, other parameters like intraspecific interactions, habitat use, sex ratio and age structure are necessary for effective management of animals (Härkönen and Heikkilä 1999; Williams et al. 2002; Eggert et al. 2003).

Reliable information on population status, demographic structure and survival rates of harvested ungulates which are been hunted by clients who pay money and select animal for hunt (Lindsey et al. 2007) based on the qualities like the gorgeous appeal of horns and their size and sex (Von Brandis and Reilly 2007). The long term monitoring of harvested ungulates is necessary because continuous hunting of selected species may lead to a shift toward individuals with small horns within a hunted population (Allendorf and Hard 2009) and an overabundance of ungulate leads to over-browning which in turn decreases the diversity and plant cover, alters carbon and nutrient cycle, modify the vegetation dynamics and patterns of relative abundance. These changes indirectly affect other animals like birds, insects and other mammals (Côté et al. 2004).

1.1 Description of Astor Markhor

The markhor *Capra. f. falconeri* belongs to the caprine group of family Bovidae (Roberts 1977; Schaller 1977). Both males and females are reddish-grey in colour which tends to be more yellowish in summer and more grey in winter (Roberts 1977). Markhors are group-living animals in which females and young males associate in small herds and sometimes large herds when the terrain is of restricted nature. Adult males

are largely solitary in nature, and they join female herds during the rut seasons which starts in late November and stay with them till the start of spring. Markhors used to forage in the early morning and late evening, but they forage throughout the day in mid-winter. Adult males have huge corkscrew horns and are the best climbers in their family and sometimes they used to climb on to trees for feeding on the leaves. Markhor is a very important species as it is the national animal of Pakistan and is very critical for the landscape because it is one of key prey of large carnivores like snow leopard (Schaller 1977). Adult males show seasonal migration which moves to higher altitudes in summer and lower altitudes in winter (Peerzada 2010).

Markhor is the highest-paid animal in trophy hunting program in Pakistan and it has very limited and patchy distribution (Hadier et al., 2021) (Nyhus et al. 2016) and long term monitoring of its population is necessary to make trophy hunting sustainable as a tool of conservation (Damm 2008; Buckley and Mossaz 2015; Crosmary et al. 2015) to obtains maximum sustainable yield (Sutherland 2001; Jenks et al. 2002; Milner-Gulland et al. 2009). Markhor stands at the near-threatened category of IUCN red list (IUCN 2020) and reliable information on its population size is necessary for assessment of conservation status using the criterion of Red List (IUCN 2001).

1.2 Distribution of Astor Markhor

Much of the total world population of markhor is found in Pakistan and is estimated to comprise about 3,200–3,700 animals, with numbers generally decreasing (Shackleton, 1997; Weinberg et al., 1997). However, certain conservation measures such as community-based conservation have been implemented in recent years appeared to have a positive effect on at least some markhor populations (Virk, 2000).

In Pakistan, two subspecies are distinctly recognized i.e., flared horned markhor *Capra falconeri falconeri* and straight horned markhor *Capra falconeri megaceros* (Schaller and Khan, 1975; Hess et al., 1997).

In Pakistan, the Markhor is completely protected by federal law (Rao 1986). In 1991, the federal government imposed a 3-year ban on all big game hunting. This ban officially lapsed in 1993 but practically remained in effect, although it was reviewed in the case of community-based trophy hunting programs (Shackleton, 2001).

Astor markhor, recognized as the flare-horned markhor, is confined to upper catchments of Indus River and its tributaries in Gilgit-Baltistan (Hess et al., 1997). Like other subspecies of Caprinae, Astor markhor is still threatened for its genetic isolation, specialized habitat

requirements, low reproductivity, habitat fragmentation, food competition and excessive hunting (Shackleton, 1997).

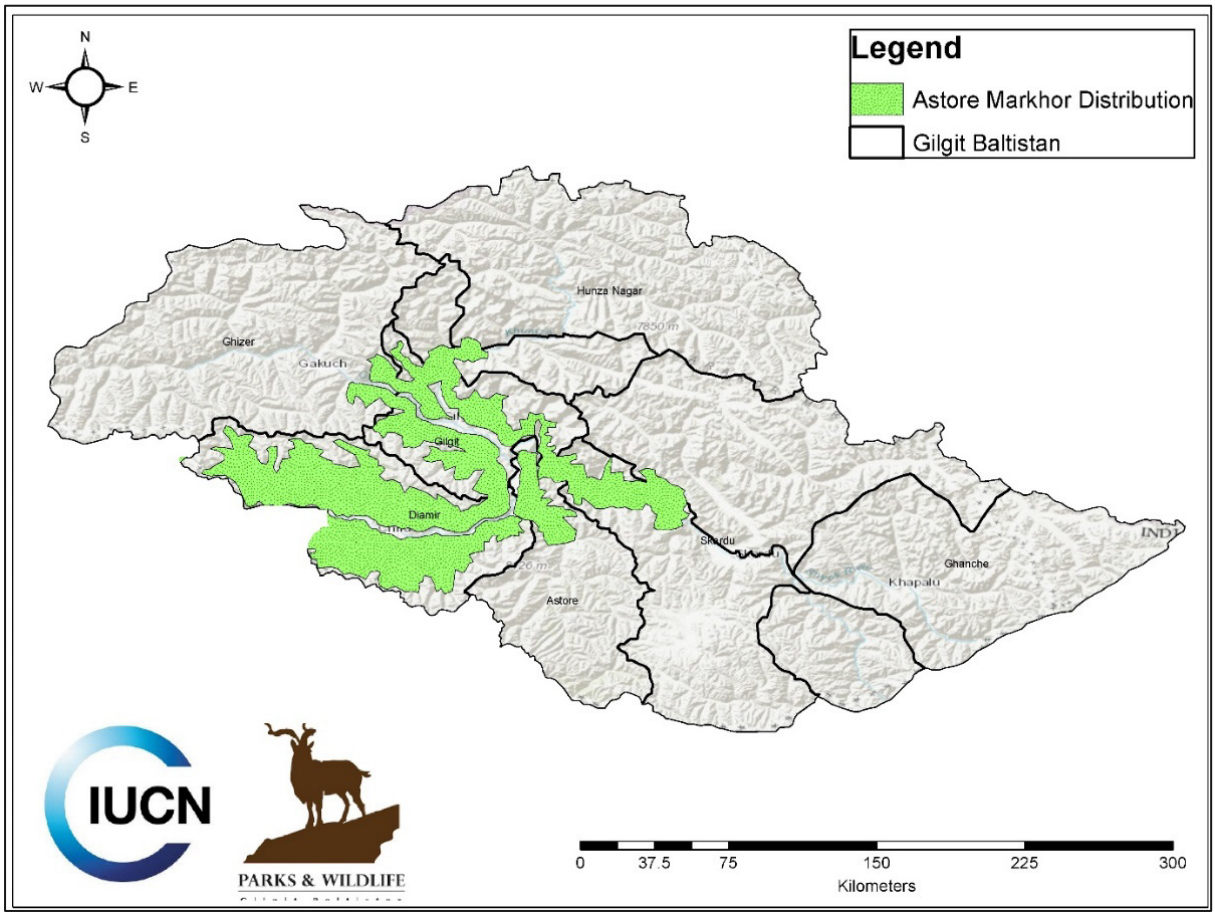

Figure 1: IUCN distribution map of Astor Markhor in Gilgit Baltistan

1.3 Description of Ladakh Urial

The urial (*Ovis vignei vignei*)) is an upland medium sized wild sheep, considered as the wild ancestor of the domestic sheep, *Ovis aries* (Mallon 1983; Shackleton 1997). The taxonomic status of the species and of the subspecies is unclear. They are either considered as a single species (*O. orientalis*) or two separate species as *O. orientalis* and *O. vignei* (Nadler et al. 1973; Roberts 1997; Rezaei et al. 2007). However, as the natural habitat range of these two sheep is overlapping and different species of the genus Ovis can hybridize producing fertile offspring, hence, most of the traditional classifications considered only one species with several subspecies (Nadler et al. 1971; Valdez et al. 1978). (*O. vignei*, 2n=58) separated from Asiatic mouflon (*O. orientalis*, 2n=54) and Argali (*O. ammon*, 2n=56) on the basis of difference in number of chromosomes (Nadler et al. 1973;

Roberts 1997; Shackleton 1997). Three subspecies of urial are found in Pakistan, namely Afghan urial (*O. orientalis* (vignei) *cycloceros* including *O. v. blandfordi*: the former considered to be occurring north of Quetta and the latter south of Quetta and in Sindh west of Indus), Punjab urial (*O. orientalis* (vignei) *punjabiensis*), and Ladakh urial (*O. orientalis vignei* or *O. vignei vignei*) (Valdez et al. 1978; Mallon 1983; Shackleton 1997; Rezaei et al. 2007). The Ladakh urial is wild sheep and sub species of urial. Its body fur changes seasonally which tends to be more greyish and less red in winters and vice versa in summers. It has black hairs on the chest ruff. Its hon turns inwards markedly at their tips and often wrinkles are rather shallow and indistinct (Roberts). Urial has now been considered a separate species. Its local names are Ureen in shina language and Yathal in Broshaski.

1.4 Distribution of Ladakh Urial

Being members of the sheep family, urials avoid rocky terrain and occupy the mountain deserts at the lower elevations in winter. In summer, they inhabit areas with gentle to steep slopes, but try to avoid precipices at the upper limits (Roberts 1977). Urials live in treeless habitats or sparsely covered areas with shrubs and herbs. At higher elevations they occupy the side slopes, always avoiding the glaciated places and moraine. They are adapted to great aridity, extremes of heat and cold and can subsist for seven months of the year on a small variety of woody shrubs, of which the most important are *Ephedra gerardiana* Wall., *Capparis spinosa* Linn., and *Artemesia* spp (Shackleton 1997). This habitat is found in a narrow belt along the main river valleys (Siraj-ud-Din et al. 2016).

The Ladakh urial is a vulnerable species and it stands on Appendix 1 of CITES (IUCN 2001). Due to tremendous growth of the human population and the opening of inaccessible areas by the construction of roads, much of the animal's habitat has been lost. Now only scattered and isolated populations of small herds are found within the remotest corners of their former habitats (Zafar et al. 2014).

Historically, the range of the Ladakh urial was extended through India and Pakistan along the valleys of the river Indus and its tributaries, downstream through Ladakh to Gilgit, Astor and Chitral, and in parts of the southwest Pamirs in Afghanistan and the USSR. However, recent studies have shown that its current distribution is confined to some regions of Gilgit Baltistan, Pakistan and Ladakh, India (Schaller 1977; Ghoshal 2018).

It has a wide-ranging distribution in the Gilgit-Baltistan, with a habitat that stretches across the desert steppes of the Indus Valley (between 1,000-1,800 m elevation) and extends along the river Indus and its tributaries until it reaches an elevation of 4,200 m in the alpine/snow field zone (Schaller 1977). This tract includes the area between Thore and Raikot and Paratap Bridge (both sides of the Indus River), and from Ramghat Bridge to Harcho in Astore valley in Diamer District. The area from Talichi to Gahkuch along Gilgit river and from Gilgit to Chalt along the Hunza river in Gilgit District is traditionally urial habitat, but the animal is virtually extinct from most of its former habitat (Hess 2002).

In Pakistan, (Schaller 1977) gave the major river valleys of the Kunar Chitral river, Indus, Gilgit river and Shyok as the main range of Ladakh urial, and (Roberts 1997) presented a similar picture. However, these distribution maps seem no longer valid, indicating instead the recent historical and not the current distribution. Ladakh urial is still widely distributed, but only in very small, isolated populations (Siraj-ud-Din et al. 2016; Abbas et al. 2021). In Gilgit District, (Hess 2002) was able to locate only one place where urial survived in 1985-86; reliable informants told him about a population of 27 animals on the right side of the lower Miatsil river (Hispar Valley) and about 10 to 15 urial from the main Hunza Valley. There is no evidence of its presence within the whole area along the Gilgit and Indus rivers upstream from Gilgit to downstream from Chilas. Most occurrences of the taxon in northern Pakistan are from Baltistan District. Besides (Schaller 1977) map, additional records exist for the Kharpacho hills close to Skardu, and from a reliable report for the Tormik valley and the area near Rondu (Hess 2002).

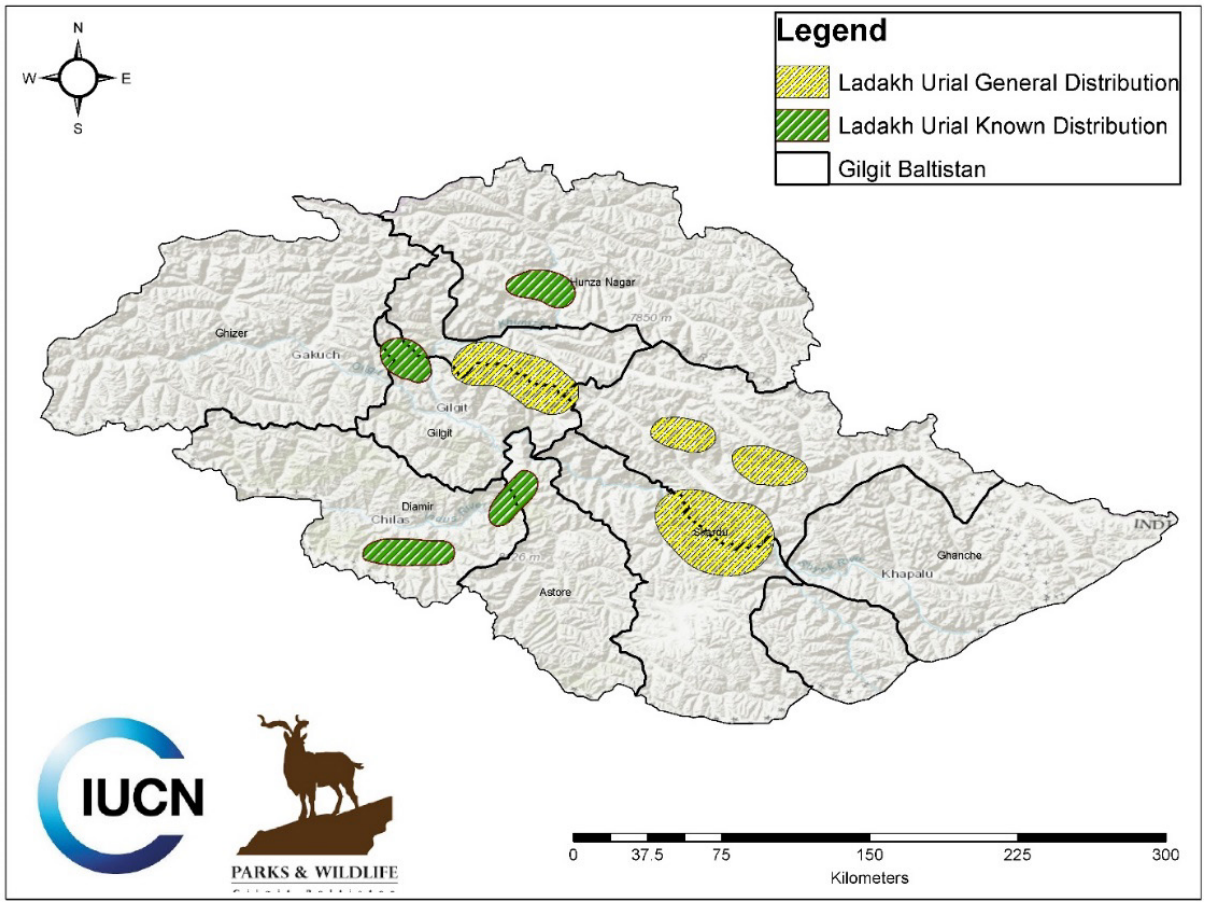

Figure 2: Present and Past Distribution map of Ladakh Urial in Gilgit Baltistan

1.5 Threats to ungulates

Shackleton (1997) pointed out that most Caprinae species face threats of extinction due to genetic isolation, specialized habitat requirements, and low reproductive rates besides anthropogenic causes. The CITES placed a ban on all forms of export of a species which are endangered.

Mountain ungulates around the world have been threatened by illegal hunting, habitat modification, increased livestock grazing, disease and development (Suryawanshi et al.

2012). (Frisina and Keigley 2004) stated that various diseases are transmitted to markhor through domestic goats and sheep.

The Khyber Pakhtunkhwa Wildlife Department reported that thirty to fifty individuals of markhor died of the 19 diseases transmitted from livestock that was brought from Afghanistan (Malik 1985; Shackleton 1997). However, when threats such as excessive poaching and/or habitat loss contribute to a decline in the population of the species within a country, the CITES ban on export becomes less effective for the conservation of the species (Caughley 1977).

(Hess 2002) noticed that Pakistan is a unique country in the world which has rich diversity of Caprinae and is famous for conservation of wild sheep and goats. Out of the twelve sub species of wild goats and sheep, only markhor is a coveted trophy for game hunters.

Populations of markhor outside the protected areas, especially community managed conservation areas (CMCA) are still negatively influenced by poaching, habitat degradation, slow reproductively and genetic isolation (Shackleton 1997; Hess 2002).

In Pakistan, Ladakh urials have severe threats of habitat degradation, poaching, lamb picking, and disease transfer from domestic livestock. Hence the national status of the species is considered “endangered” (Sheikh and Molur 2005).

1.6 Rutting season and reproduction

Astor markhor is a social animal and lives in small herds. The herds consist of females, their kids, yearlings, and young males. Mature males live alone outside the herds and only join the herds during the winter rut season in late December and it is diurnal crepuscular animals but they can be seen feeding irregularly during winter throughout the day (Roberts 1997).

The females in straight-horned markhor reproduce at about three years (Roberts 1977), while for the female of flare-horned markhor, it is two years (Malik 1985). December is the rut season, and it continues for one month. The gestation period is approximately six months (Schaller 1977; Roberts 1997).

In Gilgit-Baltistan the young are born at the end of May to early June, which indicates a gestation period of about 160 days. Similarly, in Baluchistan the young are born in early April. Other authors have reported varying gestation periods from 147 to 180 days (Schaller 1977; Shackleton 1997). The rut season of Ladakh urial starts in October-November that results in the congregation of large numbers of animals (Khara et al. 2021).

1.7 Trophy hunting as conservation tool

According to (Shackleton 2001) trophy hunting has a significant role in conservation as compared to other uses of wildlife. Likewise, trophy hunting can be used as a tool for the conservation of endangered species even when excessive exploitation might be the original cause of the conservation problem. For a hunting Programme to be sustainable, the population of the species must be monitored, managed, and conserved on a sound basis.

Sustainable use of natural resources through community involvement is acceptable if the overall management process is economically and socially attractive to local people as a long-term livelihood strategy (Ahmad and Sattar, 2001). Due to its economic value, sustainable management of wildlife can be used as a development tool for rural communities (Lamarque 1995).

Trophy hunting is a significant wildlife management strategy in many countries of Asia, Africa, and Europe (Lechuga 2001) that has resulted in a positive change in attitudes of local people towards wildlife, the active involvement of communities in natural resource projects, and the achievement of conservation goals (Baker 1997; Lewis and Alpert 1997).

(Shackleton 2001) investigated that trophy hunting is advocated by the conservationists based on the assumption that trophy animals are mostly older males which spent the maximum of their lifespan, which seems rationally wrong.

Trophy males are always in their major reproduction years. It is sometimes difficult to find older males in ungulates populations because once a male reaches the end of his active life, its health condition weakens quickly, and the individual gave up to natural predators or starvation or could not stand severe weather conditions.

Trophy hunting discourages poaching and, if funds generated from trophy hunting were used for the activities related to conservation, the impact of a well-managed trophy hunting programme could be positive (Shackleton 2001; Harris and Pletscher 2002). In the study area, trophy hunting of four adult male Markhors is being carried out annually and 80% share of the revenue from a trophy hunting license goes to the local communities for their socio-economic wellbeing (Shackleton 2001).

1.8 Objectives of study

- To assess the distribution and population status of Astor markhor in Gilgit-Baltistan
- Identifying trophy size animals in different conservancies to allocate trophy quota in Gilgit Baltistan
- To assess the distribution and population status of Ladakh Urial in Gilgit-Baltistan

2. MATERIALS AND METHODS

2.1 Study Area

Gilgit-Baltistan (GB), formerly known Northern Areas of Pakistan, encompassing an area of about 72,496 km^2 in the extreme north of Pakistan between 34° to 37° N and 72° to 75° E, bordering internationally with the Xinjiang Uygur Autonomous Region of China in north, Wakhan corridor of Afghanistan in west, and India in east (Fig. 1), is home to around 1.5 million people (Khan et al., 2011). Climatically, GB falls in the temperate zone and it varies widely from monsoon-influenced moist temperate to arid and semi-arid cold deserts in the north. Below 3000 m, precipitation is less than 200 mm per annum while there is a sharp precipitation gradient along the altitude, and over 2,000 mm annual snowfall above 6000 m ASL. Temperatures in the lower parts of valleys vary from extreme hot (+40ºC) in summer to many degrees below freezing point (-10ºC) during winter (Khan et al., 2010). Only 2% of the total area is arable and 4% is covered with natural forests. Vegetation is classified into four distinctive zones viz., Mountain Sub-Tropical Scrub Forests, Mountain Dry Temperate Coniferous Forests, Mountain Dry Temperate Broadleaved Forests and Northern Dry Scrub Forests, each having peculiar biota (Rao and Marwat, 2003). Habitats are separated primarily on the basis of terrain ruggedness and elevation, and apparently there is less distributional overlap among species inhabiting rugged terrain than for those inhabiting plain and open hills (Rao and Marwat 2003).

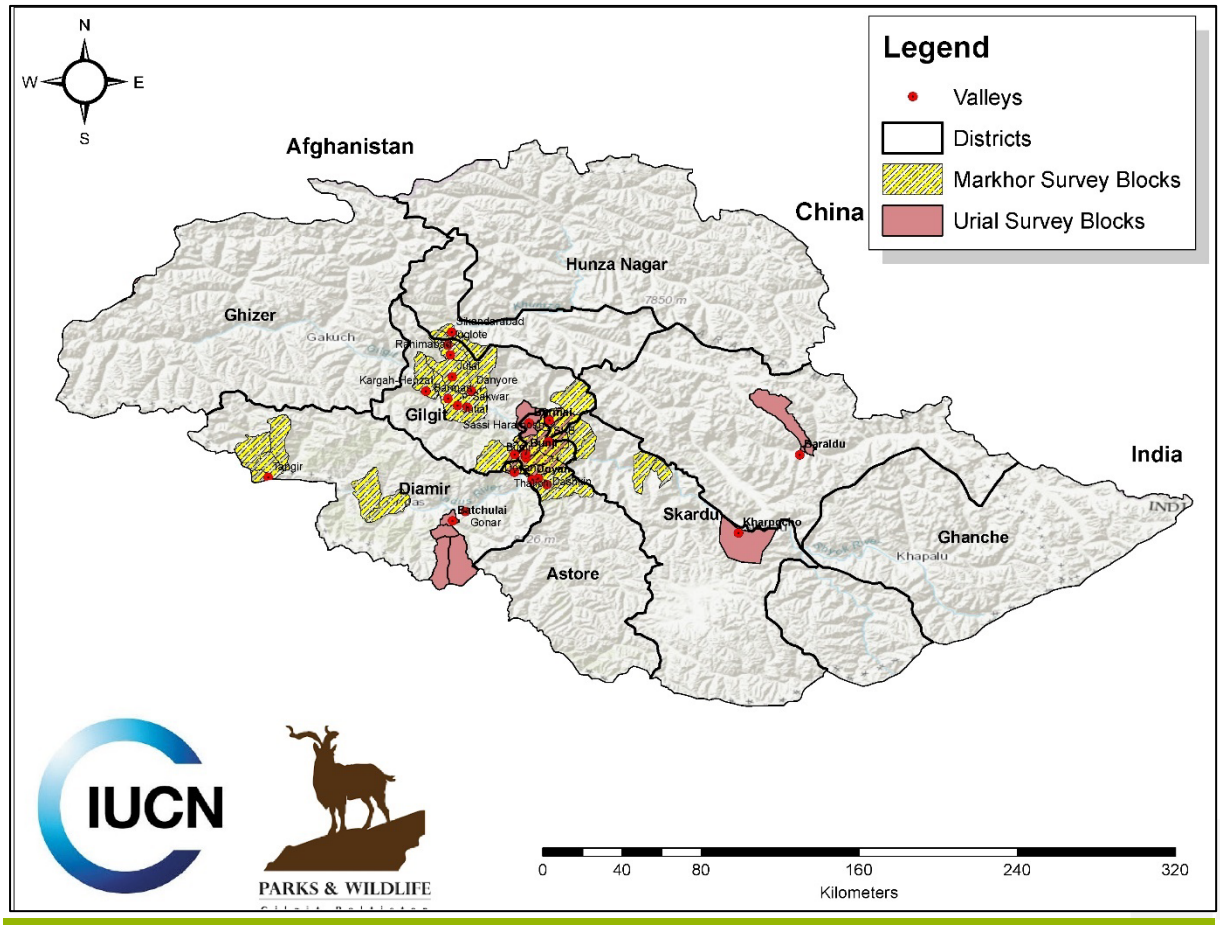

Figure 3: Study area map with survey blocks

2.2 Data Collection

Two different sampling methods were employed to collect data for Astor markhor and Ladakh urial based on behavior of animals and characteristics of habitat.

Fixed point direct counting method (Direct counting while walking in predefined survey blocks) was used to collect data during rut season (November-December 2022) for Astor markhor. The study area (21 conservancies/valleys) was divided into 36 blocks based on watershed delineation. Each block was scanned by survey teams and the maximum area of each block was covered to maximize animal counts except inaccessible areas. Animal observations were taken at dawn and dusk when animals were active for feeding and drinking. Binoculars (16 × 56) and Spotting scopes (30x85) were used to scan the rugged terrain. Hand GPS (Garmin 64S) was used to record location coordinates and elevation. Compass was used to measure the angle while distance to the herd was estimated approximately. Data sheets were used to record observations on animal counts, age and sex structure, geo referencing, animal behaviour and site covariates. High magnification digital camera (Nikon Coolpix P1000) was used to capture photos and videos of sighted animals and their habitat. Upon sighting, animals were classified to different classes i.e., young, yearling, female, sub-adult male, adult male and trophy size male based on their body and horn size.

Double observer method was used to collect data during November 2022 for Ladakh urial in which two observers scanned the same block and counted animals simultaneously without giving any signal or clue to each other. Both observers were independent and adopted the same route while maintaining a temporal difference of 20 minutes. 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. However, animals spotted during mid-day time were also recorded. All animals were observed using binoculars and spotting scopes and coordinates of sighting locations were taken using the Garmin GPS. All data was recorded on data sheets. Hence, an individual group of ungulates becomes the unit that is being “marked” and “recaptured” in double-observer technique. Upon sighting of animal’s 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 (>4 years), Class III (>5year), and Class IV (>6 years).

At the end of the day both observers matched their data and similar groups were identified based on herd size, demographic categories, habitat types and location. Hence, an individual group of ungulates becomes the unit that is being “marked” and “recaptured” in double-observer technique. The data was entered in Excel sheet and exported as comma delimited values file for analysis.

2.3 Data Analysis

2.3.1 Fixed Point Direct Counting

Results were analyzed in Microsoft Excel and different parameters were calculated using built in formulas. Mean group size, standard deviation, standard error, variance, and confidence intervals for all conservancies were calculated. All graphs and tables were also prepared in Excel. Distribution maps were developed in ArcGIS Map 10.5 using field coordinates of locations of animal herds.

2.3.2 Double Observer Method

Following the double observer surveys, data was organized in excel and analysed in a Bayesian framework using the 'BBRecapture' package in R statistical and programming environment (version 4.1.1) software ((R Core Team 2019). The package bootstraps the binary input of detection and non-detection of number of groups, which generates an estimated number of groups ($\hat{G}$) from a normal distribution. This is then multiplied with the estimate of group size (μ) that is obtained from the median of a parametric distribution of various group sizes in the data set. This provides a robust total population estimate (N). The same process was repeated to obtain the range of the population estimate, i.e., the upper and lower bounds.

The analysis was conducted on the number of groups while age-sex composition, group size, and habitat feature and geographical location of sighting were used to assess whether a group was re-sighted by the second team. A group was coded "11" if recorded by both teams, "10" if only the first team recorded it, and "01" if only the second team recorded it. We modeled the detection for the two teams separately ("mt" model). To estimate the number of groups ($\hat{G}$) of each Ladakh urial in our study areas, we fit the "mt" model using the function BBRecap with a "uniform prior" (Suryawanshi et al. 2012).

We did 10,000 MCMC iterations with 1000 burn-in (Khanyari et al. 2021). Further details on model fitting are available in (Fegatelli and Tardella 2013). The estimated detection probability by model "mt" for occasion one and two was interpreted as the detection probability for observer teams one and two. To estimate the population (N) of Ladakh urial, we used an estimated number of groups and their mean size (μ). Using the variance in estimated number of groups and the mean size, we estimated the confidence intervals by generating a distribution of estimated group size through its bootstrapping of 10,000 times with replacement. A distribution of estimated population for Ladakh urial (N) was generated by multiplying 10,000 random draws of estimated number of groups ($\hat{G}$) weighted by the posterior probability and draws of mean group size (μ). The estimated Ladakh urial population (N) was median of resultant distribution and the percentiles of 2.5 and 97.5 were used to assess lower and upper confidence intervals respectively.

3. RESULTS

3.1 Astor Markhor

Animals were sighted in 32 blocks out of 36 that were surveyed (Figure 4). No animals were sighted in 4 blocks naming Hukur, Hudur, Harali and Jalipur. A total of 1319 individuals of Astor markhor were counted in 82 herds in 18 conservancies/valleys (Figure 4). The mean group size was 16 ± 2.71: 95%CI. The calculated variance was 151.25 while the standard deviation from mean was 12.29. The highest population of 341 was recorded in Bunji conservancy that shows its highest potential for Astor markhor. The overall population of Astor markhor in different valleys/conservancies of Gilgit Baltistan is shown in Figure 5.

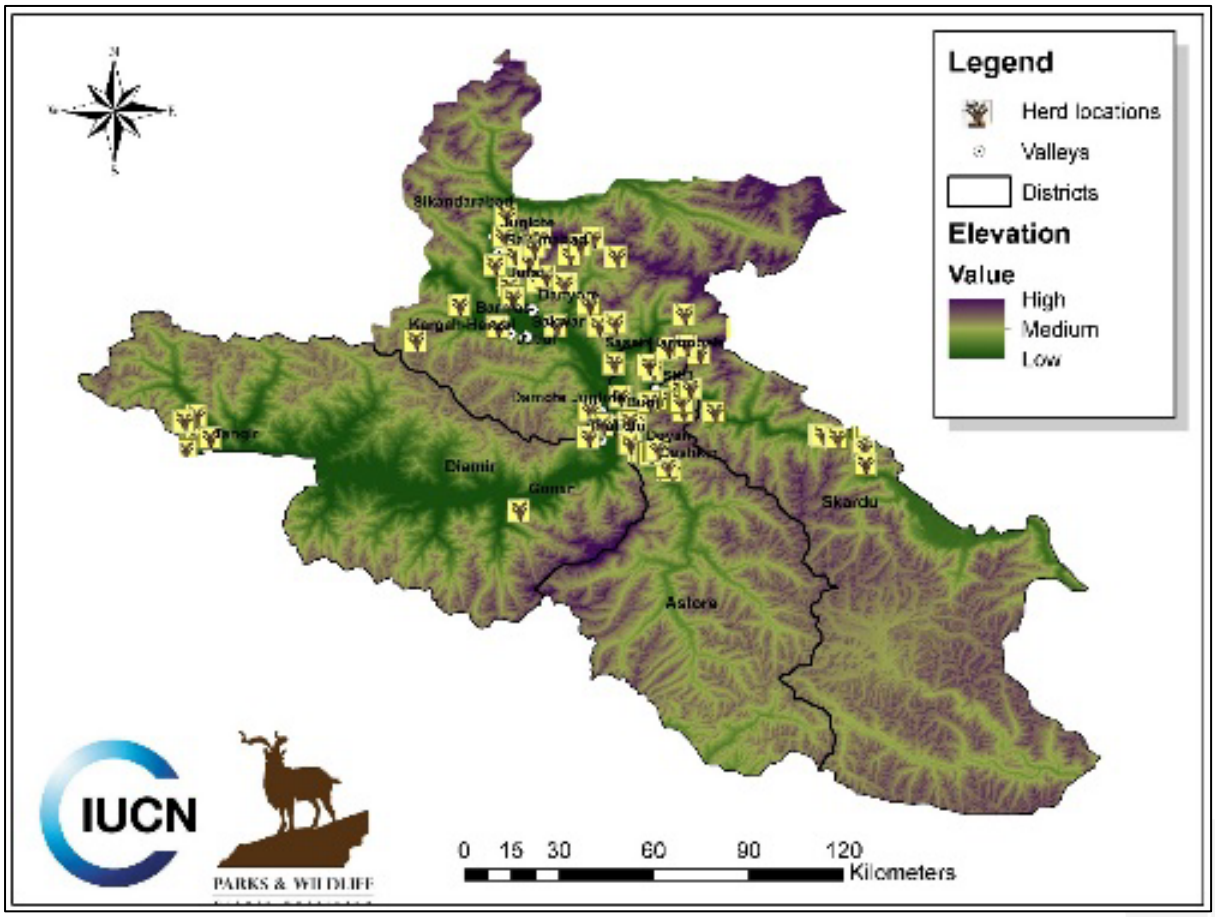

Figure 4: Geographical locations of herds in Gilgit-Baltistan

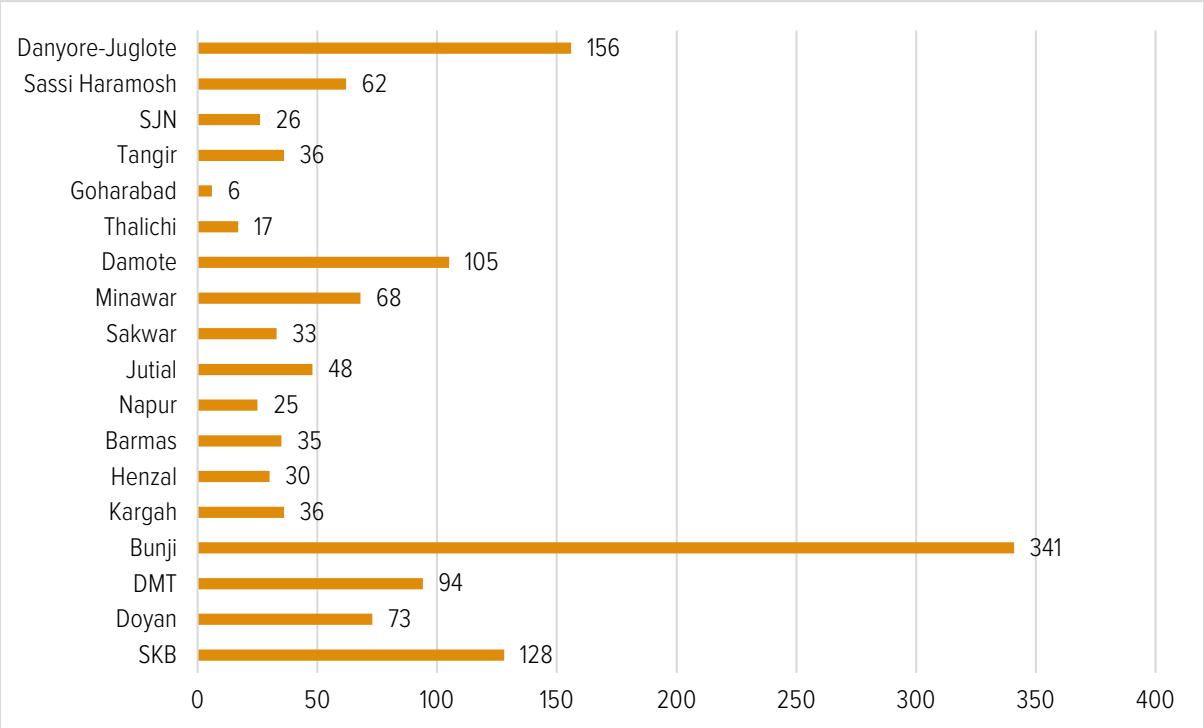

Figure 5: Population of Astor Markhor in Different Conservancies/Valleys

A total of 82 herds were sighted in 18 conservancies/valleys of Gilgit Baltistan. Highest number of 14 herds were observed in Bunji, followed by 9 herds in Danyore-Juglote conservancy and 7 herds in SKB, DMT and Damote each. The overall numbers of herds sighted in different valleys/conservancies of Gilgit Baltistan are shown in Figure 6.

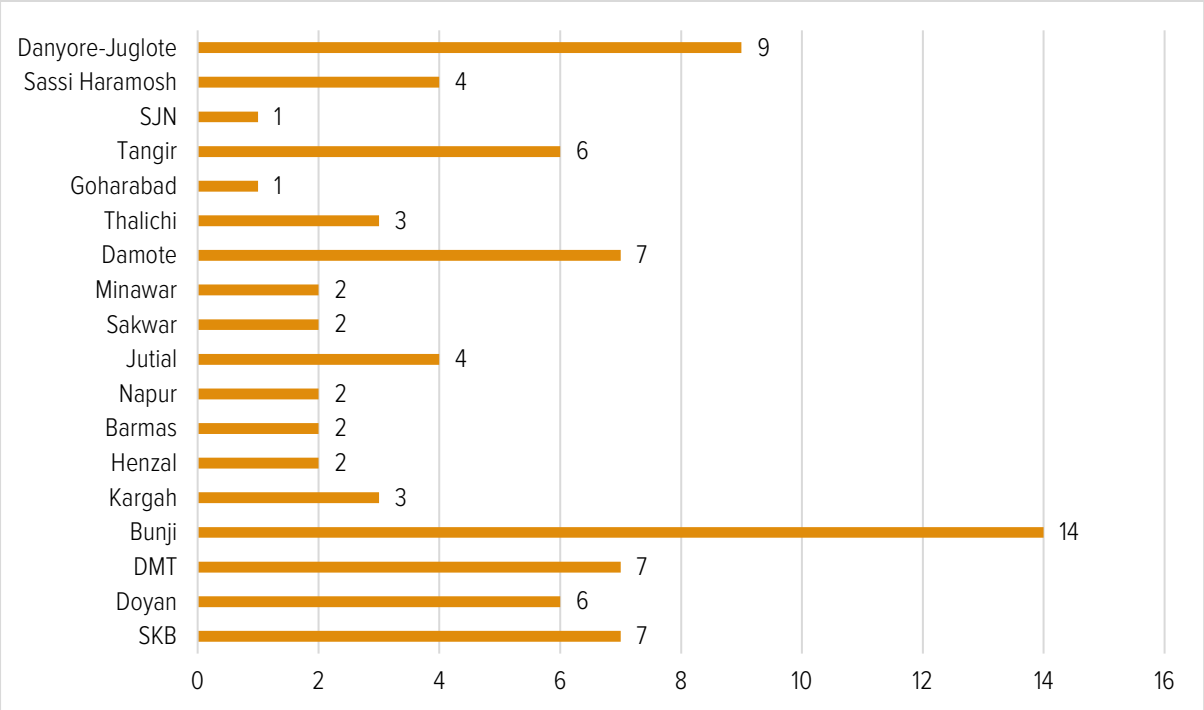

Figure 6: Numbers of herds sighted in different conservancies/valleys

During Rut season survey we observed 79 Trophy size animals in the different areas of Gilgit Baltistan. Highest number of 19 trophy animals were observed in Bunji conservancy, followed by 11 in Danyore-Juglote conservancy. The overall numbers of trophy size animals of different valleys/conservancies of Gilgit Baltistan are shown in Figure 7.

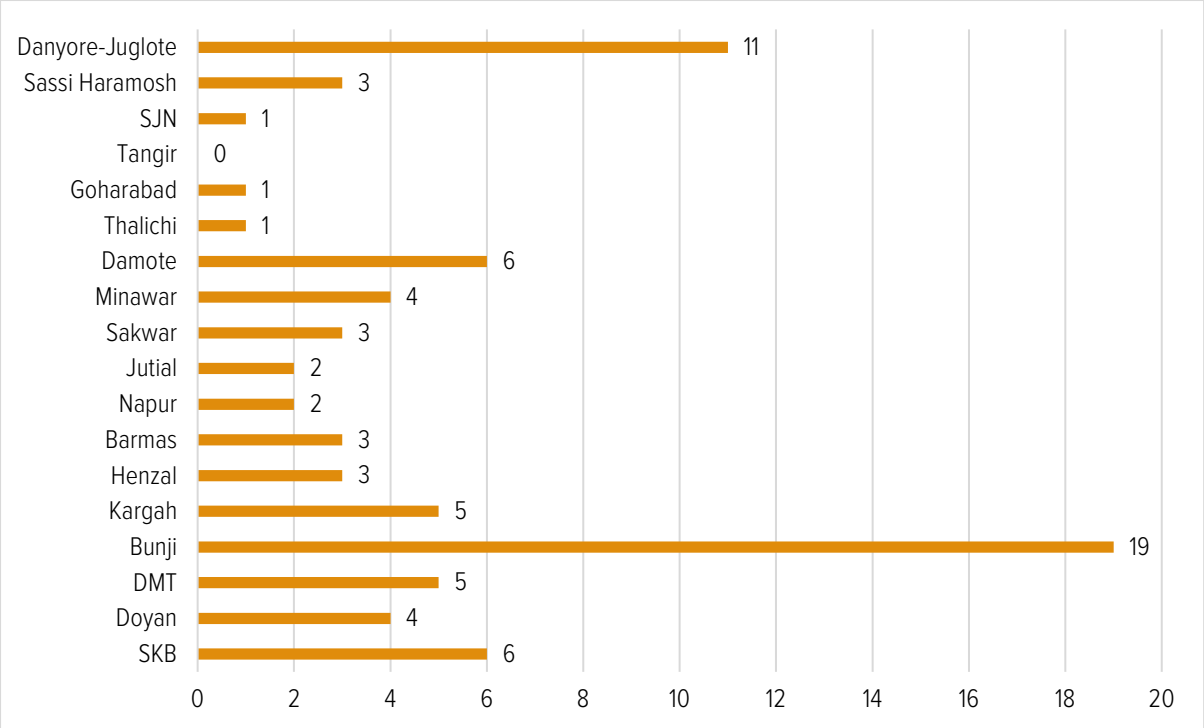

Figure 7: Number of trophy animals sighted in different conservancies/valleys

The highest number of 50 detections were recorded between the elevation ranging from 1800 to 2600 meters, and 21 detections in elevation range of 1000-1800 meters and 12 detections were recorded in the elevation range of 2600-3400 meters (Figure 8).

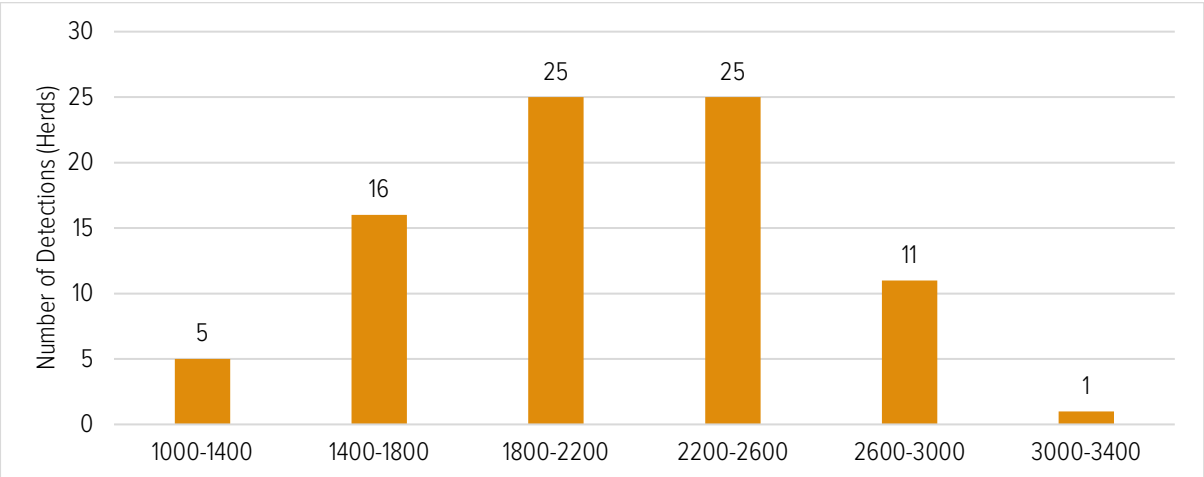

Figure 8: Number of sighting (detections) on different elevation ranges

The detection (sighting of herds) of animals was high in early morning (6:00-9:00am) and decreased following the sunset and again increased to peak levels in the evening (3:00-

6:00pm) following sunset. The number of detections between 9:00am to 12:00pm was seventeen. The lowest detections were recorded between 12:00 to 3:00pm (Figure 9).

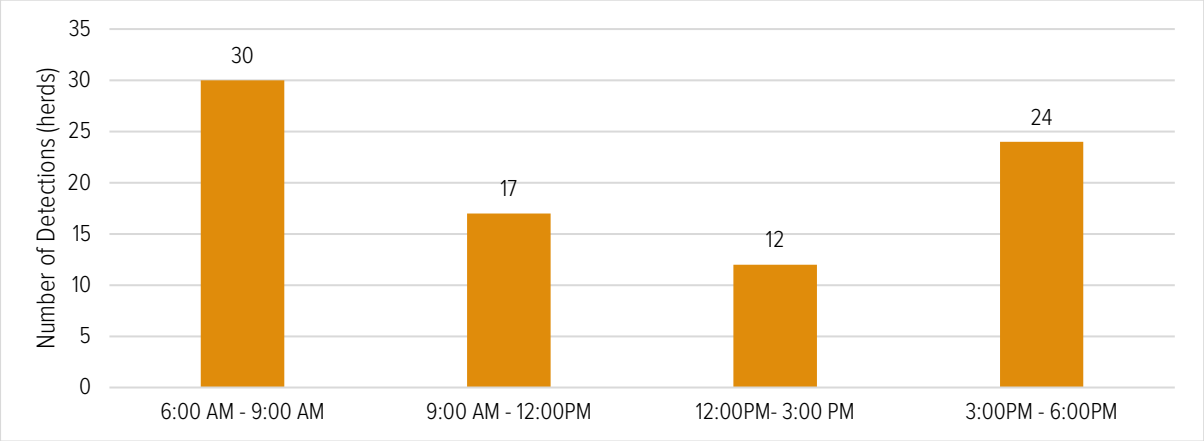

Figure 9: Number of sightings (detections) over time

Out of the total population of Astor Markhor, 477 were females, 193 yearling, 218 young and 431 males. Males were assigned to different classes based on the size of the horns. A male with unique horns was also captured at one camera station (Figure 10). In male population, 197 were sub-adult males, 155 adult males and 79 trophy males.

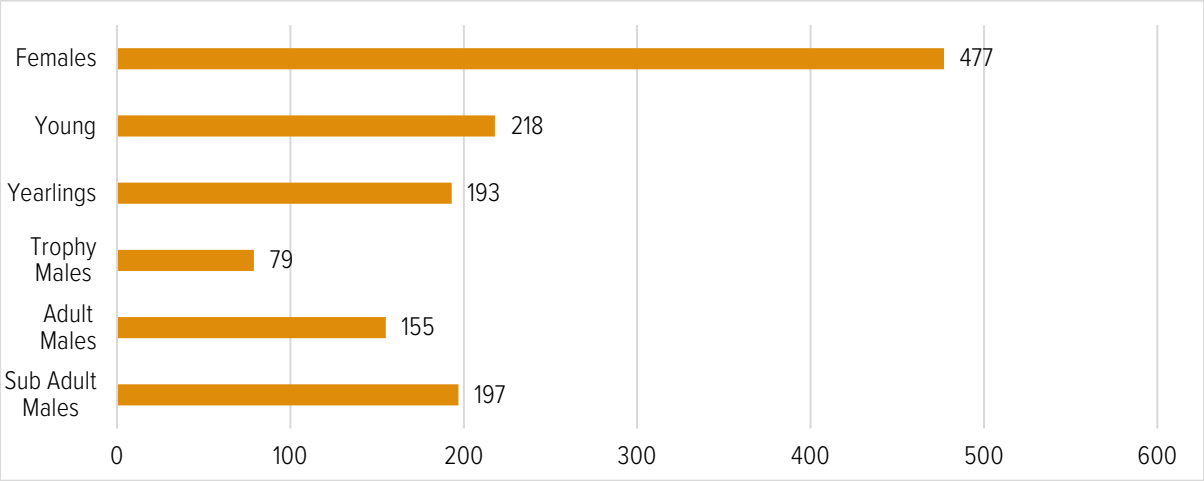

Figure 10: Population of different age and sex classes

3.1.1 Population of Astor Markhor in District Astore

The estimated population Astor markhor in district Diamer was 508 individuals in 27 herds including 179 females, 80 young, 76 yearling, 68 sub-adult males, 75 adults and 27 trophy size animals (Figure 11). The mean group size was 18.81 ±7.21 (CI: 95%). The highest number of 341 animals in 14 herds were recorded in Bunji, followed by 94 animals in 7 herds in DMT and 73 animals in 6 herds in Doyan conservancy. Highest number of 19 trophy size animals were recorded in Bunji, followed by 5 animals in DMT and 4 animals in Doyan conservancy (Table 1).

Table 1: Population of Astor Markhor in District Astore

Conservancy/ Valley	Population	No. of Groups	Trophy Animals	Mean Group size	Standard Deviation	Standard Error
Bunji	341	14	19	24.35	23.25	6.21
Doyan	73	6	4	12.16	3.43	1.41
DMT	94	7	5	13.42	10.48	3.96

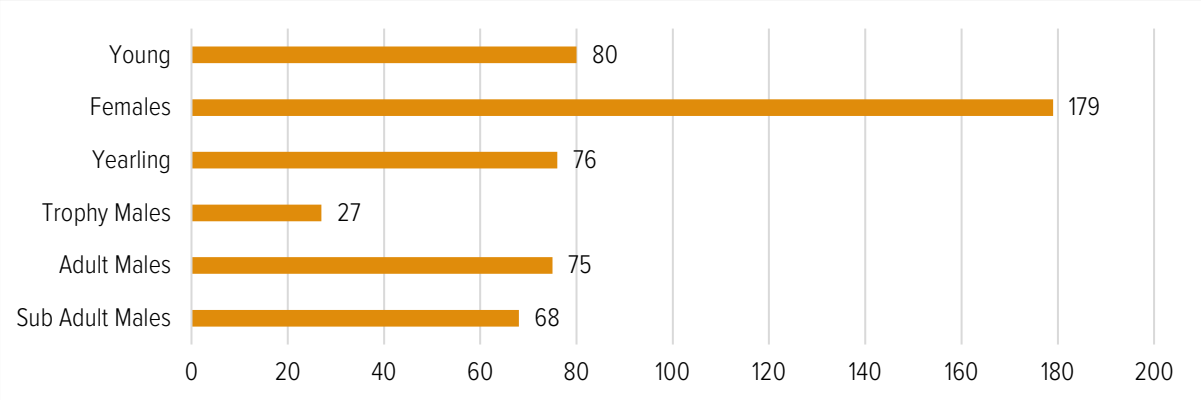

Figure 11: Age and Sex structure of Astor markhor in District Astore

3.1.2 Population of Astor Markhor in District Gilgit

The estimated population of Astor markhor in district Gilgit was 598 individuals in 37 herds including 199 females, 96 yearling, 91 young, 102 sub-adult males, 68 adult males and 42 trophy size males (Figure 12). The mean group size was 16.16 ±2.58 (CI: 95%). The highest number of 156 animals in 9 herds were recorded in Danyore-Juglote conservancy, followed by 105 animals in 7 herds in Damote, 68 animals in 2 herds in Minawar, 62 animals in herds in Sassi Haramosh. A total of 48 animals in4 herds were recorded in Jutial, 36 animals in 3 herds in Kargah, 35 animals in 2 herds in Barmas, 33 animals in 2 herds in Sakwar and 25 animals in 2 herds in Napur. No animals were sighted in the Harali area. Highest number of 11 trophy size animals were recorded in Danyore-Juglote conservancy, followed by 7 animals in Damote, 4 animals in Sassi-Haramosh and Jutial each (Table 2).

Table 2: Details of population of Astor markhor in district Gilgit with other parameters

Conservancy/ Valley	Population	No. of Groups	Trophy Animals	Mean Group size	Standard Deviation	Standard Error
Kargah	36	3	5	12	5.56	3.21
Henzal	30	2	3	15	7	5.0
Barmas	35	2	3	17.5	3.53	2.5
Napur	25	2	2	12.5	3.53	2.5
Jutial	48	4	2	12	2.94	1.47
Sakwar	33	2	3	16.5	2.12	1.5
Minawar	68	2	4	34	14.14	10
Damote	105	7	6	15	6.68	2.52
Sassi Haramosh	62	4	3	15.5	7.59	3.79
Danyore-Juglote	156	9	11	17.33	8.27	2.75

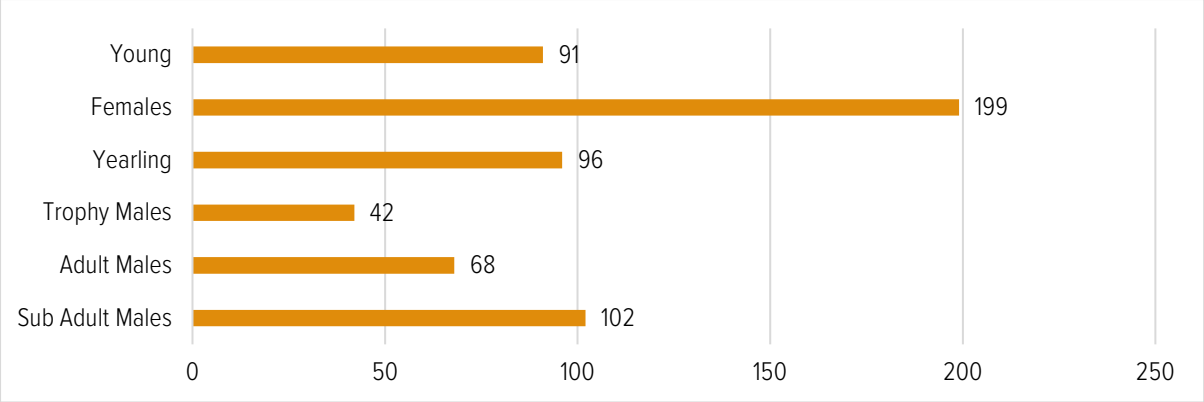

Figure 12: Age and Sex structure of Astor markhor population in District Gilgit

3.1.3 Population of Astor Markhor in District Diamer

The estimated population Astor markhor in district Diamer was 59 individuals including 26 females, 6 young, 7 yearling, 13 sub-adult males, 5 adults and 2 trophy size animals (Figure 13). The mean group size was 5.9 ±1.83 (CI: 95%). The highest number of 36 animals in 6 herds were recorded in Tangir valley followed by 17 animals in 3 herds in Thalichi and 6 animals in single herd in Batchulai. No animals were sighted in Hudur, Hukur and Jalipur area. Two trophy size animals were recorded in Batchulai and Thalichi each. There was no trophy size animal observed in Tangir (Table 3).

Table 3: Details of population of Astor markhor in district Diamer with other parameters

Conservancy/ Valley	Population	No. of Groups	Trophy Animals	Mean Group size	Standard Deviation	Standard Error
Thalichi	17	3	1	5.76	4.16	2.41
Goharabad	6	1	1	-	-	-
Tangir	36	6	0	6	2.19	0.89

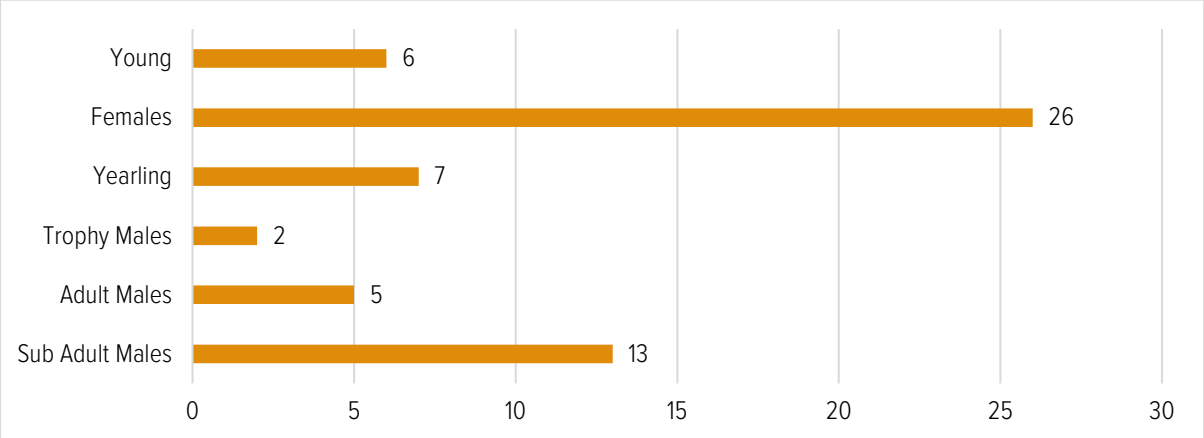

Figure 13: Age and Sex structure of Astor markhor population in District Diamer

3.1.4 Population of Astor Markhor in District Skardu

The estimated population Astor markhor in district Skardu was 128 individuals in 7 herds including 60 females, 34 young, 14 yearling, 9 sub-adult males, 5 adults and 6 trophy size

animals (Figure 14). All animals were recorded in Sokoyo-Kharbatan and Basingu (SKB conservancy). The mean group size was 18.21 ±4.58 (CI: 95%). The standard deviation from mean was 4.59.

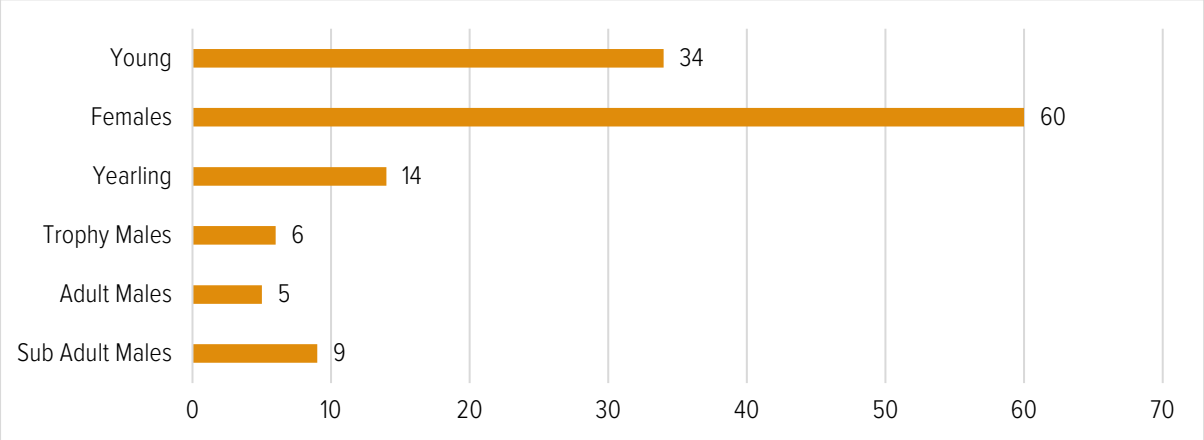

Figure 14: Age and Sex structure of Astor markhor population in District Skardu

3.1.5 Population of Astor Markhor in District Nagar

The estimated population Astor markhor in district Nagar was 26 individuals in single herd in Sikandarabad-Jaffarabad-Nilt (SJN conservancy) including 12 females, 7 young, 4 sub-adult males, 2 adult males and 1 trophy size male (Figure 15).

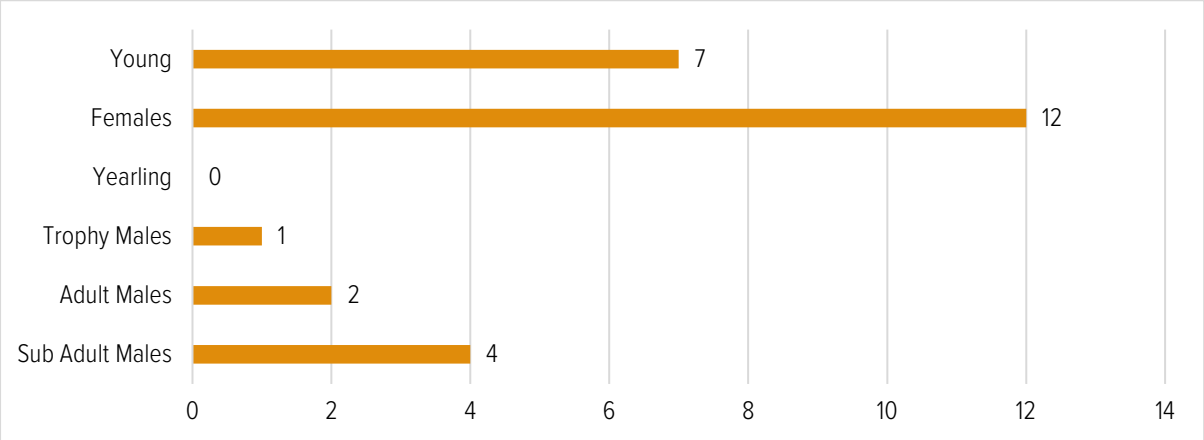

Figure 15: Age and Sex structure of Astor markhor population in District Nagar

3.2 Ladakh Urial

A total of 134 individuals of Ladakh urial were sighted in 11 herds in 5 valleys of Gilgit Baltistan (Figure 16). The estimated population was 158 individuals. The upper confidence interval was 236 (CI: 97.5%) and the lower confidence interval was 134 (CI: 2.5%) and the mean herd size was 12.8 ±3.83 (CI: 95%). The standard deviation from mean group size was 6.49. The detection probability of observer 1 and observer 2 were 0.68 and 0.61 respectively. The calculated variance was 42.14. Highest number of 94 animals in 7 herds were recorded in Bunji valley, 10 animals in single herd in Doyan and 15 animals in Batchulai (Raikot). In Bruldo, Shigar, 12 animals were recorded and 3 animals in Kharpocho in singles herds respectively (Figure 17).

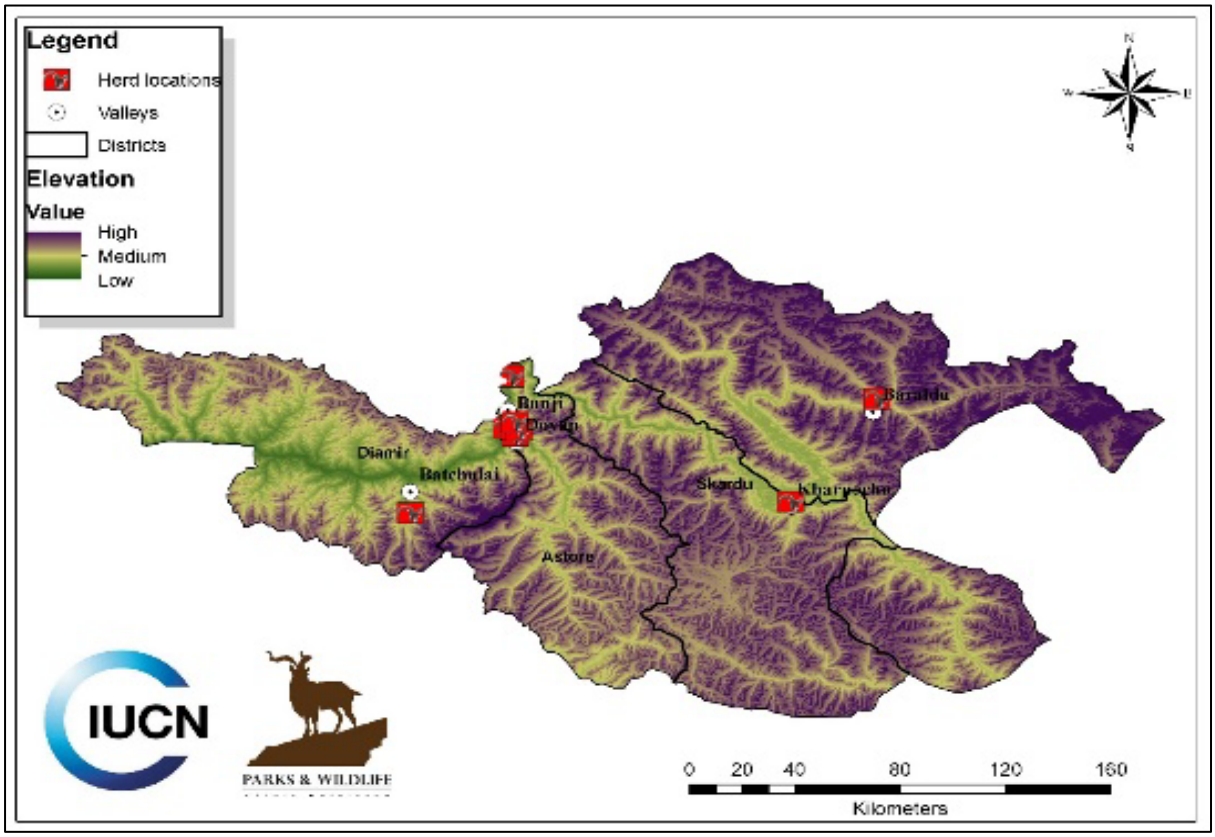

Figure 16: Geographical locations of herds sighted in different valleys

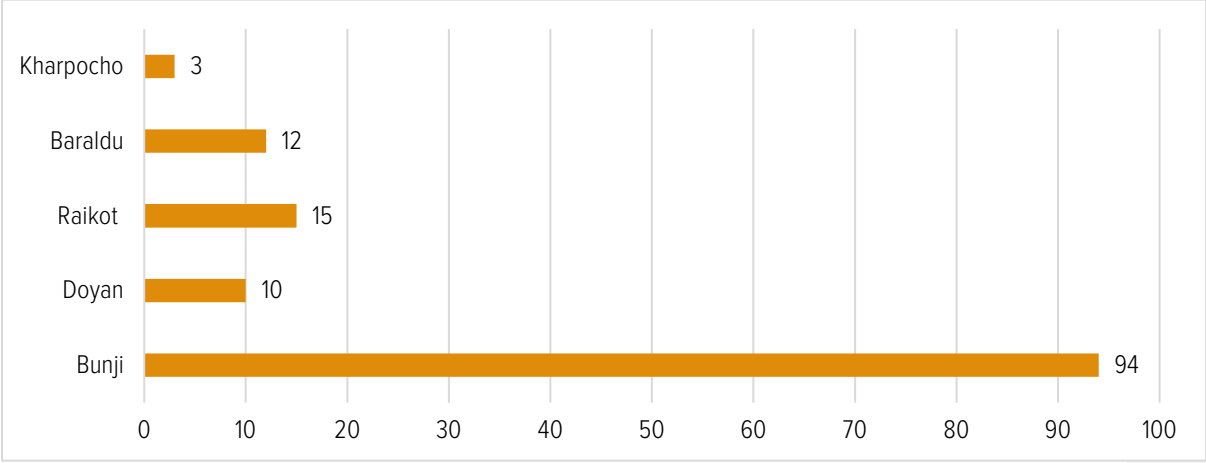

Figure 17: Population of Ladakh Urial in different valleys

A total of 11 herds were recorded during this survey in 5 valleys of Gilgit Baltistan. Seven herds were recorded from Bunji and single herds were recorded from all remaining valleys (Figure 18).

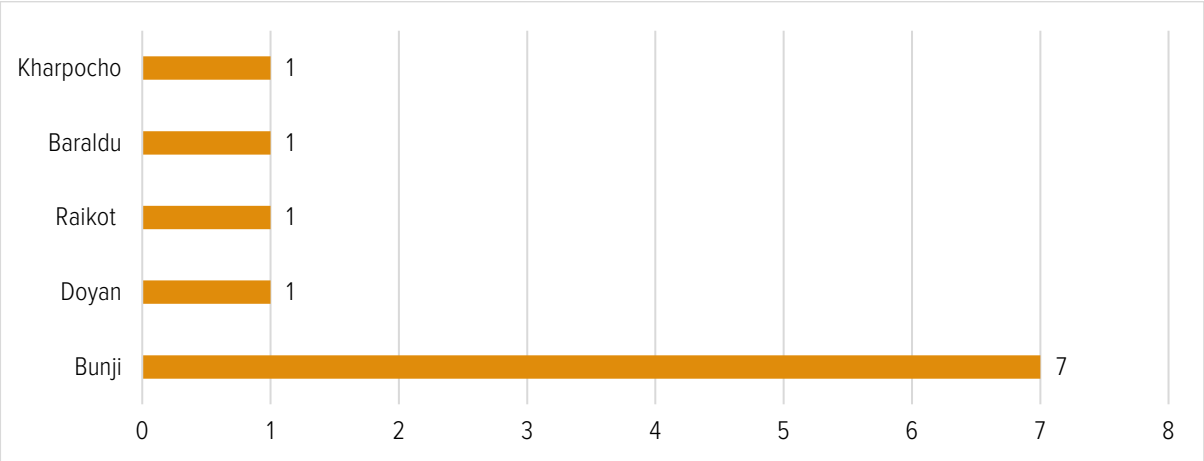

Figure 18: Number of herds sighted in different valleys

Out of total population, 69 were females, 13 yearlings, 27 young and 19 males. Males were assigned to different classes based on the size of the horns. In male population, 5 were class I males, 6 class II males, 3 Class III males and 5 class IV males (Figure 19).

Figure 19: Age and Sex Structure of Ladakh urial

The highest number of 6 detections (sighting of herds) were recorded between the elevation of 1900-2500 meters, 3 detections were recorded in the elevation range of 2500-3400 meters and 3 detections were recorded in the elevation range of 1300-1900 meters (Figure 20).

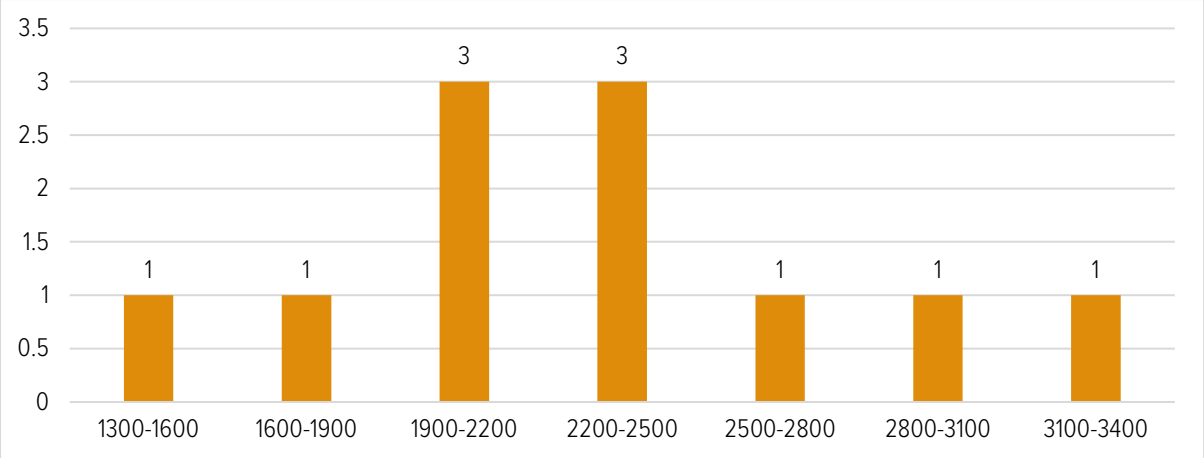

Figure 20: Number of detections (sighting) at different elevations (meters)

The detection of animals was high in early morning (6:00-9:00am) and decreased to 3 following the sunset and there were no detections from 12:00-3:00pm and again increased to 2 detections in the evening (3:00-6:00pm) following sunset (Figure 21).

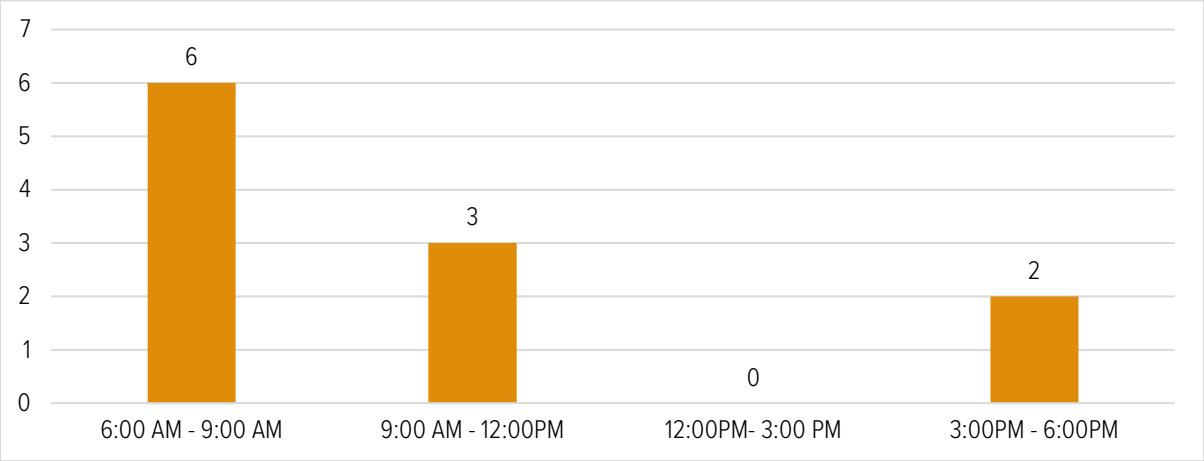

Figure 21: Number of detections of herds over time

4. DISCUSSION

Ungulates are among the most intensively managed wildlife in Gilgit Baltistan because of their importance as game species for subsistence and sport hunters who pay money for trophies. To manage ungulate populations effectively, wildlife managers must employ survey methods that can provide population estimations that are accurate and precise enough to achieve management goals, yet efficient and economical enough to remain practical (Found and Patterson 2020). Mountain ungulates play an essential role in maintaining ecosystems and their long-term monitoring is essential for ensuring sustainability especially for harvested animals (Eggert et al. 2003; Noon et al. 2012). Markhor is the highest-paid animal in trophy hunting program in Pakistan and it has very limited and patchy distribution (Nyhus et al. 2016) and long term monitoring of its population is necessary to make trophy hunting sustainable as a tool of conservation (Damm 2008; Buckley and Mossaz 2015; Crosmary et al. 2015) to obtains maximum sustainable yield (Sutherland 2001; Jenks et al. 2002; Milner-Gulland et al. 2009). Keeping these important points in mind, surveys are conducted on yearly basis both in lambing and rut season. The current survey was conducted in rut season and Astor markhor comes to lower elevation areas near to human population (Khan et al. 2017) and community watchers monitor them in the field to stop illegal hunting. Reviewing Astor markhor's past data of recent years, which was collected using double observer method (Abbas et al. 2021), we came to know that most groups were recited in most of the valleys might be due to clue provided by community watchers who were already in the field monitoring the animals that violates basic assumption of the method (Suryawanshi et al. 2012) but this is not the case with Ladakh urial which is not monitored by community watchers because it is not been harvested. Hence, we have used fixed point direct counting method for Astor markhor (Haider et al. 2021) and double observer method for Ladakh urial (Ghoshal 2018).

(Zafar et al. 2014) estimated the population of 1071 animals in potential habitat of markhor in 2014. A total of 1087 animals estimated by (Haider et al.

2021) in multiple studies that were conducted between 2015 and 2017 in Gilgit Baltistan. During rut season survey 2019-20, the estimated population was 1286 animals (Khan et al. 2020), similarly in rut season survey 2020-21, a total of 934 animals were estimated but this didn't include data from Tangir, Sikandarabad and Danyore-Juglote conservancies (Abbas et al. 2021). In the present study, we have estimated the population of 1319 animals in Gilgit Baltistan. This shows the increasing trend of population of Astor markhor in the region. It was almost exterminated from the area due to over- hunting, habitat loss, and competition with domestic livestock. that might otherwise go extinct due to overhunting, poaching, and habitat degradation However, its population has now been brought back through successful implementation of community-based conservation and trophy-hunting programs under the strictly controlled CITES quota for annual export of four markhor trophies from GB. Furthermore, it is recommended that a total of 4 individuals can be harvested in the upcoming trophy hunting season from the study area by allocating one (1) trophy animal each to Bunji, Danyore-Juglote, SKB, Damote, DMT, Kargah, Minawar and Doyan conservancies. The female to male ratio was little higher (Khan et al. 2020).

Ladakh urial was once widely distributed in Gilgit Baltistan but due to habitat loss and illegal poaching its distribution has been limited to different patches in Gilgit Baltistan. Currently, it is living in small herds in different watersheds and Bunji is a stronghold of its population while the remaining valleys have very little population (Siraj-ud-Din et al. 2016). In the present study, the estimated population of Ladakh urial was 158 in 11 herds individuals that is little higher than the population estimated by (Zafar et al. 2014) in 2014. Except Bunji, very small herds were recorded in all other valleys of GB. Male to female is very low and only 19 males were recorded in the current survey while there were69 females.

5. CONCLUSION AND RECOMMENDATIONS

Based on 2021-22 range wide joint winter markhor and urial surveys, it can be concluded that most of these conservancies have good markhor population. However, this will further require monitoring trend in markhor population in these conservancies through annual or biannual surveys to see whether population is stable, decreasing or increasing. One thing is clear that the status of markhor population in these conservancies needs to be further improved if local communities and authorities like to see sustainable trophy-hunting programs and introduce wildlife-based tourism as an alternate source of livelihood. The surveys also confirmed that markhor herds, including trophy-size animals, are now coming down to lower elevations close to human settlements and seasonal homes in search of forage during winter when higher elevations are covered with snow. Ladakh urial population is also increasing slowly but its male to female ratio is very low, thus, a better management and planning is required for its effective propagation.

- Department should ensure long term monitoring of markhor and other wildlife to ensure sustainability.
- Government should initiate translocation and reintroduction programs for Ladakh urial to expand its distribution.
- A strict ban on illegal poaching of Ladakh urial and other wildlife is required on urgent basis.

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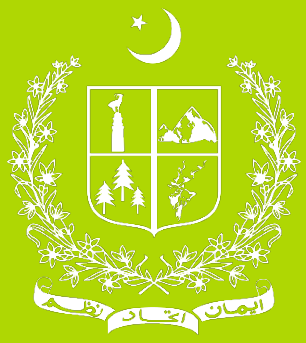

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