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Research paper

Population Status and Distribution of Hangul Deer (*Cervus hanglu hanglu*, Wagner) in Dachigam National Park, Kashmir, India

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ABSTRACT

Present study on the population status and distribution of Kashmir Red Deer (*Cervus hanglu hanglu*) in Dachigam National Park, Srinagar, J&K was conducted from October 2011 to December 2015. An intensive study area of 53 km^2 was selected at different habitat types, aspects and altitudes of the National Park, representing various ecological zones of the Park. The objective of the study was to determine the status, relative abundance/density and distribution of Hangul deer in Dachigam. A total of 12 transects/stands were established in the potential favourable habitat of Hangul deer. Each stand was walked twice every month from November 2011 to December 2015 to estimate the Encounter Rates (ER) and density of Kashmir Red Deer. The deer abundance was also estimated by scanning of vantage points. Seasonal variations of Hangul deer were estimated by regularly monitoring and traversing through trails in the study area in different time periods. The mean seasonal ER and density of Kashmir Red Deer ranged from 0.78 to 0.95/km and 1.58 to 1.82/km^2 respectively with the overall mean ER and density of 0.84/km and 1.61/km^2 respectively. Seasonal ER and density estimates differed greatly from year to year, although the estimations were consistent. In less disturbed regions, abundance calculations were greater. The ER of Hangul deer in the area was strongly correlated with the density estimates. The overall ER for Hangul Deer in Reshwadri was 1.48/km and the density estimates were 5.20/km^2 (highest in autumn).

1. Introduction

1.1 Description of Hangul

Hangul is a subspecies of Red Deer (one of the largest deer species) native to northern Pakistan and India, especially in Jammu and Kashmir.

Kingdom: Animalia	Phylum : Chordata
Class: Mammalia	Order: Artidactyla
Suborder: Ruminantia	Family: Cervidae
Subfamily: Cervinae	Genus: Cervus
Species: hanglu	Subspecies: hanglu

The Kashmir Red Deer (*Cervus hanglu hanglu*, Wagner), also known as Hangul, is a member of the Artiodactyla (or cloven-hoofed mammals) order, and is distinguished by having two weight-bearing functional central toes, enclosed in horny hooves of roughly equal size, and giving the appearance of a sin-

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-gle hoof split down the middle on each foot (Roberts, 1977; Grub, 1993).

This deer has a light rump patch and a brown coat with speckling throughout the hairs. The buttocks' inner surfaces are a greyish white colour. The antlers of stags begin to grow in the spring and are shed every year, generally at the end of the winter. Each antler consists of 3-6 tines. Antlers typically measure about 50 cm in total length and are made up of bone which can grow at a rate of 1.0-2.0 cm a day. Velvet is a soft coating that protects freshly formed antlers in the spring. The velvet is lost and the antlers stop developing when the stag's testosterone levels decline. The antler begins to calcify as fall approaches, and the stag's testosterone production increases in preparation for the impending rut (mating season). Deer acquire thicker coats of hair in the fall, which helps to insulate them throughout the winter.

The deer is one of the shy and hesitant animals. It is extremely repulsive to any interference and defies caging violently. Hangul generally spend their winters at lower reaches of Dachigam and migrate to the higher elevations of the park, where forage is better for the calving season. The fawns take birth in May-June, after which the migration usually starts (Ahmad et al., 2002; Kaul et al., 2018).

Dominant stags follow groups of hinds during the rut, from September to early winter. The Hangul is a polygamous species (one male mating with many females) and generally the number of males is very less to that of females (Schaller, 1969; Kurt, 1977; Bhat et al., 2009).

1.2 Status and Distribution of Hangul

The Hangul (*Cervus hanglu hanglu*), the state animal of Jammu and Kashmir is a subspecies of European Red Deer and is surviving only under the moist temperate forests of Kashmir region. Hangul was declared as a critically endangered animal by IUCN (2004) and has now been declared least concerned species by Red Data Book of the International Union for Conservation of Nature and Natural Resources (IUCN, 2012).

The conservation of this species is important since it is the sole Red Deer Group survivor on the Indian subcontinent (Ahmad and Khan, 2007). Prior to 1950, deer were plentiful and widely spread throughout Kashmir's highlands (Schaller, 1969; Farooq et al., 2012). After 1950, however, the drop in Hangul populations was ascribed to widespread poaching and the loss of its habitat due to cultivation and cattle grazing. Dachigam National Park (DNP) and its surrounding regions are now the only places where this deer may be found (Ahmad, 2007; Sharma et al., 2010). They were also known to be present in the upper Bringi valley (Holloway, 1971) in Bandipora, Gurez, Sindh valley, Drass valley, Lidder valley and Desu (South-east of Srinagar) (Kurt, 1978). Despite the fact that there are more than 150 species of deer worldwide, Hangul is the only existing race of the European Red Deer family in the subcontinent. Hangul's only viable population is now confined to Dachigam National Park and its surrounding protected areas (Kurt, 1978; Ahmad et al., 2002; Iqbal et al., 2005; Ahmad, 2006). In the highlands of Kashmir, Hangul was formerly extensively spread (Schaller, 1969). Hangul's historical range was limited to a 65-mile arc north - northeast of the Jhelum and lower Chenab rivers, from Shalurah in the north to Ramnagar in the south (Lydekker, 1924; Holloway, 1971). The Gamgul Siya-Behi Sanctuary in Himachal Pradesh, near the state boundary with Jammu, is the only known location outside of Jammu and Kashmir where Hangul populations ever existed. Hangul was only found in the damp temperate woods on the northern side of the Kashmir valley and a few other nearby valleys (Prater, 1965; Kurt 1978). Today, however, the Dachigam population is the sole viable population (Schaller, 1969; Holloway, 1971; Kurt, 1978; Department of Wildlife Protection, 2004) distributed between an elevation of 1,700 m to 3,500 m.

Between the Zanskar and Pir Panjal mountain ranges in Kashmir is the endangered Hangul's range. In its current distribution range, the Hangul population has dropped significantly. Only Dachigam National Park has a demographically sustainable population of Hangul in its current range. From the 1940s until 2004, the Dachigam Hangul population has been declining. Since 1947, the numbers have dropped dramatically (Gee, 1966; Schaller, 1969; Holloway, 1970; Department of Wildlife Protection, 2004). Before freedom, the Dachigam Hangul populace was around 1000-2000 people, but by the late 1950s, it had shrunk to around 400 people (Gee, 1966), then to 140-170 people (Holloway, 1970; Bhat & Sofi, 2021).

The census exercises conducted by the Wildlife Department of Jammu & Kashmir from 2004-2009 have put the numbers in between 150 to 200 (Suhail

et al., 2009). However, the recent census conducted in Mach 2011 by the combined group of personnel from Wildlife Institute of India (WII), State Wildlife Protection Department (JKWLPD), Universities and NGO's puts it as 218±13.96. According to the report, there has been a 43 percent increase. Dachigam National Park and nearby regions including as Dara, Nishat, Braine, Cheshmashahi, Khonmoh, Khrew, Wangath, Shikargah, Khiram, Khangund Conservation Reserves, and neighboring forest areas of Sindh Forest were surveyed in March 2011 across an area of 1,107 kilometres in 87 transects. Although the figures show an upward trend after 2009, they do not indicate a considerable growth in the Hangul population.

There was a decrease with just 140 to 170 Hangul surviving in 1970 (Gee, 1966), down from an estimated 2000 Hangul in 1947 (Holloway, 1970; Sathyakumar et al., 2009). Grazing, poaching, and human disturbance were found as important factors impacting Hangul recovery in Dachigam National Park (Kurt, 1978, 1979). Deer numbers began to increase to a significant level when Dachigam was declared a National Park in 1981 and steps taken for its recovery. However, a wave of militancy in 1989 and subsequent political upheaval in the state put the deer in jeopardy once more. The most recent censuses done by the Wildlife Department of J&K between 2004 and 2012 estimates the population between 150 and 220.

The other Red Deer subspecies, Cervus elaphus wallichi (Shou), which used to live in East Sikkim's highlands, is now extinct. Hangul is significant because it is the lone Red Deer survivor in the Indian subcontinent. Historically, the Hangul range was limited to a 65-kilometer arc north and east of the Jhelum River, as well as the Lower Chennab River, stretching from Shalurah in the north to Ramnagar in the south (Holloway, 1970; Kumar et al., 2017). In the winter, the Hangul occupied a total of 148 square kilometres, including 84 square kilometres in Dachigam, 52 square kilometres in regions surrounding Dachigam in Central Division, and 13 square kilometres in South Division. According to the study and interviews, a few Hanguls live outside of Dachigam all year in locations such as Gurez, Ajas, Bunakot, Bandipora, Kangan, Surpharo Baltal, Harmukh, and Wangath (Qureshi et al., 2009). The presence of Hangul has been suggested by reconnaissance surveys and interviews undertaken in Upper Dachigam (Leech Top to Gunas Nar) and Sindh Forests. Changdaji has an excellent habitat in the North Division, with reports of Hangul presence (Qureshi et al., 2009). Outside of Jammu and Kashmir, a tiny population lived in the Himachal Pradesh district of Chamba (Lydekker, 1924), but it is now extinct. The current state of affairs is due to widespread biotic intervention, habitat fragmentation, and degradation. Only Dachigam National Park has a demographically sustainable population of Hangul in its current range (Qureshi et al., 2009; Mukherjee et al., 2021).

Sharma et al., (2010) found that Hangul habitat usage exhibits seasonal shifts in consumption patterns, which can be linked to variations in habitat structure as well as abiotic elements like temperature and snowfall. Altitude, aspect, slope, habitat type, food availability-abundance and quality, escape terrain, escape cover, and cover from harsh weather and biotic stressors are some of the key elements that influence ungulate habitat utilisation in the Himalaya. In Dachigam NP, there was a substantial change in Hangul's habitat usage habits. In the winter and spring, the most sightings and signs were reported in valleys with flat regions, which offer Hangul with protection from harsh cold and heavy snowfall in its distribution zone, as well as meeting its feeding needs, as valleys or streams are thought to give a better refuge. Hangul preferred riverine habitat in the winter and spring because it was close to water and supplemented with artificial food (salt lick) by park administration. Extreme cold weather conditions in the upper altitudes can be blamed for the migration of Hangul people from upper elevations to valley locations in the winter and spring. The predilection for eastern and steeper slopes stemmed from the fact that eastern slopes receive more sunshine, which gives relief from the brutal cold winds. In the summer, however, maximum Hangul sightings and signs were documented in the 2,500-2,700 m altitudinal range because they do segregate, with females forming smaller groups and males developing social hierarchy and travelling in various locations, similar to other Red deer. The southern slopes provide rich fodder in the summer, but the valley areas are too hot for Hangul, so they migrate to the Dachigam NP's upper elevations. The abundance and quality of forage in Dachigam fluctuates annually, resulting in seasonal fluctuations in Hangul's diet.

Hangul distribution in Dachigam NP follows a seasonal pattern: in the spring, Hangul is found in the lower riverine forest of Dachigam, while in the summer, Hangul is found in the upper reaches of Dachigam in Upper Dachigam. Hangul used lower and medium elevations of riverine, pine woods, and grasslands in the fall and winter seasons, and their distribution is clustered in Dachigam's lower altitudes. Hangul extends their range during the summer season, staying at a height of 3000 feet from mid-June to mid-September (Shah et al., 2011). The great majority of Dachigam's highlands, notably the whole upper Dachigam, including the Dagwan, Nagaberan, and Marsar districts, are now populated by large herds of animals. Lower Dachigam has mild southern slopes. Coniferous woods or grasslands cover their ridges, attracting deer and herders from the surrounding settlements. Similar hills crest the northern slopes of lower Dachigam. However, these places have been overrun by man-made savannas, which Hangul used to graze on during heavy snowfall on the higher slopes (Aziz et al., 2010; Charoo et al., 2010a,b; Sharma et al., 2015).

The major cause of Hangul decrease is poaching by Gujjars, Bakarwals, as well as other nomads who transport their livestock to Upper Dachigam during the summer (Stockley, 1936; Gee, 1966). This is exacerbated in Dachigam by huge biotic disturbance caused by cattle controlled by the State Animal Husbandry Department that graze on Dagwan in Upper Dachigam. Thousands of sheep, goats, horses, and cattle are grazed by native farmers, gujjars from Kashmir, as well as Bakarwals and Banyaris from Jammu, in the huge expanses of Nageberan and Marser (Bhat and Yatoo, 2018). This has resulted in prospective rivals as well as ongoing causes of disruption for Hangul throughout the summer months. The Dachigam Hangul population declined from 3000 animals in the 1940s to about 200 by 1969, whereas sheep imported by the State Animal Husbandry Department in 1961 to Dachigam NP rose from 20 to over 3000 during the same time period. Upper Dachigam is where the sheep spend the summer and Lower Dachigam is where they spend the winter (Kurt, 1978; Ahmad et al., 2013; Nigam, 2014).

Grazing appears to be a constraint on Hangul's ability to fully utilise its environment. During the summer months, the alpine meadows are populated by enormous herds of nomad herbivores and sheep from the Govt. Sheep Breeding Farm, Dachigam (Bhat, 2008; Ahmad et al., 2009). The alpine meadows are abundant in broad-leaved plants, which served as the major source of nutrition for deer during the summer (Kurt, 1978). Deer no longer move to these places for eating as a result of the massive disturbance in the upper reaches, and are pushed to sub-optimal foraging sites (Bhat, 2008; Ahmad, 2007; Kurt, 1978, 1979). Upper Dachigam has several highly grazed regions that were prone to erosion (Bhat, 2008; Maviya Majid et al., 2019). The risk of sheep parasites and illnesses spreading to deer is always present (Longhurst et al., 1954).

In Dachigam, illnesses such as Johne's disease (Kurt, 1978), Foot and Mouth (Stockley, 1936), Rinderpest, Anthrax, Tuberculosis, Malignant catarrhal fever, and Brucellosis have impacted the Hangul people. In the past, cattle and Hangul has been affected by Foot and Mouth disease (Stockley, 1936; Sharma et al., 2013; Bacha and Fund, 2015).

Iqbal et al. (2005) found 25% Hangul incidence in Leopard scats, accounting for 61% of the prey biomass devoured by Leopard. This suggests that the leopard is heavily reliant on Hangul. Predation by other predators such as pariah dogs, shepherd's dogs, jackals, black bears, and other carnivores is also a possibility. Although Stockley (1936) identified black bears as "destroyers of new-born calves/fawns," Kurt (1978) has not seen black bear predation on Hangul fawns. There are several ecological links that need to be addressed in the knowledge of the Hangul population (Yadav et al., 2021).

2. Study Area

Dachigam National Park is located in the Western section of the Great Himalayan range, between 34°05"N and 34°11"N and 74°54"E and 75°09"E. (Fig. 1). The National Park's mountainous range is a part of the Great Zansakar range, and the natural boundaries of the famous Dachigam National Park are formed by two steep ridges, one rising from Harwan Reservoir with peaks around 2600 to 3000 metres above sea level, and the other rising to 4100 metres above sea level (Mah-Dev). The folds of this mountain form a series of undulations that enclose tiny gullies and wider out flanking valleys known as "Nar." Srinagar and Pulwama districts have civil authority over the area. Its biogeographical province is 2.38.12 (Himalayan Highlands), and its biogeographic zone is 2A. It is situated in the Zabarwan mountain range of

the Great Himalayas, 21 kilometres north-east of Srinagar (the summer capital of Jammu and Kashmir). The nearest airport is 32 kilometres distant, while the nearest train station is 315 kilometres away.

Two high mountain ridges, one coming from Harwan water reservoir on the park's south west side and the other originating from Dara/Khimber side, form the park's natural limits, with a height gradient of 2,600m to 3,000m (Bhat et al., 2020). Dachigam is bordered on the north-east by Sindh Valley, Tarsar, Lidderwath, Kolhai of Lidder Valley, and Overa-Aru Wildlife Sanctuary, and on the far east by Overa-Aru Wildlife Sanctuary. In the south-east, the Tral range, and in the west and south-west, the Harwan, Brain, and Nishat ranges (Kurt, 1978; Khurshid et al., 2021). In the field, artificial borders are drawn. Pillars are essential to safeguard the area's and law enforcement's integrity.

2.1 The Intensive Study Area

An intensive study area of 53 km^2 was selected for the study of population dynamics, in various habitat zones of the National Park. The decision was based on the results of a reconnaissance study conducted in October and November 2011. With a large altitudinal range, numerous aspect and slope categories, and various plant kinds, it is indicative of the entire Dachigam region (Ahmad and Farooq, 2018). Other arguments for the choice of the location include its relative ease of access and the presence of the research animals at various anthropogenic levels. The intensive area comprised of many geographical zones viz., Badin Nalla, Draphama, Reshwadri, Pahlipora, Drog, Manyu Nar, Namblan, Kaunar, Zahil, Grat Nar, Hangalmarg and Nagaberan. The road is macamadized from Dachigam Gate to VIP Guest House, Draphama and other areas are approachable only along bridle paths through rugged terrain along the main Dachigam Nalla (Fig. 1).

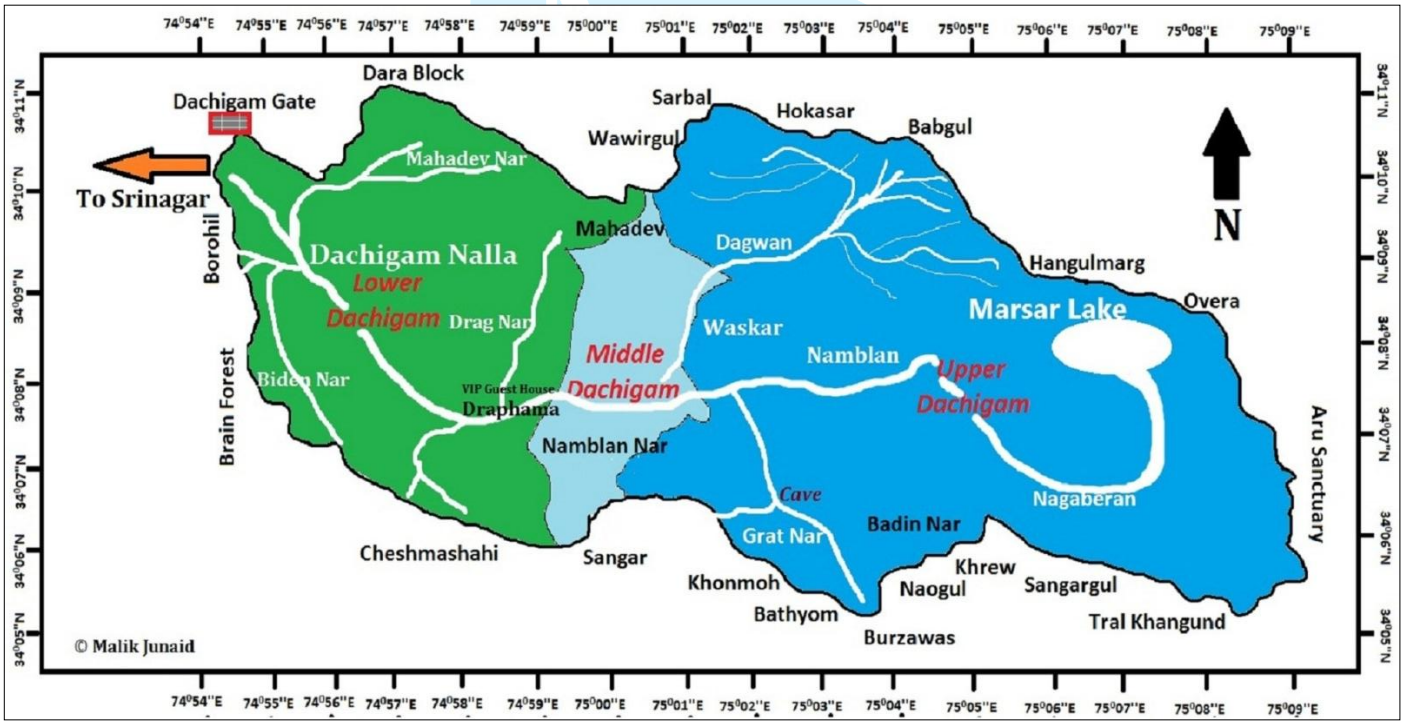

Fig. 1 A broad view of the study area

3. Materials and Methodology

3.1 Background

The population size and structure of a species in an area is decided through interplay between the potentials and/ or needs of a species, like habitat requirements for food and shelter, group behaviour, mortality and natality. The population, being a living entity, changes to different degrees in response to the changing external environmental conditions and hence is dynamic. Population dynamics thus focus changes in the number of individuals of a species and analysis of factors affecting the population size and/ or movements with relevance to some area. Knowing the population size and dynamics in a species helps in understanding the present status of the population of a species in certain area and also in visualizing the future possible trends.

Surveys (Schaller, 1977; Gaston et al., 1981; Fox et al., 1988; Sathyakumar, 1993) and a few systematic studies are the major sources of information on

ungulate abundance in the western Himalaya (Green, 1985; Sathyakumar, 1994). Green (1985) was the first to document the density of musk deer in Kedarnath Wildlife Sanctuary, followed by Kattel (1990) in Sagarmatha National Park. The number and density of major ungulates such as goral, musk deer, Himalayan tahr, barking deer, serow, and sambar were documented by Sathyakumar (1994) at the Kedarnath Wildlife Sanctuary. Except for research on Kashmir Red Deer, there has been no thorough study of mountain ungulates in the National Park (Ahmad, 2006; Bhat, 2008; Srivastava and Vasudevan, 2021).
In this study, an attempt has been made to estimate the abundance and density of Kashmir Red Deer of Dachigam National Park covering various seasons and along the gradients of anthropogenic disturbances.

3.2 Methods

The reconnaissance survey of the study area, selection and marking of stands/ quadrats and identification of vantage points for scanning was made during November 2011. This included systematic coverage of the study area by establishing stands in the potential favourable habitat of the deer, distributed in Dachigam National Park. A total of 12 stands were established in the potential favourable habitat of the deer (Badin Nalla, Draphama, Reshwadri, Pahlipora, Drog, Manyu Nar, Namblan, Kaunar, Zahil, Grat Nar, Hangalmarg and Nagaberan). Stand characteristics are presented in Table 1. Each stand was visited and sampled during different seasons, between 2012 and 2015 for population studies, irrespective of the total potential area of the stand.

The basic methods of visual supervision with the help of telescope were adopted, as exploited previously by Fakhar-i-Abbas (2006) for goral in Pakistan and by Sathyakumar (1993, 1994) for Himalayan Tahr and Himalayan Musk deer in Keadrnath Musk deer sanctuary and Great Himalayan National Park. However, the present study is carried with certain modifications for population study. For the purpose, different number of suitable observation posts and view towers were carefully selected in each stand area, on some cliff, having wider unobstructed view, keeping in view the size of the area of the stand, heterogeneity of the habitat and convenience. The numbers of animals present within visual range of the available telescope (Optolith, 50X) were directly counted. The shades of colour of the fur, features of horns, muzzle and back tails of the majority of the solitary individuals or some prominent individual in the herd were recorded. These records were maintained and used to check possible double counts of the individuals in the sampling area. Keeping in view the crepuscular nature of the Hangul deer, the observations were made in the morning (07:00 to 11:00) and the evening (15:00 to 19:00) sessions. For every mammal sighting, date and time, species, number, sex, sighting angle, sighting distance and animal activity were recorded.

The information was extracted on the possible number of Hangul deer surviving in the area from local people, shepherds, hunters and notables. The information was checked for its reliability, keeping in view the status of the individual, his exposure to the wild areas and educational level. This information was, however, maintained as a countercheck to data obtained through field surveys. The information gathered from the locals though usually remained close to the calculated values, yet it was not used for the general deductions on the population parameters.
Altitude was measured with a GPS and also verified with the Survey of India toposheet of the study area. Slope was measured on a five point scale *viz.* 0.07-10°, 10-20°, 20-30°, 30-40° and 40-50° by visual estimation. Vegetation cover categories were measured on a four point scale (0-25%, 26-50%, 51-75% and >75%) based on visual estimation.

3.2.1 Encounter Rate (ER)

Encounter (ER) rate is a standardised expression of number of animals encountered per unit of survey effort. ER can be based on direct sightings or indirect evidences such as pellet groups and other signs and given as rate per kilometre or hour.

Sathyakumar (1994) estimated the abundance of ungulates in Kedarnath Wildlife Sanctuary by this method. Similarly Gaston et al. (1981) and Gaston and Garson (1992) estimated the abundance of mammals and pheasants in Great Himalayan National Park, expressed as encounter/ 100-h search. Surveys conducted by Ahmad (2006) in Dachigam National Park, Gaston & Garson (1992), Sathyakumar (1994) in Kedarnath Wildlife Sanctuary and Vinod & Sathyakumar (1999) in Great Himalayan National Park expressed the ER of major ungulates as number seen/ hour effort. Transects in the present study pass through various altitudinal ranges and the searching effort varied with time of the day and seasons. Hence,

the encounter rate of Hangul deer in the present study was expressed as number/ km walk. As the number of animals seen/ hour varies with respect to terrain type and observer efficiency. It is advisable to express ER as;

$$ER = \frac{n}{km\ walk}$$

3.2.2 Density Estimates

The crude population density was calculated for each observation post by dividing the number of the Hangul deer seen by the sampled quadrate area. The density figures for each stand and for the total area were calculated by usual averaging. The standard errors were calculated using the stand densities.

$$D = \frac{n}{area\ sampled\ (km^2)}$$

Table 1 Characteristics of the Stands laid in Dachigam National Park

Stnd. No	Stand (Transect)/ Location Name	Sampled Area (km^2)	Altitude(m)
1	Badin Nalla	5	1,600-1,900
2	Draphama	7	1,800-2,400
3	Reshwadri	5	1,800-2,400
4	Pahlipora	5	2,150-2500
5	Drog	4	1,950-2,600
6	Manyu Nar	5	1,900-2,400
7	Namblan	5	2,550-3,350
8	Kaunar	4	2,500-3,450
9	Zahil	4	2,700-3,100
10	Grat Nar	3	2,700-3,150
11	Hangalmarg	3	3,450-4,025
12	Nagaberan	3	4,000-4,100

4. Results and Discussion

4.1 Encounter Rate

The overall encounter rate for Hangul deer in transects namely Badin Nalla, Draphama, Reshwadri, Pahlipora, Drog, Manyu Nar, Namblan, Kaunar, Zahil, Grat Nar, Hangalmarg and Nagaberan were 0.67, 1.36, 1.48, 0.59, 1.17, 1.84, 0.74, 0.92, 0.10, 0.28, 0.24 and 0.76 per km walk respectively (Table 2). There were no significant variations in the yearly encounter rate for Hangul in the area (Table 3; Fig. 2). Hangul ERs were different in more disturbed and less disturbed areas. The less disturbed area had a higher ER. The encounter rate of Hangul deer in key transects differed significantly across seasons. Winter had the highest rate of encounters, followed by spring, autumn, and summer. This might be attributable to the fact that deer form larger groups throughout the winter due to the scarcity of snow-free feeding sites. During the spring, autumn, and summer, the encounter rate of Hangul deer decreased. During these seasons, the animal could spread to more snow-free places since there was sufficient of water and fodder to go around. Another reason for the low encounter rate might be that the ambient temperature was greater in the spring, summer, and early fall, causing the animal to seek cooler places (upper Dachigam) away from the transects. Hangul appears to react negatively to human disruptions, as evidenced by the increased encounter rate in less disturbed environments. As chief transects of the present study are the representative of Hangul deer habitats in Dachigam National Park, the overall ER of 0.84/ km can be taken as the encounter rate of Hangul deer in the Hangul habitat of Dachigam. However, the overall ER for Hangul deer in Drog, Reshwadri and Draphama transects of Dachigam National Park was 1.79 Hangul/ km walk (Qureshi et al., 2009), which is slightly higher than the present estimate.

Table 2 Seasonal Encounter Rates (#/ km walk) for Hangul deer in the Study area (2012-2015)

Transect/ Stand	Spring (N=85)	Summer (N=84)	Autumn (N=84)	Winter (N=96)	Overall (N=349)
Badin Nalla	0.25	0.33	0.88	1.22	0.67
Draphama	1.50	1.13	1.12	1.72	1.36
Reshwadri	1.90	1.00	1.12	1.93	1.48
Pahlipora	0.35	0.46	0.66	0.92	0.59
Drog	1.10	1.27	1.22	1.12	1.17
Manyu Nar	1.92	1.64	1.84	1.96	1.84
Namblan	0.66	0.82	0.64	0.84	0.74
Kaunar	0.86	0.92	0.92	1.00	0.92
Zahil	0.22	0.20	0.00	0.00	0.10
Grat Nar	0.27	0.27	0.23	0.37	0.28
Hangalmarg	0.15	0.21	0.23	0.22	0.24
Nagaberan	0.79	1.13	0.92	0.20	0.76
Overall	**0.83**	**0.78**	**0.81**	**0.95**	**0.84**

Table 3 Overall/ Seasonal Encounter Rates (#/ km) of Hangul deer in Dachigam National Park (2012-2015)

Season	Overall Encounter Rate
Spring	0.83
Summer	0.78
Autumn	0.81
Winter	0.95
Overall	**0.84**

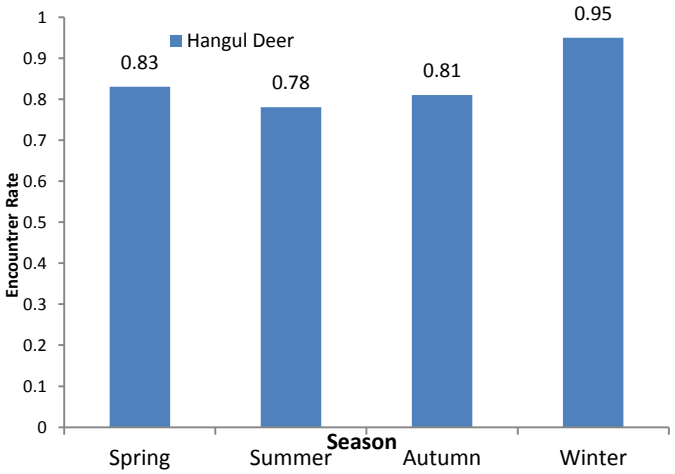

Fig. 2 Diagram showing Overall Seasonal Encounter Rates (#/ km) of Hangul deer in Dachigam National Park (2012-2015)

4.2 Abundance and Density

The summary of the available data on the abundance, distribution and density of the Kashmir Red Deer population in different stands have been presented in Tables 4, 5 , 6 and 7 with respect to seasons.

4.2.1 Spring

Table 4 suggests that in spring the population of the Hangul is distributed in different parts of Dachigam with a population density of 1.61 per km² respectively for 53 km² of the total sampled potential habitat. The spring Hangul density, in different stands established under the present study, ranges between 0.00 (3 stands) and 4.60 per km² (Reshwadri). The population density of the species is different in different broad habitat tracts/ localities.

The highest density of Hangul deer has been recorded for Reshwadri (4.60/ km²) followed by Draphama (2.71/ km²), Drog (2.00/ km²), Pahlipora (1.80/ km²), Kaunar (1.75/ km²), Badin Nalla (1.60/ km²) and the lowest density has been recorded in Hangalmarg (0.33/ km²).

Table 4 Population abundance and density (per km²) of Hangul deer in Dachigam during Spring

Locality/ Stand	Area Sampled (km²)	Hangul Deer	
		No. Observed	Pop. Density (per km²)
Badin Nalla	5	8	1.60
Draphama	7	19	2.71
Reshwadri	5	23	4.60
Pahlipora	5	9	1.80
Drog	4	8	2.00
Manyu Nar	5	7	1.40
Namblan	5	3	0.60
Kaunar	4	7	1.75
Zahil	4	0	0
Grat Nar	3	0	0
Hangalmarg	3	1	0.33
Nagaberan	3	0	0
TOTAL	**53**	**85**	**1.61**

4.2.2 Summer

Table 5 suggests that in summer the population of Hangul deer is distributed in different parts of Dachigam with a population density of 1.58 per km² respectively for 53 km² of the total sampled potential habitat. The summer Hangul density, in different stands established under the present study, ranges between 0.00 (1 stand) and 3.80 per km² (Reshwadri). The population density of the species is different in different broad habitat tracts/ localities.

The highest density of Hangul deer has been recorded for Reshwadri (3.80/ km²) followed by Draphama (2.42/ km²), Pahlipora (2.00/ km²), Badin Nalla (1.80/ km²), Manyu Nar (1.60/ km²), Kaunar (1.00/ km²), Drog (0.44/ km²), and the lowest density has been recorded in Nagaberan (0.33/ km²).

Table 5 Population abundance and density (per km²) of Hangul deer in Dachigam, during Summer

Locality/ Stand	Area Sampled (km²)	Hangul deer	
		No. Observed	Pop. Density (per km²)
Badin Nalla	5	9	1.80
Draphama	7	17	2.42
Reshwadri	5	19	3.80
Pahlipora	5	10	2.00
Drog	4	9	0.44
Manyu Nar	5	8	1.60
Namblan	5	4	0.80
Kaunar	4	4	1.00
Zahil	4	0	0
Grat Nar	3	1	0.33
Hangalmarg	3	2	0.66
Nagaberan	3	1	0.33
TOTAL	**53**	**84**	**1.58**

4.2.3 Autumn

Table 6 suggests that in autumn the population of Hangul deer is distributed in different parts of Dachigam with a population density of 1.58 per km² respectively for 53 km² of the total sampled potential habitat. The autumn Hangul density, in different stands established under the present study, ranges between 0.00 (4 stands) and 5.20 per km² (Reshwadri). The population density of the species is different in different broad habitat tracts/ localities.

The highest density of Hangul deer has been recorded for Reshwadri (5.20/ km²) followed by Draphama (3.14/ km²), Drog (2.00/ km²), Badin Nalla (2.00/ km²), Pahlipora (1.80/ km²), Manyu Nar (1.00/ km²) and the lowest density has been recorded in Namblan (0.20/ km²).

Table 6 Population abundance and density (per km²) of Hangul deer in Dachigam, during Autumn

Locality/ Stand	Area Sampled (km²)	Hangul deer	
		No. Observed	Pop. Density (per km²)
Badin Nalla	5	10	2.00
Draphama	7	22	3.14
Reshwadri	5	26	5.20
Pahlipora	5	9	1.80
Drog	4	8	2.00
Manyu Nar	5	5	1.00
Namblan	5	1	0.20
Kaunar	4	3	0.75
Zahil	4	0	0
Grat Nar	3	0	0
Hangalmarg	3	0	0
Nagaberan	3	0	0
TOTAL	**53**	**84**	**1.58**

4.2.4 Winter

Table 7 suggests that in winter the population of Hangul deer is distributed in different parts of Dachigam with a population density of 1.82 per km² respectively for 53 km² of the total sampled potential habitat. The winter Hangul density, in different stands established under the present study, ranges between 0.00 (4 stand) and 4.40 per km² (Reshwadri). The population density of the species is different in different broad habitat tracts/ localities.

The highest density of Hangul deer has been recorded for Reshwadri (4.40/ km²) followed by Drog (3.00/ km²), Draphama (2.57/ km²), Pahlipora (2.40/ km²), Badin Nalla (2.20/ km²), Manyu Nar (2.00/ km²), Kaunar (1.75/ km²) and the lowest density has been recorded in Namblan (0.80/ km²).

Hangul deer density estimations reflect a tendency comparable to the ER in the area. Winter density estimates were greater than other seasons, and transects Reshwadri, Draphama, Badin Nalla, and Drog had higher density estimates than other transects. In these transects, human activity was quite modest. From the spring through the winter seasons, there was an upward trend in density estimates. During the spring, summer, and fall, the animals could be moved to more snow-free areas with abundant of water and feed, allowing them to wander about freely. The density estimates in the area ranged from 0.00/ km² to 5.20/ km². The overall density estimates for Hangul deer in the area was 1.64/ km². However, the overall density for Hangul deer in Drog, Reshwadri and Draphama transects of Dachigam National Park was 3.09 Hangul/ km² (Qureshi et al., 2009), which is much higher than the present estimate. Though, the present estimate is concurring in the same transects (Reshwadri, Draphama, Drog, Badin Nalla) observed by Qureshi et al. (2009). Hangul deer Encounter rate and density estimates in the area showed a positive correlation (Table 3, 8). Thus Hangul ER in the area may be taken as a reliable indicator for Hangul deer density.

Table 7 Population abundance and density (per km²) of Hangul deer in Dachigam, during Winter

Locality/ Stand	Area Sampled (km²)	Hangul deer	
		No. Observed	Pop. Density (per km²)
Badin Nalla	5	11	2.20
Draphama	7	18	2.57
Reshwadri	5	22	4.40
Pahlipora	5	12	2.40
Drog	4	12	3.00
Manyu Nar	5	10	2.00
Namblan	5	4	0.80
Kaunar	4	7	1.75
Zahil	4	0	0
Grat Nar	3	0	0
Hangalmarg	3	0	0
Nagaberan	3	0	0
TOTAL	**53**	**96**	**1.82**

Table 8 Overall/ Seasonal Population Density (#/ km²) of Hangul deer in Dachigam National Park (2012-2015)

Season	Overall Population Density
Spring	1.61
Summer	1.58
Autumn	1.58
Winter	1.82
Overall	**1.64**

5. Conclusion

Ungulates have a wide distribution in Western Himalayas. They are the principal prey species for major carnivores. Present study explores the status, relative abundance/density and distribution of Hangul deer in Dachigam National Park which lies between 34°05"N - 34°11"N and 74°54"E-75°09"E in the Western region of Great Himalayan range. A total

of 349 individuals of different age and sex of Kashmir Red Deer were recorded during the study in 53 sq. km area with the Encounter Rate of 0.84/km walk and population density of 1.64/km^2.

It is envisaged that the results can be used as baseline information for habitat management and species conservation in the park and in the broader sense for Western Himalayas. The methodology and tools used in the study can be useful to the wildlife managers, conservators and stakeholders to understand species behaviour.

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Author contributions

All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

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Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Research Ethics

This research was conducted using line transect/stand methodology and did not involve the capture and handling of mammals that were the subject of research. Approval for the conduct of this research was requested and granted from the Department of Wildlife Protection, Govt. of Jammu and Kashmir. All national, international, and institutional guidelines were adhered to for the conduct of line transects for this research.

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