STATUS AND DISTRIBUTION OF HANGUL *CERVUS ELAPHUS HANGLU* WAGNER IN KASHMIR, INDIA

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Hangul (*Cervus elaphus hanglu*) is an endangered cervid restricted to the Kashmir valley. At present, a demographically viable population of Hangul occurs only in Dachigam National Park. Between March 04 and 06, 2004, the Hangul population estimation exercise was carried out at a landscape level in central and southern divisions of Kashmir valley. Two hundred and ninety-six observers were trained in February 2004 for this exercise; in the Central division 175 observers walked 964 km, and in the South division 121 observers walked 2,014 km for data collection. In the Central division, Hangul population was estimated to be 214 (SE = 29). Density was estimated to be 3.09 hangul/sq. km (SE = 0.66). In the South division, the minimum Hangul population estimate was 30. The fawn ratio was observed to be 21 fawns/100 hinds, and sex ratio was 20 stags/100 hinds. The decline in hangul population can be reversed by controlling factors responsible for fawn mortality, grazing pressure/disturbance in the habitat, control of pariah/domestic dog population and discontinuing the release of problem leopards in the area. There is an urgent requirement to initiate a conservation breeding programme to augment Hangul population in the wild.

Key words: Hangul population, Line Transect, Lincoln-Peterson, Bounded-Count, sex ratio, Fawn Ratio, monitoring

INTRODUCTION

India has witnessed unprecedented loss of species due to human action in recent times. Conservation efforts in India intensified in the 1970s to safeguard species and habitats. The lack in implementation of scientific monitoring programme to track the population response under rapidly changing scenarios has left no information to take corrective measures in time. Hangul (*Cervus elaphus hanglu*) amongst many other endangered species like Barasingha (*Rucervus duvauceli*), Tiger (*Panthera tigris*), Gharial (*Gavialis gangeticus*), Vulture (*Gyps* sp.), and Great Indian Bustard (*Ardeotis nigriceps*) are facing problem due to lack of response to detrimental factors in appropriate time.

The endangered Hangul's range in Kashmir lies between Zanskar and Pir-Panjal mountain ranges. The other subspecies of Red Deer *Cervus elaphus wallichi* (*Shou*), which used to occur in the mountains of East Sikkim, is now extinct. Hangul assumes great significance as the only survivor of Red Deer in the Indian subcontinent. Historically, Hangul range was restricted to an arc of 65 km in width; north and east of Jhelum, and lower Chenab river, from Shalurah in the north to Ramnagar in the south (Lydekker 1924; Holloway 1970). A small population existed outside Jammu and Kashmir in the Chamba district of Himachal Pradesh (Lydekker 1924), which is now extinct. In the recent past, Hangul population has declined considerably in their existing distribution range. The present situation can be attributed to a large scale biotic interference, habitat fragmentation and degradation. In its present range, a demographically viable population of Hangul occurs only in Dachigam National Park.

There is a need to adopt robust sampling methods to establish the trends in the Hangul population. The total count of Hangul had been attempted by the Wildlife Protection Department (Jammu & Kashmir) with the right intention, but it failed to provide meaningful trends. Monitoring programme for species should be based on appropriate scientific design, inclusive of detection probabilities for individuals (Pollock *et al.* 2002). Usually data is gathered with a vague hope that somehow it will prove useful for conservation; instead it should be focused on precise information needed (Nichols and Williams 2006). We initiated a population estimation programme at landscape level to evaluate current status, and thereby design an effective monitoring protocol.

STUDY AREA

The Hangul population estimation was mainly done in the landscape of central and southern divisions of Kashmir valley, encompassing an area of approximately 808 sq. km. These divisions include ten conservation reserves, three

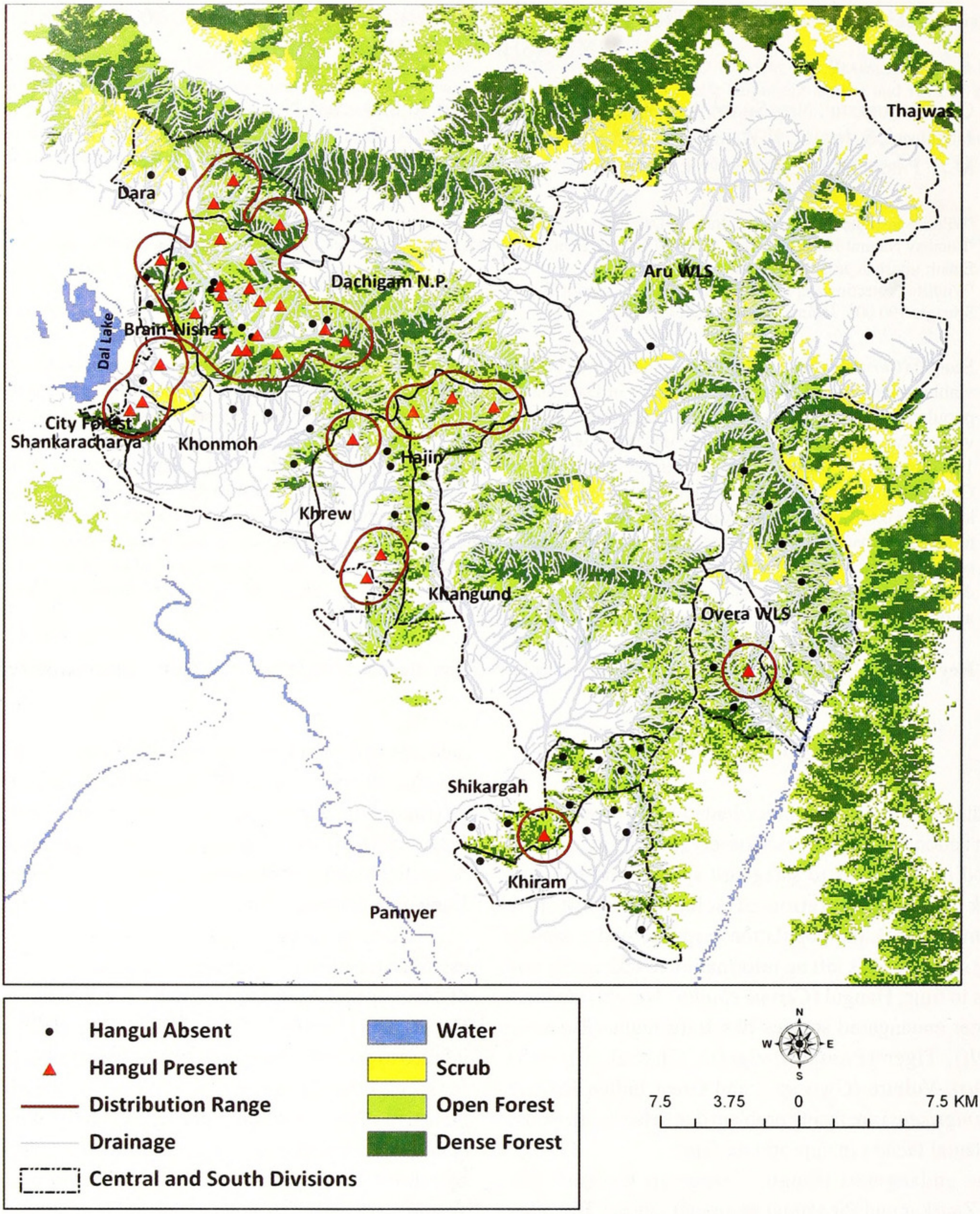

Fig. 1: Hangul distribution and area surveyed (2004) in Central and South divisons of Jammu and Kashmir

wildlife sanctuaries (Daksum, Overa-Aru and Thajwas), and Dachigam (lower) National Park (Table 1, Fig. 1).

Hangul is distributed between an elevation of 1,700 m to 3,500 m. This area harbours broad leaf mesophyll forest of Maple (*Acer* sp.), Mulberry (*Morus alba*), *Ulmus* spp., *Rhus* spp., Walnut (*Juglans regia*), *Hatab* (*Parrotiopsis jacquemontiana*), a variety of conifers such as Deodar (*Cedrus deodara*), Blue pine (*Pinus wallichiana*), Spruce (*Picea smithiana*), and Fir (*Abies pendrow*) (Singh and Kachroo 1987; Bano *et al.* 1995; Ahmad *et al.* 2002). The riverine vegetation below 2,300 m elevation is dominated by broad-leaved forest. The major shrub comprise of *Viburnum cotinifolium*, *Berberis lycium* and *Parrotiopsis jacquemontiana* (Singh and Kachroo 1987; Bano *et al.* 1995).

The higher reaches (above 3,300 m) comprise of scrub vegetation of Birch (*Betula utilis*) and *Rhododendron* spp. interspersed with meadows (Bano *et al.* 1995), followed by a permanent snow line, which is above 3,500 m (Rodgers and Panwar 1988).

METHOD

The population estimation exercise was systematically carried out in 1960s. Gee (1965) had guestimated the population size in 1957 and 1965. Schaller (1969) estimated Hangul population during the rut and concluded that rutting period is not good for population estimation. Holloway (1971) conducted a count in November 1969 and February 1970. He divided the area into six blocks; each block was scanned by a group of individuals so as to maximize the detection. The Jammu and Kashmir Wildlife Department followed Holloway's method for Hangul counts. The census method of Wildlife Protection Department was more or less consistent and enumeration was done largely in mornings except in a few cases when it was conducted both in the morning and evening (Department of Wildlife Protection 1996, 1997, 2000, 2001, 2002, 2003).

The present hangul population estimation exercise was carried out in the Central and South division of Kashmir valley. February 2004 was the training period and actual count exercise was conducted between March 04 to 06, 2004 (Table 1, Fig. 1). On March 13, Hangul sex ratio exercise was conducted. This exercise for population estimation has been modified by adapting the transect method. In all, 296 forest staff and volunteers were trained for a period of two weeks during February 2004 in transect marking and data collection. The data collected includes ocular sighting distance, hangul group sizes, age and sex, habitat type and other animal species of interest.

Table 1: Landscape covered for population estimation exercise

Area	sq. km
Brain-Nishat	15.75
City Forest	9.00
Khrew	50.25
Khonmoh	67.00
Dara	34.00
Hajin	22.08
Khangund	15.00
Shikargah	15.5
Pannyer	10.00
Khiram	15.75
Overa-Aru Wildlife Sanctuary	378.13
Thajwas Wildlife Sanctuary	55.5
Rajparian Wildlife Sanctuary	20
Dachigam (lower) National Park	100.36
Total Area	808.32

In Central Division, a total of 49 transects were marked and data was collected by 175 forest staff/volunteers walking 964 km and investing 864 hours in search effort (Fig. 1). In South Division, a total of 40 transects were identified and marked where 121 staff members walked 2,014 km and invested 890 hours to collect data (Fig. 1).

Analysis

Hangul abundance was estimated by four analytical methods, (a) density estimate based on Hayne's estimator, (b) encounter rates based on length walked and time spent in search (c) Bounded count and (d) Lincoln-Peterson estimate.

a) **Hayne's Estimator**: The transect data was analyzed for estimating abundance, based on angular distance (Hayne 1949; Eberhardt 1978; Gates 1979; Laake *et al.* 1993). The angular distance gives an idea about the visibility of animal in a given habitat (Hayne 1949; Gates 1979; Burnham *et al.* 1980; Lancia *et al.* 1994). The estimator for group density is

$$Dgrp = \left(\left(\frac{n}{2L}\right) * \left(\frac{1}{n}\right) * \Sigma\left(\frac{1}{ri}\right) \right)$$

where Dgrp = Group density, n = number of groups, L = Total Transect Length and ri = Angular distance of each sighting.

The variance was estimated using Delta Method (Seber 1982) as

$$VarDgrp = (Dgrp)^2 * \left(CV\left(\frac{n}{l}\right)\right)^2 * \left(CV\left(\frac{1}{ri}\right)\right)^2$$

where CV = coefficient of variation, n/l = encounter rate per transect and 1/ri = harmonic mean of angular distances.

The density of individuals (Dind) was estimated by, Dind = (Dgrp * Xgrp), where Xgrp = Mean Group Size and variance of individual density is estimated as

$$VarDind = (Dind)^2 * \left(CV\left(\frac{n}{l}\right)\right)^2 * \left(CV\left(\frac{1}{ri}\right)\right)^2 * (CV\,grp)^2$$

where CVgrp = CV of Group Size

The Hayne's estimator based density should be treated as an index of abundance and will be an useful estimate particularly in absence of equipment like compass and range finder.

b) **Encounter Rate** was estimated by transect length (number of hangul on each transect / transect length) and search time (number of hangul on each transect / search time on each transect).

c) **Bounded-count Method**: Here it is assumed that all animals could be counted without duplication during a survey of the population and that the process can be independently repeated. Regier and Robson (1967) proposed a Bounded-count Method which is based on the Jackknife Method of Quenouille (1956). The abundance estimator is based on the theory of estimating a truncation point by Robson and Whitlock (1964). Letting $\tilde{N}$ denote the true abundance and *m* the number of times the population is assessed, the bounded-count estimator is

$$\tilde{N} = 2\,x_m - x_{m-1}$$

where,

$\tilde{N}$ = Population Estimate

x_m = largest of the *m* counts obtained;

x_{m-1} = second largest count obtained.

An approximate confidence interval for population estimate $\tilde{N}$ with lower limit being x_m (the largest count) and upper limit by:

$= 1/\alpha\,(x_m - (1-\alpha) - x_{m-1})$, where α (significance level) we used was 0.1 (90%).

The assumptions of the Bounded-count Method include, probability of detection should be sufficiently high. The *m* counts are independent, probability of detection is constant across all replicate, animals are not counted more than once and population is closed during the course of the surveys (Overton 1969).

d) **Lincoln-Peterson Estimate**: The problem of estimating the size of a population from "total counts" known to be inaccurate has been approached from several directions. The binomial count disparate or multiple are applicable when the entities being counted cannot be distinguished individually, but each of these methods suffer from the requirement that the population is counted, *albeit* incompletely, on numerous occasions (Caughley 1974; Magnusson *et al.* 1978; Young and Peace 1999; Williams *et al.* 2001; MacKenzie *et al.* 2002; Royle and Dorazio 2008). Chapman's (1951) modified Lincoln-Peterson Estimator was used to calculate the abundance of groups;

$$\text{Ngrp} = \frac{(S1+1) * (S2+1) - 1}{(B+1)}$$

and its Variance is estimated by

$$\text{Var Ngrp} = \frac{(S+1) * (S2+1) * (S1-B) * (S2-B)}{(B+1)^\wedge 2 * (B+2)}$$

where, S1 and S2 are number of group types (1,4,8,12,16 and >22) seen on each transect in 1st and 2nd survey, and B group types common to both survey (Pollock *et al.* 1990; Young and Peace 1999; Chao *et al.* 2001).

The number of individuals (Nind) was estimated by,

Nind = Ngrp * Xgrp,

where, Xgrp is Mean Group Size

Population variance was estimated by Delta Method (Seber 1982) using variance of group estimate and group size,

$$\text{VarNind} = (\text{Nind})^2 * (\text{CV Ngrp})^2 * (\text{CVgrp})^2$$

where VarNind=Variance of population estimate, CV Ngrp = CV of Number of Groups in Population, and CVgrp = CV of Group sizes Observed.

The population was closed in terms of death, predation, birth, emigration and immigration, and individuals are equally likely to be sighted in different surveys.

The use of Lincoln-Peterson and Bounded-count Method assumes that the two counts are independent and that there is constant probability of seeing each group by a given method of survey. Clearly, such a sampling frame exists only conceptually for wildlife populations (Bowden *et al.* 1984). Alternatively, cluster sampling uses groups as the sampling unit (Bowden *et al.* 1984), because many species, especially ungulates, are typically observed in social groups. The assumption that groups are selected with equal probability (Bowden *et al.* 1984) is unreasonable in many cases because of visibility bias. More appropriately, we can estimate the probability of observing groups of animals by developing models of visibility bias.

The reliability of sight-resight estimate in this condition needs to address two crucial aspects, i.e., (i) the detection of group sizes are proportional in all surveys to evaluate aggregation or splitting of groups, thus group size categories used for estimation were compared across three counts using Fishers Exact Test and (ii) the average detection distance, i.e., visibility and effort is similar in surveys, detection distances were compared using Kruskal-Wallis ANOVA. This method is used in this case considering the area sampled remains same and group sizes used as an identity do not differ significantly across surveys, if groups are very fluid this method cannot be applied.

Statistical analysis was done using R 2.5. (R Foundation for Statistical Computing, 2007), S plus 4.5 (Lucent Technology Inc.), Excel (Microsoft Inc.) and Care 1 (Chao *et al.* 2001).

Hangul Distribution

All transects were mapped with the help of a Global

Positioning System (Garmin©).

Minimum Convex Polygon and Kernel methods were used for Hangul distribution (Animal Movement extension in ARC GIS9.1, ESRI INC). The area from Kernel Method was used as effective area occupied by Hangul.

RESULTS

Hangul Population Estimate:

A three-day population estimate and transect-based density estimate was only possible for the Central division as the South division had very few Hangul sightings (Tables 2 and 4). The group sizes were proportionally similar (P=0.95) across three surveys and there was no difference in detection distance of groups (P=0.24) among these surveys, thus satisfying our assumptions for use of Bounded-count and Lincoln-Peterson analysis, i.e., group sizes do not change and there is no detection bias.

Central Division

The mean count for three days was 213 ($\pm$25) (Table 2). The Bounded-count based estimate was 247 (Table 3). Three Lincoln-Peterson estimates for hangul group abundance ranged from 25 to 33 (Table 3). The mean population estimate was 214 (Table 3). The best hangul sighting in Dachigam National Park was in Reshwadri followed by Draphama, Drog, Manyu, Kaunar and Badin nalla.

Hangul Density and Encounter Rate: Hangul group density was 0.43 hangul group/sq. km (SE=0.07) and density of individuals was 3.09 hangul / sq. km (SE=0.66, CV=22%).

Transects in Mulnar, Drog, Reshwadri, Oak patch to Draphama area had the highest encounter rate of 1.79 hangul/km. The hangul encounter rates in areas surrounding Dachigam were 0.23/km in Nishat, 0.11/km in Khrew and 0.08/km in Dara. Hangul was not sighted in the Khonmoh sector, though indirect evidences were observed.

The other species seen on transects in Central Division were Musk Deer (*Moschus chrysogaster*), Langur (*Semnopithecus entellus*), Rhesus Macaque (*Macaca mulatta*), Black Bear (*Ursus thibetanus*), Leopard (*Panthera pardus*), Jackal (*Canis aureus*), Fox (*Vulpes bengalensis*), Yellow-throated Martin (*Martes flavigula*), Porcupine (*Hystrix indica*), Chakor (*Alectoris chukar*), Koklas (*Pucrasia macrolopha*) and Monal (*Lophophorus impejanus*).

South Division

In South Division, analysis of population estimation was not possible as data set was too small. The maximum count of 30 was taken as minimum population of Hangul in this division (Table 4).

Encounter rate of Hangul in this Division was very poor as compared to the Central Division. In South Division, Shikargah had the highest mean encounter rate 0.14 hangul/km followed by Khangund 0.04 hangul/km and Overa 0.02 hangul/km. Indirect signs of Hangul presence were observed in Pannyer Conservation Reserve. The areas that need validation for Hangul occurrence are Khiram Conservation Reserve and Daksum Wildlife Sanctuary.

The intensive surveys indicated presence of Musk Deer, Langur, Rhesus Macaque, Black Bear, Leopard, Jackal, Jungle Cat (*Felis chaus*), Fox, Koklas, Monal and Chakur. Four Wolves (*Canis lupus*) were sighted in Nanphran nalla

Table 2: Hangul population based on three-day sample counts (March 2004) in Central Division (Dachigam and its surrounds)

Locality	4th March	5th March	6th March	Mean	SE
1. West Boundary-Draphama (South)	24	33	27	28	2.64
2. Draphama-Pahlipora (South)	12	41	29	34	3.72
3. Namblan (South)	5	14	2	17	6.02
4. West Boundary Draphama (North)	84	87	79	83	2.34
5. Draphama to Pahlipora (North)	31	31	35	32	1.34
6. Pahlipora to Washkhar (North)	0	0	0	0	0
7. Nishat to Cheshmashahi	7	14	13	11	2.19
8. Khonmoh	0	0	0	0	0
9. Khrew	12	0	0	4	4.01
10. Dara	4	0	8	4	2.31
Total	179	220	193	213	24.57

Table 3: Population estimate of Hangul based on Bounded-count and sight-resight estimator (Chapman modified) in Central Division (March 4-6)

Survey Dates	Group Estimates	CI-L	CI-U	SE	CV (%)
pair(4,5)	25	25	29	1	4
pair(4,6)	29	28	33	1	3
pair(5,6)	33	32	41	2	6
	Individual Estimate				
pair(4,5)	184	138	230	23	13
pair(4,6)	214	163	265	26	12
pair(5,6)	243	173	314	36	15
Bounded-count	247	243	261		

Abbreviations: 90% CI-L - Confidence Interval Lower, CI-U - Confidence Interval Upper and CV - Coefficient of Variation

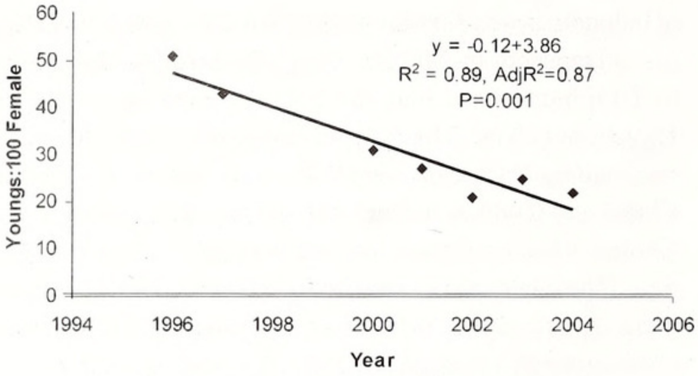

Fig. 2: The decline in Hangul young: hind ratio between 1996 to 2004

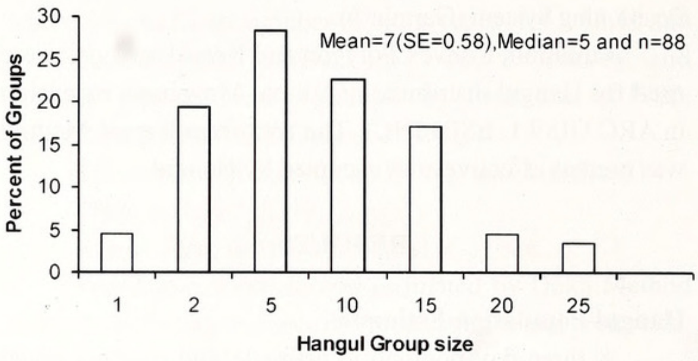

Fig. 3: Hangul Group size distribution in Dachigam (Central Division) present study

(Lidder-Aru) and a Snow Leopard (*Uncia uncia*) track was recorded in Sattragi (Lidder-Overa) on March 05, 2004.

The Hangul population estimate based on extrapolation of density on an area occupied in the Central and South divisions was 260 individuals.

Hangul sex ratio and young: hind ratio

Hangul sex ratio was estimated to be 18 stags/100 hinds (SE=1.73) (Table 5). On March 13, observers equipped with binoculars estimated sex ratio as 20 stags/100 hinds. The four days mean was 19 stags/100 hinds (SE=1.33, Table 5). The fawn ratio was 21 fawns/100 hinds. Declining trends have been observed in the Hangul fawn:hind ratio since 1996 (b=-0.12, P=0.001, Fig. 2).

GROUP COMPOSITION

In this exercise a total of 88 Hangul groups were sighted ranging from 1 to 25. The solitary hangul sightings were 4.5% and maximum sightings (28.4%) were in groups of 3-5 individuals (Fig. 3). Mean hangul group size was 7 (SE=0.58) and the median was 5.

Table 4: Hangul sighted in South Division from March, 4-6, 2004

Block	Locality and Transect Number	(4^{th})	(5^{th})	(6^{th})
Khangund	Dangnar to Serwan (Satura B)	0	1	2
	Kandernar, Aripal & Saturbal (Satura A)	0	2	0
	Aripal nallah – Brain nar	1	0	0
Shikargah	Pinglish, Haput nadji, Nagware nar	15	0	5
	Brain nar- Haputnar	6	5	0
	Tsersangnar to Goggidar	6	0	0
	Gungwan area	0	2	0
Overa-Aru	Gumri upto Rewas	2	0	0
Total		30	10	7

Present Hangul Distribution

At present, Hangul is largely restricted to approximately 504 sq. km of Kashmir valley in South and Central divisions; there is no report of its existence outside Jammu & Kashmir (Fig. 1). The effective area occupied by hangul in winter was 148 sq. km (Fig. 1), of which 84 sq. km was in Dachigam, 52 sq. km in areas surrounding Dachigam in Central Division and remaining 13 sq. km in South Division. The survey and interviews suggest that a few hanguls do continue to remain outside Dachigam all year round in areas of Gurez, Ajas, Bunakot, Bandipora, Kangan, Surpharo Baltal, Harmukh and Wangath. Reconnaissance surveys and interviews conducted in Upper Dachigam (Leech top to Gunus nar) and Sindh Forests suggest the presence of Hangul (Mr. Gh. Mohidin pers. comm.). In the North Division, Changdaji has a good habitat with reports of Hangul presence. These reports need to be further confirmed through systematic intensive surveys.

DISCUSSION

Hangul was once distributed widely in the mountains and valleys of Kashmir (Schaller 1969). The only Hangul report outside Jammu & Kashmir was from Gamagul Siya-Behi Sanctuary in Himachal Pradesh (Kurt 1978). Holloway (1970) mentions its distribution to be confined to an area of *c*. 65 km in width to the North and East of Jhelum and lower Chenab rivers, from Shalurah in North to Ramnagar in South. Unconfirmed reports of isolated small populations do occur within the aforesaid range, particularly in the North (Kurt 1978). 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). At present, Hangul is largely restricted to *c*. 504 sq. km of Kashmir valley in South and Central

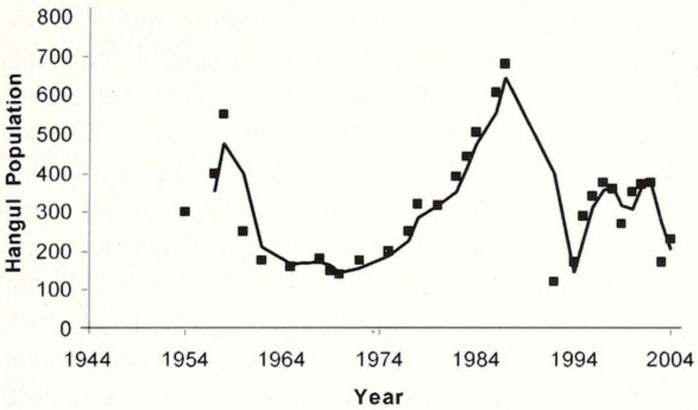

Fig. 4: Population trend in Dachigam and adjoining areas from 1954 to 2004

divisions; there is no report of its existence outside Jammu & Kashmir (Fig. 1). The range size has been reduced in comparison to Kurt's (1978) distribution map.

Hangul adult sex ratio was reported to be 151 stags/100 hinds during rut (Schaller 1969) and in non-rutting period it ranged from 15 to 25 stags/100 hinds (Holloway 1970,1971; Department of Wildlife Protection 1996, 1997, 2000, 2001, 2002, 2003) (Table 6). The Hangul sex ratio differs in different seasons due to differential habitat use by both sexes. Clutton-Brock *et al.* (1982) reported sexual segregation in Red Deer during winter. The adult sex ratio in Red Deer reportedly ranges from 50 to 70 stags per 100 hinds (Whitehead 1972; Clutton-Brock *et al.* 1982; Bonenfant *et al.* 2004). The sex ratio estimates of February-March 2004, which include all age classes, are low, but seem to be stable over the years (Table 5). The sex ratio data may be biased, but is consistent and thus difficult to provide the reasons of low ratio in comparison to Red Deer elsewhere in the world.

The young to hind ratio were estimated considering all hind age classes due to difficulty in identifying reproductive age class of hind. The young:hind ratio in Hangul was reported to range between 21 to 51 young/100 hinds during February and March (Department of Wildlife Protection 1996, 1997, 2000, 2001, 2002, 2003 and this study (2004). Schaller (1969) reported 45 juveniles/100 hinds. The counts from 2000 to 2004 indicate a decreasing trend (Department of Wildlife Protection 1996, 1997, 2000, 2001, 2002 and 2003) (Table 6, Fig. 4). The studies on Red Deer indicate fawn:hind ratio to range from 16 to 54 per 100 adult hinds, more than 30 is considered to be a good ratio (Clutton-Brock *et al.* 1982; Houston 1982; Boyce 1989). The observed trends (21 Juveniles/100 hinds) in fawn:hind ratio in Dachigam are alarming, and need careful monitoring and management. Establishing reasons for declining fawn:hind ratio is crucial.

Gee (1965) guestimated the population to be 400 in 1954, which raised alarm for the plight of Hangul. Holloway (1971) conducted a systematic count in 1969 and 1970. The population estimate of Hangul had shown an increasing trend since the 1970s and by 1987 there were 700 Hangul. After a gap of six years (1994), the population estimate was 120 (Fig. 4), the reason of this decline is not well understood, may be earlier estimates were wrong, or poaching and anthropogenic disturbances may have taken the toll. The population steadily grew to 375 individuals by 2002, which again declined to 212 in 2003 (Department of Wildlife Protection records). The total estimate in 2004 was 244 Hangul, 214 in Central and 30 individuals in South division. The extrapolation of density estimate on area occupied in South and Central divisions gave an estimate of 260 Hangul (Fig. 1). The population trend indicate decline of 5 percent /annum. There is an urgent need to establish captive breeding facility for long term conservation similar to the process done in Kanha for the Barasingha (Panwar 1978).

Table 5: Hangul Sex Ratio & Hind Young Ratio (March 4-6, March 13, 2004) in Dachigam and adjoining areas

Date	Stags : 100 Hinds	Young : 100 Hinds
4^{th} Mar. 2004	21	18
5^{th} Mar. 2004	18	28
6^{th} Mar. 2004	15	24
13^{th} Mar. 2004	20	15
Mean	19	21
Standard Error	1.32	2.93

Table 6: Sex Ratio and Young : Hind ratio of Hangul in Dachigam and adjoining areas

Year	Month	Stag: 100 Hinds	Young: 100 Hinds	Reference
1969	October	151	45	Schaller 1969
1970	February	25	-	Holloway 1971
1987	March	25	17	Inayatullah 1987
1996	February	15	51	Deptt. of Wildlife Protection,1996
1997	February	16	43	Deptt. of Wildlife Protection, 1997
2000	March	18	31	Deptt. of Wildlife Protection,2000
2001	March	21	27	Deptt. of Wildlife Protection,2001
2002	March	22	21	Deptt. of Wildlife Protection,2002
2003	February	18	25	Deptt. of Wildlife Protection,2003
2004 *1	**3^{rd}-6^{th} March**	**19**	**21**	**Present study**

*1: Mean based on estimates done on 4th, 5th and 6th March 2004

Hangul population had been affected by diseases like Johne's disease (Kurt 1978), Foot and Mouth (Stockley 1936), Rinderpest, Anthrax, Tuberculosis, Malignant Catarhal fever and Brucellosis in Dachigam (Mir Mansoor pers. comm.). Foot and Mouth disease had taken toll of livestock and Hangul in the past (Stockley 1936).

Iqbal *et al.* (2005) reported 25 per cent Hangul occurrence in Leopard scats, which has contributed 61 per cent of prey biomass consumed by Leopard. This indicates substantial Leopard dependence on Hangul. There is a possibility of predation by other carnivores too, like pariah dogs, shepherd's dogs, jackals, black bear and other carnivores. Ward (1921) and Stockley (1936) have reported leopards taking significant number of Hangul stag and hinds. Stockley (1936) has described black bears 'as destroyer of new born calves/fawns' though Kurt (1978) has not seen predation of Hangul fawns by black bear. There are many missing ecological linkages in the understanding of the Hangul population, which need to be addressed.

Dachigam and other parts of Hangul distribution range were historically exposed to heavy anthropogenic pressure. Ward (1925), Stockley (1936), Gee (1965), Schaller (1969), Holloway (1971), Kurt (1978) and Inayat Ullah (1985) described in detail, the detrimental effects of grazing in upper Dachigam, poaching, affect of sheep breeding farm, disease, dogs of shepherds, excessive traffic in the Park and natural resource extraction by locals. After almost 88 years since these detrimental factors were first documented, most of them continue even today to affect Hangul survival and there is an urgent need to address these problems.

The population and distribution range of Hangul is getting impacted by change in habitat quality, low recruitment, predation pressure and anthropogenic pressure. It's important to monitor and evaluate factors responsible for decline in Hangul population. The adjoining areas of Dachigam National Park, Dara Conservation Reserve, Nishat Brain Conservation Reserve, Khrew and Khonmoh are facing heavy biotic interference due to developmental activities. It is recommended to have operational *chowkis* during summer, particularly in areas where Hangul and livestock overlap in habitat use. Protection, landscape level population management, and conservation breeding programme is imperative for long term hangul conservation in Kashmir.

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