

Population Estimation and Monitoring Protocol for Hangul in Central & South Division of Kashmir



Qamar Qureshi & Nita Shah

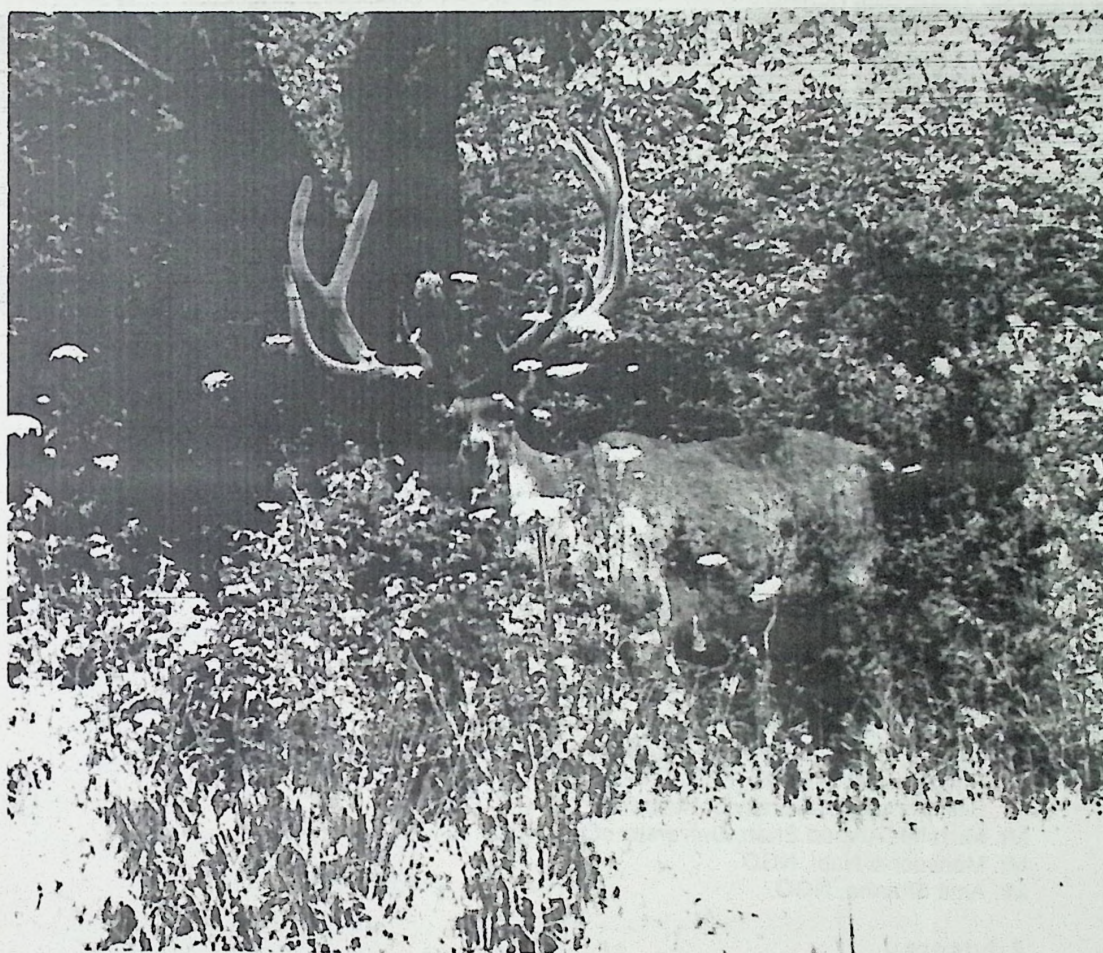


भारतीय वन्यजीव संस्थान
Wildlife Institute of India



Department of Wildlife Protection
Jammu & Kashmir Government

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Mr. Nasier Ahmad Kitchloo, Regional Wildlife Warden, Headquarter
Mr. Shafiq Hussain, Wildlife Warden, Central.
Mr. Rashid Yahya Naqash Wildlife Warden, South.
Mr. M. A. Parsa, Wildlife Warden, North.
Mr. Rouf Ahmad Zargar, Wildlife Warden, Technical.
Mr. Imtiyaz Ahmad Lone, Wildlife Warden (Co-ordinator)
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Preface

*The Jammu & Kashmir owes a great deal to its excellent environment of rich and diverse fauna and flora. Dachigam National Park in the vale of Kashmir is known for its fragile Himalayan eco-system, and it inhabits endangered Red Deer species known as Hangul (*Cervus elaphus hanglu*) in association of other animal/bird species. Prominent among these are Leopard, Himalayan Black Bear, Musk Deer, Martins, Golden Eagle and Monal Pheasant. Hangul assumes a great significance in the National Park.*

Census of Wildlife is an investigation that requires knowledge of, how many animals are present either now or in the future. It is important to examine the methods and use the robust, the ones in consultation with the concerned specialists.

The Department of Wildlife Protection has been conducting regular census of Hangul in Dachigam National Park by adopting traditional method of total count in blocks.

The estimation of numbers of wild animals has now achieved a level of sophistication and the methods have gone from simple counts to complex relation, involving numerous assumptions. The aim of this exercise was not to follow the counting of population, but to explore the trend of population in order to monitor the same in future.

In this census estimates of total population have been included within the limits of assumptions that have given an estimated population in a specified area of Dachigam National Park and its surrounding areas. A total of approximate 800km² was systematically covered while conducting the census; applying an appropriate statistical analysis. Besides Dachigam National Park, 3 Wildlife Sanctuaries (Thajwas/Overa-Aru and Daksum) and 8 Conservation Reserves (Khrew, Khunmoh, Dara, Hajan, Khangund, Shikargah, Panner and Khiram) were covered. The results indicate the distribution of Hangul in Khangund, Shikargah, Overa, Panner and Khiram. The presence of Hangul needs to be confirmed in Daksum Wildlife Sanctuary.

While adopting this method a clear distinction has been made between accuracy, precision and fineness. It also includes details as sex, age of given species (Hangul) for a given area. Estimates have been obtained by adopting procedure keeping in view the terrain and analysis done statistically.

The cost of estimating an animal population with high accuracy goes high due to extra time and manpower needed to obtain large samples and to double – check field records, data computing, analysis and instruments., since actual counts of wild animals are rarely possible or desirable because of the cost required.

The attempt to achieve main objectives were to present the conceptual basis for census methods, describe the method in sufficient detail so that with a little effort the field staff could follow them in future

Besides an exercise to reach a definite conclusion by adopting actual test for significance, efforts are made to establish index related to Hangul, Leopard, Bear, Musk Deer in the form of droppings, scats and tracks etc.

In the regular census carried out in previous years. The methodology adopted was obsolete. In order to over come these problems, the Director Wildlife Institute of India (Dehradun) was approached to send specialists for carrying out census of Hangul. In response Dr. Qamar Qureshi was deputed and Dr Nita Shah, Wildlife Biologist was invited to carry out the census of Hangul in Dachigam. These specialists along with the officers and field staff have put tremendous efforts to complete this exercise, which is highly appreciated and a model for carrying out census in future has been established.

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INTRODUCTION

The Hangul (*Cervus elaphus hangul, wagner*) is critically endangered species. It assumes a great significance as the only Asiatic survivor of red deer. Hangul however, has had a limited global distribution and were once distributed widely in the mountains of Kashmir, with small population outside Jammu & Kashmir in Chamba District of Himāchal Pradesh. The historical distribution of Hangul was restricted to an arc of 40 miles in width; north and east of Jehlum and lower Chenab River, from Shalurah in the north to Ramnagar in the south (Lydekker 1924, Holloway 1970). During the recent past the Hangul appears to have drastically declined from its past distribution range, possibly due to large scale biotic interference owing to habitat fragmentation and degradation. At present the viable population of Hangul occurs only in Dachigam National Park and a few isolated populations in the adjoining areas. The hangul population had shown decreasing trend from 1940's till date 2003 in Dachigam and adjoining areas (Fig 1, Appendix G).

The management is often judged in terms of population size, in the process it is over sold and has always become a contentious issue. The population size is thus like a currency by which the success of many management programmes ultimately are judged. This trend is prevalent in majority of Protected Areas in our country. The population estimate at one point in space or time is of limited value, and it provides much less information about status than is commonly thought of (Lancia *et al* 2002). What is important is to have multiple count in same area at different times or different habitats of an area and repeat these counts in different years to get a trend of population, sex ratio and female fawn ratio. It is the trend of population which would enable the management to comprehend the pulse of a population and thereby making right decision at appropriate time. What is important for management is to use sound method which provides reliable trend to compare over time. It is of utmost importance to use a method which will have potential to detect change in population and that to having sensitivity towards decrease in population.

The population estimation of Hangul was taken up with an objective to improve population estimation method, develop a monitoring protocol and train staff in monitoring of population

using simple field technique, which will have the potential to recognize changes in the population over the years. The population estimation part is simpler aspect of monitoring process; often it is more difficult to assess the significance of the change that has been encountered.

Most monitoring programmes face two important sources of variation; i.e. space and detectability that must be incorporated into the survey design (Lancia *et al* 1994, Pollock *et al* 2002, Mackenzie *et al* 2002). The source of variation that is caused by size and configuration of landscape can be taken care of by sampling in a manner that permits inference to the entire area of interest. The latter source of variation (detectability) is of prime importance for monitoring, the method should address this by having robust estimator for detection probabilities. Changes in the count may be a product of random variation or changes in detectability, so it is impossible to make useful inferences about the system.

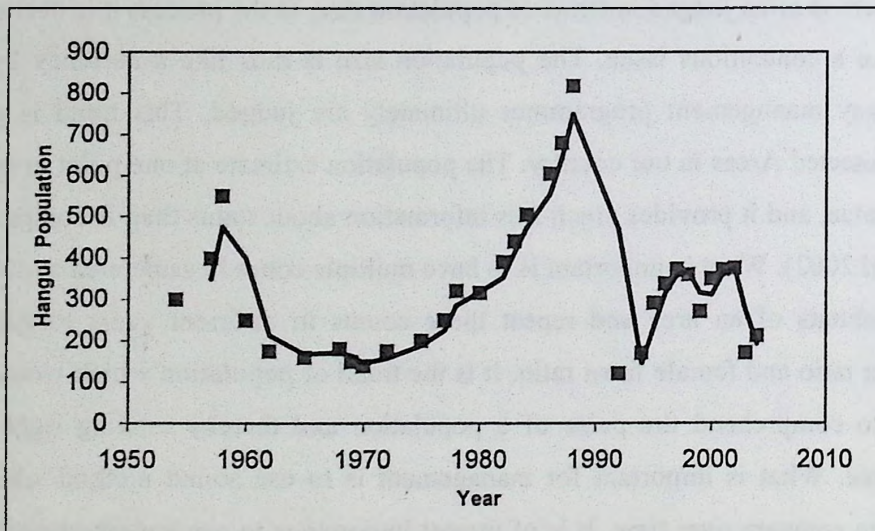


Fig 1: Population trend in Dachigam and adjoining areas from 1954 to 2003 (see Appendix G for reference)

STUDY AREA

The landscape area covered for the hangul population estimation was mainly in the Central and South Division of Kashmir, encompassing an area of approximately 808.3sqkm. these divisions include eight conservation reserves (Khrew, Khanmoh, Dara, Hajin, Khangund, Shikargah and Khiram), three wildlife sanctuaries (Daksum, Overa-Aru and Thajwas) and Dachigam National Park (Table 1a).

Table- 1a Population estimation exercise was conducted in following Areas

Area	Sq.km
Lower Dachigam	100.36
Brain/Nishat	15.75
City Forest (Cheshmashahi)	9.00
Khrew Conservation Reserve	50.25
Khunmoh Conservation Reserve	67.00
Dara Conservation Reserve	34.00
Hajin Conservation Reserve	22.08
Khangund Conservation Reserve	15.00
Shikargah Conservation Reserve	15.5
Panyer Conservation Reserve	10.00
Khiram Conservation Reserve	15.75
Overa Wildlife Sanctuary	43.15
Pahalgam Wildlife Sanctaury	55.5
Aru Wildlife Sanctuary	334.98
Daksum Wildlife Sanctuary	20.00
Total Areas	808.32

Table 1b: Broad Vegetation types of Central and South Division, Kashmir.

Forest or Shrub Climax	Forest	Scrub	Successions Savanna	Herb comm. /pasture.
Dwarf evergreen shrub (3500 – 3700m)				alpine herbs (2500 – 3700m) <i>Stachys sericea</i> <i>Sieversia elata</i> <i>Veronica melissaefolia</i>
<i>Juniperus recurva</i> <i>Rhododendron anthopogon</i> Tall evergreen shrub (3200 – 3400) <i>Rhododendron campanulatum</i> <i>Syringa emodi</i> Birch Forest <i>Betula utilis</i> <i>Rhododendron campanulatum</i>		dwarf Evergreen Tall Evergreen		Alpine pasture (2500 – 3000m) <i>Fritillaria spp</i> <i>Polygonum</i>
Silver fir forest (2300 – 3200) <i>Abies pindrow</i> with <i>Betula utilis</i> (3100m) <i>Picea smithiana</i> (2700m) <i>Rhus succedanea</i> and <i>Ulmus wallichiana</i> (2400)	Blue pine			Broadleaved belts (2300- 2900m)
		<i>Parrotiopsis</i> (1700-2400) <i>P.jacquemontiana</i> <i>Rosa webbiana</i> <i>Indigofera heterantha.</i> <i>Isodon plectranthoides</i>		
Blue pine forest (1700-3000)	<i>C. colurna.</i> <i>P. cornuta</i>	Deciduous thorn (1700 – 2400)		
<i>Pinus griffithii</i> with <i>Rosa brunonii</i> and		<i>Rosa webbiana</i> Deciduous thorn (contd.) (1700-2400)		grasslands (1800 – 200m) <i>Cynodon dactylon</i> <i>Bothriochloa pertusa</i>
Blue pine forest (1700-3000) <i>P. jacquemontiana.</i> (1700m) <i>Viburnum cotiniifolium</i> and <i>Staphylea emodi</i> (2300)		<i>Berberis lycium</i> <i>Indigofera heterantha</i> Deciduous thorn (1700-1900m)		
<i>Morus alba</i> community		<i>Rosa brunonii</i> <i>Rosa webbiana</i>	Scrub savanna (1700-1900m)	
<i>Morus alba</i> <i>Rhus succedanea</i>		<i>Robinia</i> (1800m)	<i>Chrysopogon</i> <i>echinulatus</i> <i>Themeda</i> <i>anathera</i> <i>Artemisia spp</i>	
Stream side forest (1600-1800) <i>Ulmus villosa</i> <i>Populus ciliata</i> <i>Salix spp</i>		<i>Robinia pseudoacacia</i> <i>Celtis caucasica</i>		

Kurt, 1978

The hangul range in Kashmir lies between Zaskar mountain range and Pir-panjal of North-West Himalayan Bio-geographic zone (2A) (Rodgers and Panwar 1988).

Dachigam National Park holds the major hangul population. The Dachigam is divided into two units, the Lower Dachigam and Upper Dachigam. The lower Dachigam altitude ranges from 1700 m to 3000 m. Vegetation types with broad leaf mesophyll forest of maple (*Acer* sp.), mulberry (*Morus alba*), *Ulmus* spp. *Rhus* sp. and walnut (*Juglans regia*), *Hatab* (*Parrotiopsis jacquemontiana*) and a variety of conifers such as deodar (*Cedrus deodara*), blue pine (*Pinus wallichiana*), spruce (*Picea smithiana*), and Fir (*Abies pindrow*) grow in an altitudinal sequence. Upper Dachigam altitude ranges from 3000 m to 4700m. It comprises vegetation gradient of sub alpine community of forest followed by scrub vegetation of birch (*Betula utilis*) and rhododendron (*Rhododendron* spp.) interspersed with meadows of herb rich grasslands over 3300 m. This zone gradually merges into the zone of permanent snow, which is above 3500 m (Rodgers and Panwar, 1988). The vegetation of Dachigam National Park is typical of Himalayan moist temperate forest; sub-alpine forest and alpine forest type (Champion and Seth, 1968). The other areas in Central division have similar vegetation as that of Dachigam, except in highly disturbed areas.

In South Division major vegetation associations are almost similar to that of the Dachigam P.A. Overa-Aru Wildlife Sanctuary shows varied vegetation types. The riverine vegetation below 2300m elevation is dominated by broad-leaved forest comprising mainly of *Aesculus indica*, *Juglans regia*, *Morus alba*, *Rhus succedanea*, *Celtis caucasica*, *Ulmus villosa*. The major shrub comprise of *Viburnum cotinifolium*, *Berberis lycium*, *Parrotiopsis jacquemontiana*.

The sub-alpine community between 2300-3000 m elevation is interspersed with silver fir and Blue pine forests. The major composition in this forests include *Pinus wallichiana*, *Rosa brunonii*, *Abies pindrow*, *Picea smithiana* and *Ulmus wallichiana* these are in association with some dominant shrubs namely, *Indigofera heterantha*, *Taxus wallichiana*. The alpine meadows between 3000 to 3500m are dominated by *Betula utilis* interspersed with *Rhododendron* and *Juniperus* species.

METHOD

The wintering range of Hangul is restricted mainly in lower Dachigam with Gratnar, Waskhar and west of Dagwan being its eastern limits. This area was selected to design the present population estimation exercise. Dachigam National Park and its contiguous areas were part this exercise. The population estimation exercise was carried out from 4th to 6th March 2004 with the help of 296 observers in Central and South Division covering eight conservation reserves, three wildlife sanctuaries and national park (Table 1a, Appendix A1 and A2).

Past method used for hangul census: Holloway (1971) conducted a systematic 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. Gee (1965) had guesstimated 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.

The Wildlife Department census reports indicated that Holloway's method was adopted largely for hangul counts. The census method of Wildlife Protection Department was more or less consistent and enumeration was done largely in mornings excepting in few cases when it was conducted both in morning and evening (Department of Wildlife Protection 2003, 2002, 2001, 2000, 1997, 1996).

The present exercise (4th to 6th March 2004) for population estimation was structured and modified. In Central Division a total of 49 transects were walked, where 175 staff members were involved in data collection. Within lower Dachigam 23 nallahs and ridges were marked (Sample Areas 1 to 6, Appendix A1 and Map) and in areas adjoining with Dachigam 26 nallahs and ridges were marked (Sample Areas 7 to 10, Appendix A1 and Map). In South Division total of 40 areas were identified and marked where 121 staff member were involved in data collection (Appendix A2 and Map). All areas mentioned in Appendix A1 and A2 were covered on 4th March and were all repeated again for counts on 5th and 6th March respectively. The nallahs and ridges were sampled each day intensely. The nallahs were mainly preferred so that the sampling areas would be marked for posterity. The starting points of each transects were marked on ground with the help of ribbons which would subsequently be permanently marked on trees, with

numbered metallic plates and Geographic Coordinates (with the help of GPS) would be noted for all the starting points of every transect, (Appendix-A1 , A2 and Map).

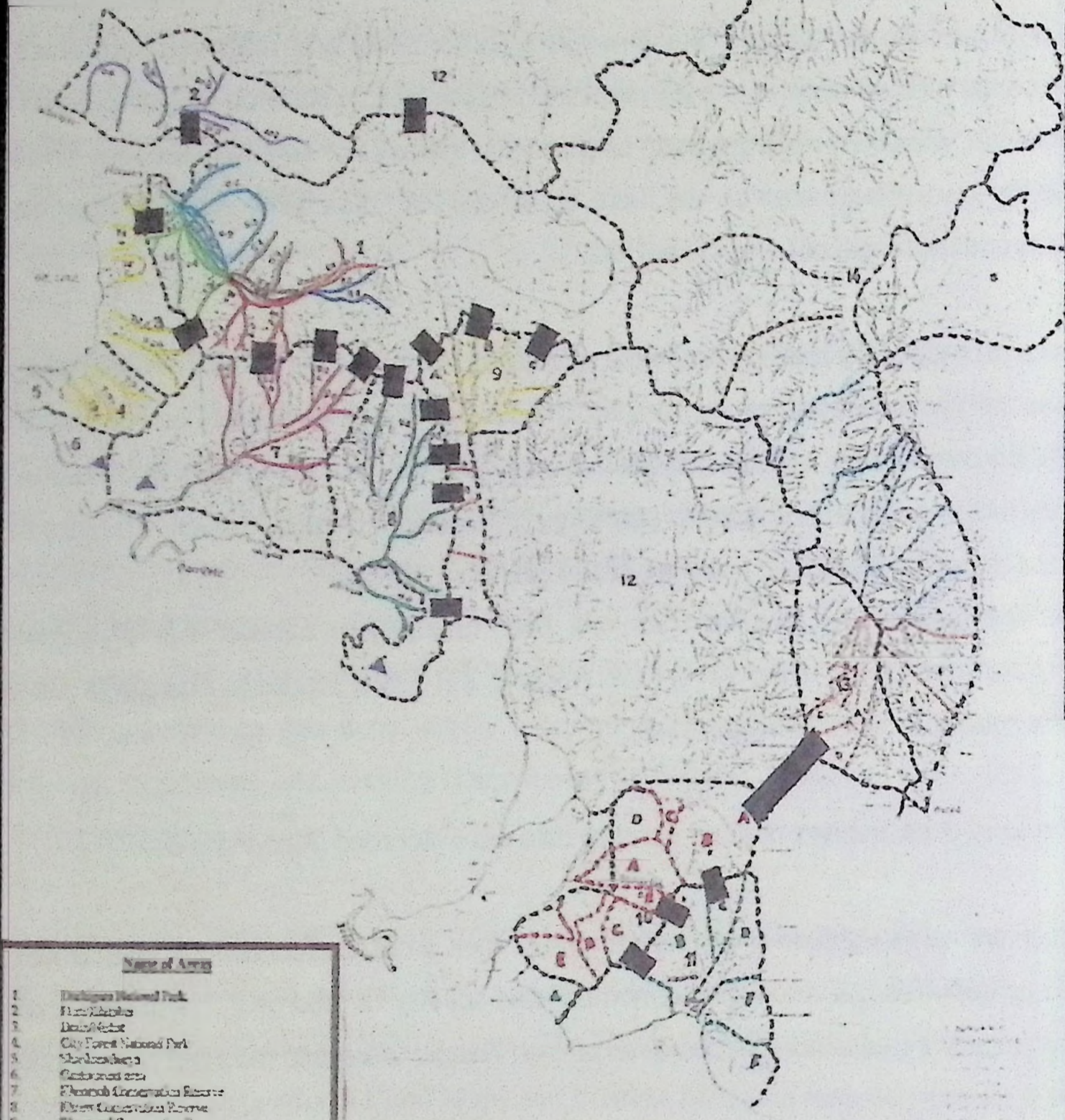
It is difficult to have gadgets like binoculars, pedometers and magnetic compasses for all, therefore the method adopted should address this problem. In absence of such gadgets the best possible way was to estimate detection of animal on the basis of angular distances. The detection probability also is estimated on the basis of number of hours spent searching for animals on transects and the length of transects walked.

Our idea is to make the method as simple so that the Wildlife Guards can follow it easily and an exercise which would be less expensive to operate. The enumeration of Hangul and other wildlife on permanently marked transects will be easy for monitoring change detection. This is best possible if the data is collected repeatedly on permanent transects (Map). The data should be collected as per the prescribed data formats (Appendix □B).

(Note: The transect 3.1 (Kaunar) has now been changed to transect 2.2 for administrative convenienc, transect 2.2 (Chandernar) and transect 2.3(Power House to Phalipora) has changed to a new code of 2.3 and 2.4 respectively.

1. The party code, transect number, locality data were recorded (Appendix B).
2. When animal is sighted for e.g. hangul group, then group composition (male, female, young and unidentified individuals) total number and activity is recorded. The distance of animal from observer is also noted. Species other than Hangul were also recorded (Appendix B).
3. The indirect signs of animals like pellets of herbivores, hoof marks, carnivore scats and scrapes, bear droppings were also recorded. Observer has to record number of indirect signs and not presence or absence.

MAP SHOWING DACHIGAM NATIONAL PARK WILDLIFE SANCTUARIES AND FOREST AREAS



- Name of Areas**
1. Dachigam National Park
 2. Harpora Wildlife Sanctuary
 3. Doodh Ganga Wildlife Sanctuary
 4. City Forest National Park
 5. Shalimar Wildlife Sanctuary
 6. Ganderbal Wildlife Sanctuary
 7. Ferozshah Conservation Reserve
 8. Ferozshah Conservation Reserve
 9. Khajimar Conservation Reserve
 10. Khajimar Conservation Reserve
 11. Khajimar Conservation Reserve
 12. Forest areas
 13. Outer Conservation Reserve
 14. Area Conservation Reserve
 15. Forest boundaries
 16. State Quarters
 17. Circles
- Dept. of W.P. C.P. 11/11/61

For transit legend see reverse of this page
 (Legend A Central Division)
 (Legend B South Division)

<p>DACHIGAM NATIONAL PARK Dachigam Southern Segment Sector - I Western Boundary upto Drapthama Area</p> <p>1.1 Harvada (Sharbat to Hader Nar) 1.2 Dada Nala 1.3 Zaba (Gandakali - Kharai - Zaha) Nivaria Tract 1.4 Foothills (Interor Gandakali Nala) 1.5 Dardak - Power House via Akharka (Along road line name) Sector - II V.P. Guest House (Drupthama) to Phalpara</p> <p>2.1 Kwa Nar 2.2 Kutra 2.3 Ghadar Nar 2.4 Power House to Phalpara (Between road and nala) Sector - III Nivaria nar 3.1 Phalpara to Vaidhapat (Towards Ghat Nar 1 section) 3.2 Phalpara to Ghat Nar (Towards) Dachigam Northern Segment Sector - I Western Boundary upto Oruppara</p> <p>4.1 Sheep Breeding Farm to Mar Nar (Towards western boundary) 4.2 Mahadun Nar (Shree Jeebhing Bari in Akhara) 4.3 Madha Dun to Asha Nar (Hanna & Panwar) 4.4 Nivaria Nivaria 4.5 Nivaria (Towards Ghat Nar to V.P. ridge) 4.6 Ghadar Sector - II (Drupthama to Phalpara (Northern))</p> <p>5.1 Dhad Nar 5.2 Maru 5.3 Base of Dhad nar upto beginning of Chab 5.4 V.P. Lodge (Drupthama) Sector - III Phalpara to Westar 6.1 Phalpara to Westar to Chab 6.2 Phalpara to Westar Total People Required (outside Dachigam)</p>	<p>NATIONAL PARK (Leesh top to Curves part) OUTSIDE DACHIGAM P.A.</p> <p>Area Nihal (Harwan) - Batin - Chashmashahi</p> <p>7.1 Nihal upto Batin (Harwan) a) Nihal nala - Harwan b) Nihal (Dargra Keera) - Harwan 7.2 Batin (Aabun Para top) a) Kral Sangri - Lal Sharbat b) Dargra - Tala Nizam return to Lal Sharbat c) Lal Sharbat - Aabun Para to Mander Top d) Aabun Para (via Ghat) - Kharag (Aabun Para Top) 7.3 Chashmashahi (Babbar to Zafiyar) a) Urban line - Ghat Dargra Nala & Labru - Bonnar - Chashmashahi b) Chashmashahi (M.D. Supply - Parashahi (Dargra Para Range) c) Dargra - Parashahi d) Obero Nala to Batin nala e) Nihal to Zafiyar</p> <p>KHIMABON CONSERVATION RESERVE</p> <p>8.1 Staff Staff Quarter to Ringpath top 8.2 Ringpath Area a) Staff Quarter to Tala Nar b) Staff Quarter to Aabun Para c) Khimabon quarter to Luchhara (Rangri) 8.3 Chab - Nivaria to Dhad nar 8.4 Rani Khimabon (Kharwar)</p> <p>KHARU CONSERVATION RESERVE</p> <p>9.1 Dhad Nar 9.2 Nivaria 9.3 Pan Nal 9.4 Dhad Nar 9.5 Khimabon 9.6 Wabhar</p> <p>DADA CONSERVATION RESERVE</p> <p>10.1 Dardak Nala to Bhat 10.2 Chab Para upto Tala nala 10.3 Dada to Nihal 10.4 Nihal to Tala Sangri 10.5 Dada to Nihal</p> <p>SPCCY FOR WATER GROUPS (HANGUA NETWORKS FROM LOCALS) Akh Forest Nagan Akh 2 Sulphur Forest Sinch Forest (Thajast) Bard, Wangra, Bandpar, Aps, Kangra, Buralol, Harmanth Guler - Tala Guler and Ganga Guler</p>
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Legend B (South Division)

<p>I HAJIN CONSERVATION RESERVE Area A) Sarulav Harwan to Aabun nar Staff Quarter to Khakapathi B) Hagan Nala Staff Quarter, Daydun, Gogyar Charyawa (Staff Qtr.) to Dangpothi C) Zashan Nala Vaidhapat to Dhad Dargra to Kharwa Panner to Kharwa D) Leech Top to Gunas nar Gunas Nar to Wadalar Top</p> <p>II KHANGUND CONSERVATION RESERVE A) Satara (b) (Dargra & Saran) B) Satara (a) (Kandoran, Anpal & Satherbat) C) Anpal Nala - Ramnar</p> <p>III SHIKARJAN CONSERVATION RESERVE A) Pingsh (Nagan Nar + Napat Nodri) Zafiyar nar to Pagan nar Napat nala to Pagan nar Lal nar to Lal nar B) Shikarjan (Urban Nar & Napat Nar) Tongar to Chashmashahi Quilang to Chashmashahi Chashmashahi to Quilang, Wabhar Mud C) Tarsan (Gogh dar) Quilang to Tangpatri, Kral top Bren nar top to Fala delav Pannar to Tangpatri D) Gargan Janoshahi to Ghat Nagan to Gargan Top Quilang to Gargan top to Jandashahi Nar E) Waganpatri (Kanta, Dachgol, Waganpatri) F) Nagan, Waganpatri to Pannar Wabhar to Buzugulu upto Sanchharat Sang to Kral top, Kral top to Zerdan</p>	<p>IV PANJER CONSERVATION RESERVE A) Dhadnar (Bachnar nala, Dhadnar nala & Dugra Nar Nala) B) Panner (Nagan) C) Sanghar (Nagan, Kharwar) D) Haba (Tangar, Pagan)</p> <p>V KHIRAM CONSERVATION RESERVE A) Dhad Beel B) Sanghar (Pahar, Dhad nar) C) Wagan (Dhad, Kharwar) D) Panner (Panner nala, Dhadnar, Kharwar) E) Aashar Beel (Kharwar, Kharwar) F) Hagan (Nagan, Kharwar)</p> <p>VI OVERA WILDLIFE SANCTUARY A) Ghat (Gunas nala upto Rewar) B) Kharwar (Kharwar upto Madan) C) Hake: Hqi D) Sakra corridor (Push path, Qulav upto connecting Panner - Tra) E) Venatan (Rashar, Kanda nala - Rewar) F) Langarbat (Quilang, Lounan, Kharwar)</p> <p>VII PAHALGAM WILDLIFE SANCTUARY (BLOCK) A) Sarbat (Zafiyar, Shinar) B) Hader Nar (Dargra) Madan Beel C) Gargan Nar (Kharwar) D) Nagan nala (Snow Covered) E) Gandakali F) Shashharat (Compartments 41-43)</p> <p>VIII ARU WILDLIFE SANCTUARY A) Chashmashahi (from Chashmashahi) B) Nagan nala (Right side)</p> <p>IX DAKSAR (RAJPARIAN) WILDLIFE SANCTUARY A) Khakapathi (from Ghat nar) B) Khakapathi to Buzabari C) Ghat to Buzabari (Right side) D) Dargra to Buzabari (Covering Madan nala)</p>
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IMPORTANT CONSIDERATIONS FOR POPULATION ESTIMATION FOR HANGUL

The staff walked transects or gradsects along nallah (*nar*) and ridges in party of two to three individuals. Each party walked transects and noted the actual time taken to walk a transect after deleting the time taken for rest. The time taken to walk the transect is converted to kilometers walked on the basis of the time the every team member will take to walk one kilometer in hilly terrain.

1. The best period for Hangul population estimation should be carried out between 7th February and 7th March. This is the best time as the rut is over, the weather becomes more consistent and hangul are largely confined to lower elevation.
2. Animal count transect should start simultaneously all across the landscape at 0630 hrs. - 0700Hrs. (with sunrise) and end by mid-day (1200Hrs). The areas would be repeated again on day two and day three respectively. This would provide the repetitive counts. Each day count will be conducted in all areas simultaneously; the team will have to maintain the schedule for all days. Population estimation should be conducted in minimum of three to four days.
3. Co-ordinators should compute and evaluate each day's data, if fluctuations are more than 20% then one has to repeat the count once more. There should be minimum of three counts with less than 20% variations.
- 4) The team of guards involved in population enumeration should be trained to estimate for time taken to travel a kilometer in the field, estimation of angular distance, identification of indirect signs specifically of Hangul pellets, Bear droppings, Leopard scats, Jackal scats and Fox scats.

The aforementioned estimations are to be conducted in the following manner:

a) **Estimation of distance walked:** In absence of pedometer the distance walked can be approximated by the time taken to travel. Every observer would differ in time taken to walk a particular distance, therefore the observer involved in the exercise should standardize his or her walking distance estimation (in the following way) prior to the commencement of the operation under the supervision of their respective in-charge officers.

Identify a track in the training area resembling the general topography of the operation sites that would be walked by the observer. In identified area mark 200 -300 meters on ground using a measuring tape. Observers have to walk this distance and should record the time taken to walk the above distance, repeat this 2 – 3 times and take the average of these walks. Estimate the time taken by each observer to walk a kilometer on the basis of this exercise.

b) **Angular distance estimation:** This exercise is an ocular way of recording distance of sighting animals from the point where the observer is standing on the point or transect. The observers require practice for such ocular estimation this would be possible in the following manner:

In a given area mark trees at distance interval classes of 30, 60, 90, 120, 150, 200, 250, 300, 400, 500, 600 and 700 feet respectively as the staff in this area are conversant with the measurements in feet. Once the trees are identified at the mentioned distances the observer has to stand at a point and estimate the distances of the marked trees. Once the exercise is done, observer's data should then be evaluated in field. If any inconsistency exists that should be rectified through practice before the commencement of population exercise. We have generally observed that individuals have committed more error in estimating distances beyond 100 feet, care should be taken to train people in distance estimation.

The planning for the operation should administratively commence atleast a month in advance for smooth functioning of the whole exercise. The staff concerned also should be informed in advance so that they can mentally be prepared for a full time involvement during the whole exercise.

The nallahs and major trails have been marked on the maps. Each observer team will be provided with map of their respective areas with the walking track marked. The observers are supposed to arbitrarily mark the location of animal sighting on to the maps along with the assistance of the enumerator and the official in-charge. The most important aspect of distribution of species would be covered under this practice.

During the exercise period on Days I, II, III it would be essential for the observers and their respective in-charge officials to interact after every day's exercise. Such discussions would help in removing the confusions and problems from the data sets. The interactions would also encourage the staff that would keep their spirits high.

HANGUL POPULATION ESTIMATE

The count should be done for minimum of three days. If fluctuations in counts are more than 20% repeat this count for two more days. The Lincoln – Peterson estimator can be used in case of hangul population, as herds follow traditional movement routes and the fluctuation in herd composition is minimum. At this population level it is easy to establish the identity of animals commonly seen by multiple observations on same day and on different days. The count done on three consecutive days suffice for closed population assumption (movement outside study area is minimal and mortality is negligible).

One needs small coefficient of variation (Appendix D) to monitor annual fluctuations in majority of cases it is difficult to understand the trend, minimum 2 to 3 years of good data will be required to understand the population trend

It is important to follow permanent transects (nallas and ridges), method, time frame and effort so as to avoid variation caused by these factors. The sample count statistics then can be compared over years for entire area or blocks in the study area.

ANALYSIS

The data was analyzed for estimating abundance and index of abundance by the following procedure. For details of analysis see Appendix D.

i) Estimation based on multiple sample counts

$$\bar{N} \text{ (Mean Population)} = \frac{\text{Sum of each count}}{\text{Number of count}} = \frac{\sum P_{ni}}{n}$$

$$\text{SD (Standard deviation)} = \sqrt{\frac{\sum (P_{ni} - \bar{N})^2}{n - 1}}$$

P_{ni} = Population sample count

$$\text{SE (Standard Error)} = \frac{\text{Standard deviation}}{\sqrt{n}}$$

n = Number of counts

95% confidence Interval = $\bar{N} \pm 1.965 \times \text{SE}$
on Population Mean

\bar{N} (Mean Population) =

ii) Lincoln – Peterson estimator for multi-date data

$$\hat{N}_{LP} = \left[\frac{(n_1 + 1)(n_2 + 1)}{(m_2 + 1)} \right] - 1$$

\hat{N}_{LP} = Lincoln – Peterson population estimate

n_1 = Animal counted on Day 1

n_2 = Animal counted on Day 2

m_2 = Animal common on both counts, based on Age & Sex Ratio and area

$$\text{Var } \hat{N}_{LP} = \frac{(n_1 + 1)(n_2 + 1)(n_1 - m_2)(n_2 - m_2)}{(m_2 + 1)^2 (m_2 + 2)}$$

$$\text{Confidence Interval} = \hat{N}_{LP} \pm 1.965 \sqrt{\text{Var } \hat{N}_{LP}}$$

iii) To estimate detectability or proportion of animals seen in a given area or transect.

$$\hat{\beta} = \frac{m}{n_1}$$

where,

n_1 = Animals seen on day 1

m = Animals seen on day 2 which are common between day 1 and day 2

$\hat{\beta}$ = Detection Probability

(MacKenzie *et al.* 2002)

iv) Animal abundance based on transect analysis:

The animal abundance analysis based on transect analysis is done by using angular distance (Gates 1979) rather than perpendicular due to lack of equipments like compass and range finder at such a large scale (Fig 2). The density estimate should be treated as an index of density. The angular distance gives an idea about the visibility and detection of animal in a given habitat. The density is estimated by using programme Distance (Laake et al. 1993). The programme can be downloaded from www.jiscmail.ac.uk/lists/distancesampling.html. The density on the bases of probability detection curve is estimated by

$$\hat{D} = \frac{n}{2L\mu}$$

n = number of animals
L = Length
 μ = Effective strip width.

The effective strip is calculated on the basis of probability of detection under the curve. The detection curve is based on Half Normal or Uniform distribution. In case Distance software is not available density can be simply estimated by

$$\hat{D} = \frac{n}{2WL}$$

n = number of animals
W = Strip width decided on the basis
of histogram of angular distances.
L = Length of transect.

The width, W is estimated by plotting histogram of angular distance and decides on the basis of it the cut off level. If number of sighting dropped more than 20% to that of preceding value, then strip width will be the preceding value. In case of fig-3 the strip width will be 80 meters as beyond this there will be a drop in number of sightings that is more than 20%. For analysis see appendix-D.

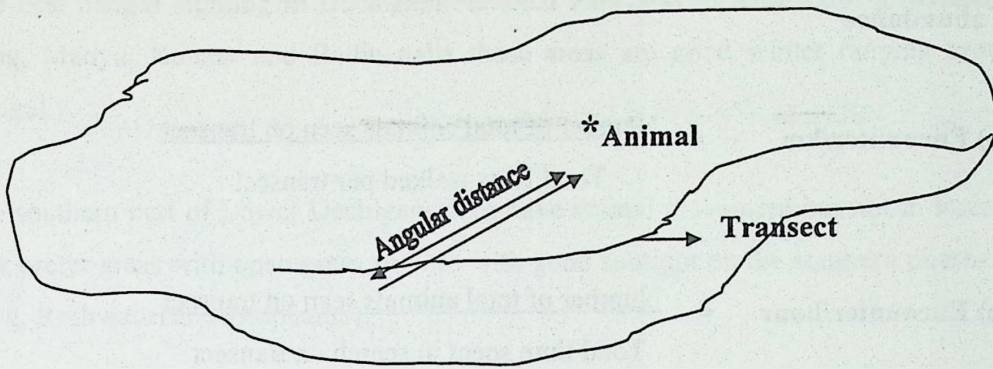


Fig-2: Diagram representing transect and angular sighting distance from the transect line to the sighted animal.

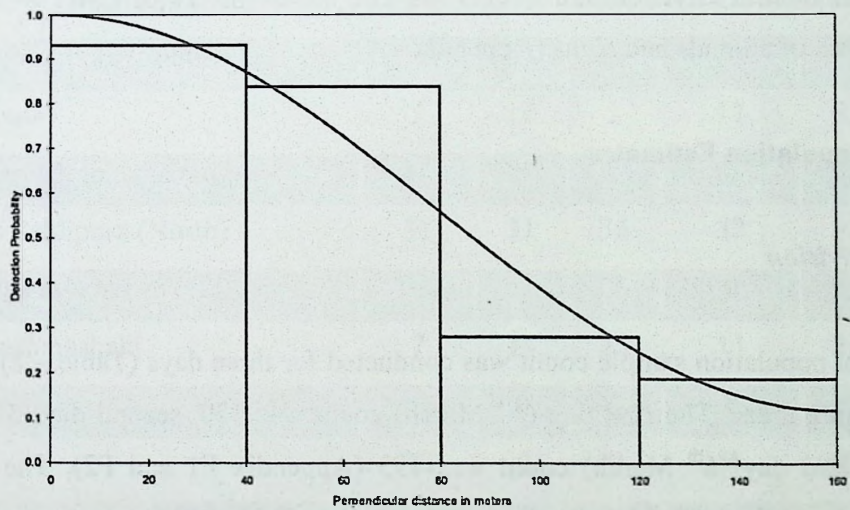


Fig-3: Histogram of Hangul detection at different angular distances plotted at an interval of 50m and probability detection curve (which will estimate the effective strip width i.e area under the curve)

v) Index of abundance

$$\text{a) Encounter/km} = \frac{\text{Number of total animals seen on transect}}{\text{Total Kms walked per transect}}$$

$$\text{b) Encounter/hour} = \frac{\text{Number of total animals seen on transect}}{\text{Total time spent in search on transect}}$$

RESULTS

A total of 1350.88 kms and 742.44 hours of effort was put in the three day population estimation exercise in Central Division and 2108.5 km and 925.58 hours of effort in South Division in active search of animals and signs (Appendix - A).

Hangul Population Estimates

Central Division

The hangul population sample count was conducted for three days (Table – 2) within Dachigam and adjoining areas. The first day (4th March) count was 179, second day (5th Feb.) count was 220 and third day (6th March) count was 193 (Appendix F1 and F2). The mean population estimate was 197 (± 21 , 95% Confidence Intervals) (Table 2). This estimate shall be used for trend monitoring of the population. (for calculation see Appendix D)

The Lincoln-Peterson estimator was used to get the population estimate. The mean estimate was 226, which ranged between 209-243 (95% confidence interval) (Table 3). The counts through the three days were less fluctuating thereby we settled with the three day exercise, had there been >20% fluctuations amongst the three day counts then an extra day count would be required.

The best hangul sighting in Dachigam National Park was in Reshwadri grassland, Draphama, Drog, Manyu, Kaunar and Badin nalla these areas are good winter ranging grounds for the Hangul.

The southern part of Lower Dachigam does have animal movement but not in lower reaches, as they prefer areas with open grass patches with good sunlight on the southern phases. (i.e Manyu, Drog, Reshwadri and Draphama).

Table:2 Population estimate of Hangul based on sample counts on three days 4th, 5th & 6th March 2004 in Central Division (Dachigam and its surrounds)

Locality	4 th	5 th	6 th	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

Summary Statistics

Mean = 197
 Standard Error = 12.2
 95% confidence Interval = $197 \pm 1.965 \times 12.2$
 = 197 ± 24
 = 173 to 221

See Appendix-D for calculation

South Division

In South Division no analysis of population estimation was done as data set was too small. The hangul population on 4th, 5th and 6th March was 30, 10 and 7 respectively (Table 4). In South Division the minimum hangul population can be taken as 30 individuals (Table 4).

Table: 3 Population estimate of Hangul based on Lincoln – Peterson estimator in Central Division.

Date	Count Day -1 n_1	Count Day - 2 n_2	Common animals Day 1 & Day 2 m_2	Population estimate N_{L-P}
4 th – 5 th March	179	220	163	242
4 – 6 th March	179	193	159	215
5 th – 6 th March	220	193	191	223

Summary statistics of estimated population

Mean Population = 226

Standard Error = 8

95% confidence Interval = 226 ± 17
= 209 to 243 Hangul

See Appendix-D for sample calculation

Table: 4 Population of Hangul seen in South Division on 4th, 5th & 6th March 2004

Block	Locality and Transect Number	(4 th)	(5 th)	(6 th)
Khangund	2A Dungnar to Serwan (Satura B)	0	1	2
	2B Kander Nar, Aripal & Saturbal (Satura A)	0	2	0
	2C Aripal nallah – Bren Nar	1	0	0
Shikargah	3A Pinglish, Haput nadji, Nag ware Nar.	15	0	5
	3B Brain nar- Haput nar.	6	5	0
	3C Tsersangnar to Goggidar.	6	0	0
	3D Gungwan area.	0	2	0
Overa	6A Gumri upto Rewas.	2	0	0
Total		30	10	7

HANGUL POPULATION ABUNDANCE INDEX

Central Division

Transect Analysis: Index of hangul abundance based on Distance analysis were 2.93/sq.km (SE= 0.86) on 4th March, 4.38/sq.km (SE=1.29) and 1.62/sq.km (SE=0.56) (Table 5). The mean density estimate was 2.98. The encounter rate was ranging between 0.084 to 0.092 hangul/km (Table 5). The density estimate should be taken as an index and not as an absolute measure of density.

Encounter rate within Dachigam (Sectors 1-6): Transects (T) in Sector four encompassing Mulnar, Drog, Reshwadri, Oak patch till Draphama area had the highest encounter of 1.79 hangul/km across the landscape of hangul distribution. Transects in sectors one, four and five had the best hangul sightings. Overall the encounters within Dachigam P.A. was highest in

Sectors T4 (1.79/km)>T1 (0.66)>T5 (0.61)>T3 (0.33)>T2 (0.22) while sector T6 had neither hangul encounter nor indirect evidences in this sector (Appendix E1).

Encounter Rates from Adjoining Areas of Dachigam (Sectors 7-10): Highest hangul encounter was in sectors Nishat T7 (0.23/km)>Khreu T9 (0.11/km)>Dara T10 (0.08/km). Khanmoh Sector(T8) had no sighting of hangul although there were indirect evidences in the area which need to be monitored for hangul movement (Appendix E1).

The other species seen on transects in Central Division apart from Hangul were Musk deer, Langur, Rhesus Monkey, Black bear, Leopard, Jackal, Fox, Martin, Porcupine, Chakor, Koklas and Monal (Appendix E1 and F1).

South Division

Encounters of hangul in this Division were very poor as compared to Dachigam (Central Division) (Appendix E2).

Encounter rate: In South Division, Shikargah had the highest encounter rate of 0.28 hangul/km. the mean of three days was 0.14 hangul/km (Appendix E2). Khangund had mean encounter rate of 0.04 hangul/km and Overa had mean encounter rate of 0.02 hangul/km (Appendix E2).

Areas that need immediate survey as indirect signs were observed during the exercise:

Shikargah Conservation Reserve: Pinglish, Haput nadji, Nagware nar; Bran nar – Haput nar; Buchgullo – Wagan gullo; Grat nal, Hapat nallah to Tangpathri.

Panner Conservation Reserve: Tang nar, Haji nar, Sang nar-Nalchi nar.

These areas need validation for hangul occurrence: Bathnoor-Basminallah-Bragnar.

Khiram Conservation Reserve: Dudoo, Sangnad, Ashdar (Kolnar, Kokernarji).

These areas need to be validated for hangul occurrence:

Hajidoab (Manxim Sali-Chutnak), Waginan (Dokden, Kazalnari), Panner nallah, Dewbawan and Kachnar.

Overa Wildlife Sanctuary: Hakerhaji, gumri need to be validated.

Daksum Wildlife Sanctuary: Bangidar and Buzalbrari need to be validated for hangul presence.

Other species: The transect data showed rich diversity of species encountered during all three days of the exercise. The species encountered were Musk deer, Langur, Rhesus Monkey, Black bear, Leopard, Jackal, Jungle cat, Fox, Koklas, Monal and Chakur (Appendix E2 & F2). Four wolves were sighted in Nanphran nalla (T8B) (Lidder-Aru) and a snow leopard track was recorded in Sattragi (T6D) (Lidder-Overa) on 5th March.

HANGUL SEX RATIO AND YOUNG: FEMALE RATIO

Hangul sex ratio from the three days count was estimated as 18 males/100 females (SE = 1.73) (Table 6a) . The sex ratio estimate was repeated on 13th March with observers equipped with binoculars, so as to avoid any visibility bias. The sex ratio was 20 males: 100 females. The four days mean was estimated as 19 males/100 females (S.E. = 1.33). (Table 6a).

Table 5 Hangul Index of density & encounter rate based on "Distance analysis" in Central Division

Parameter	4 th March,2004				5 th March,2004				6 th March,2004			
	estimate	SE	confidence Interval		estimate	SE	confidence Interval		estimate	SE	% confidence Interval	
			lower	upper			lower	upper			lower	upper
Distance (Km)	316				281				367			
Number of observations	29				24				24			
Average strip width (m)	16.57	3.12	3.20	27.4	19.32	3.73	9.73	14.43	64.41	2.05	25.18	15.95
Mean density (ind/km)	0.092	0.02	0.059	0.141	0.085	0.02	0.053	0.135	0.084	0.02	0.05	0.15
Group density (km ²)	0.48	0.092	0.28	0.78	0.48	0.12	0.28	0.79	0.25	0.081	0.13	0.47
Individual density	2.93	0.86	0.64	4.21	4.38	1.29	1.46	7.79	1.62	0.56	0.82	3.18
Group size (n)	6.17	1.93	1.53	8.40	9.17	2.28	1.87	12.22	6.32	1.88	4.76	8.39

SE= Standard Error

Table – 6 (a) Hangul Sex Ratio & Female Young Ratio (4th to 6th and 13th Mar. 2004) in Dachigam and Adjoining areas.

Date	Males: 100 Females	Young :100 Females
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

Hangul sex ratio was reported to be 151 males: 100 females during rut (Schaller 1969) and in non-rutting period it ranged from 15 to 25 males: 100 females (Holloway 1972, Department of Wildlife Protection 1996,1997, 2000, 2001, 2002, 2003) (Table 6 b).

Table - 6 (b) Sex Ratio and Young : Female ratio of Hangul in Dachigam and adjoining areas.

Year	Month	M:100 Females	Young: 100 Females	Reference
1969	6-21 Oct.	151	45	Schaller 1969
1970	10 th -19 th Feb.	25	-	Halloway 1972
1987	March	25	17	Inayatullah 1987
1996	26 th Feb.	15	51	Deptt. of Wildlife Protection,1996
1997	18 th Feb	16	43	Deptt. of Wildlife Protection, 1997
2000	24-25 th Mar.	18	31	Deptt. of Wildlife Protection,2000
2001	20-21 st Mar.	21	27	Deptt. of Wildlife Protection,2001
2002	Mar.	22	21	Deptt. of Wildlife Protection,2002
2003	IInd week of Feb.	18	25	Deptt. of Wildlife Protection,2003
2004 * ¹	4 to 6 th Mar.	18	22	Deptt. of Wildlife Protection,2004
2004 * ²	13 th Mar.	20	15	Deptt. of Wildlife Protection,2004

*1 Population estimation done on 4th, 5th and 6th March.

*2 The sample count specifically done for sex ratio and young: female ratio.

The young to female ratio was estimated with all female age classes due to difficulty in identifying reproductive age class of female. The young: female ratio for three days was estimated to be 23 (SE = 2.91) young/100 females. The 13th March, estimate was 15 young/100 females, including this the overall mean was 21 young/100 females (SE = 2.93).

The young: female ratio in Hangul was reported to range between 21 to 51 young/100 females during February and March (Department of Wildlife Protection, 1996, 1997, 2000, 2001, 2002 and 2003). Schaller (1969) reported 45 juveniles: 100 females. The counts from 2000 upto 2004 indicate a decreasing trend (Department of Wildlife Protection, 1996, 1997, 2000, 2001, 2002 and 2003) (Table 6 b, Fig 4). This is an alarming trend which needs to be monitored carefully by the management. The coming summer, staff should be deployed to monitor the fawning (i.e May end to midJuly) and also identify the prevailing threats to the fawning grounds. This should be a regular practice of monitoring of population during recruitment period in the future.

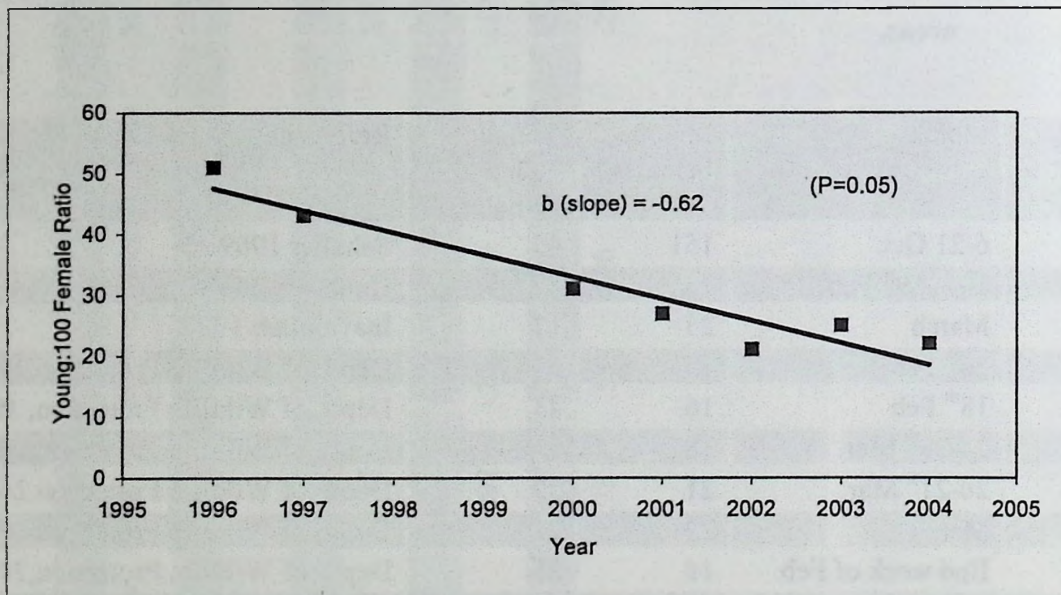


Fig 4: Hangul young is to female ratio in Central Division

GROUP COMPOSITION

A total of 88 Hangul groups were sighted which ranged from 1 to 25 (4th to 6th March) with the largest group of 55 individuals sighted in Drog area on the 13th March. The solitary hangul sightings were 4.5%. The small groups of 5 individuals were the highest observed i.e 28.4% during the population estimate conducted. Group of 10 individuals represented by 22.73%, group of 15 by 17.1%, group of 20 represented by 4.6% and group of 25 by represented by 3.41% (Fig 5).

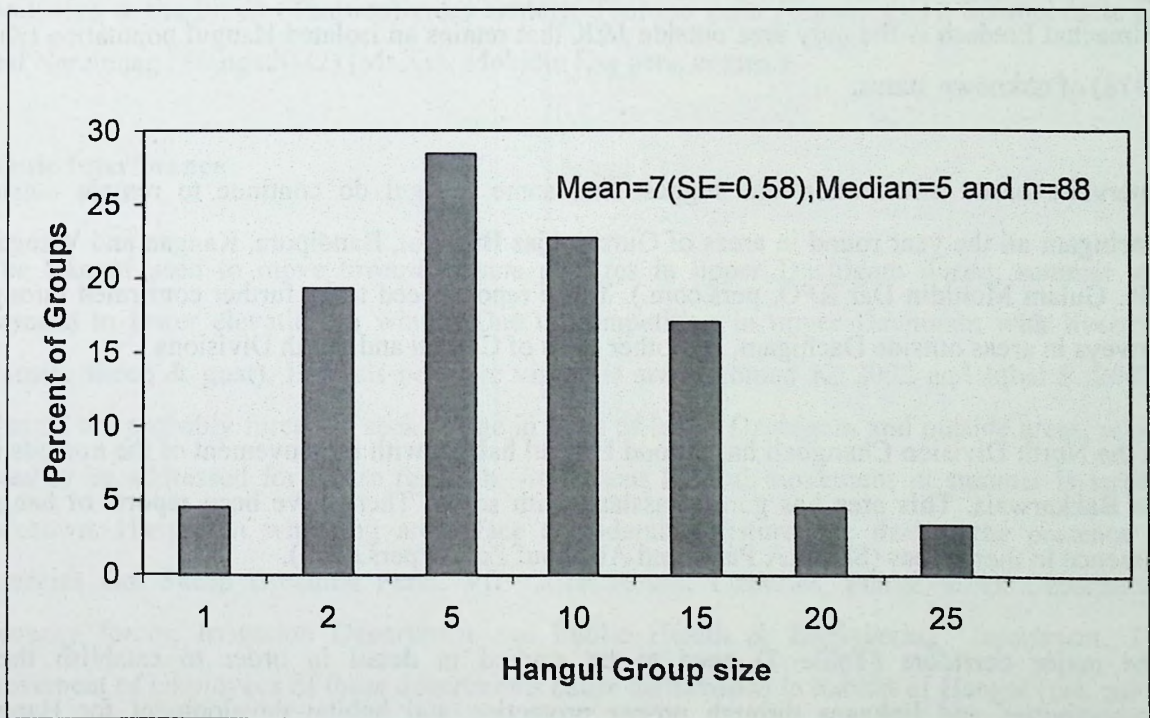


Fig 5: Hangul Group size in Central Division (Kashmir Valley)

HANGUL DISTRIBUTION

Hangul was once distributed widely in the mountains of Kashmir (Schaller 1969). Holloway (1970) mentions, that earlier in the 19th century, its distribution was confined to an area of ~65km in width to the North and East of Jhelum and Lower Chenab rivers, from Shalurah in North to Rhamnagar 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 (Southeast of Srinagar) (Kurt 1978). The Gamagul Siya-Behi Sanctuary in Himachal Pradesh is the only area outside J&K that retains an isolated Hangul population (Kurt 1978) of unknown status.

Interview based information did suggest that some Hangul do continue to remain outside Dachigam all the year round in areas of Gurez, Ajas Bunakot, Bandipora, Kangan and Wangath (Sh. Gulam Mohidin Dar RFO, pers.com.). These reports need to be further confirmed through surveys in areas outside Dachigam, and other parts of Central and North Divisions.

In the North Division Changdaji has a good Hangul habitat with no movement of the nomads i.e the Bakkarwals. This area has good grassland with scrub. There have been reports of hangul presence in these areas (Sh. M.A.Parsa and Ab. Rouf Zargar pers.com.).

The major corridors (Table 7) need to be studied in detail in order to establish these connectivities and linkages through proper protection and habitat development for Hangul movement. The only breeding viable population at present exists in Dachigam. The present population estimation exercise conducted did confirm that small groups do seem to be re-establishing in winter areas like Shikargah (27 hanguls), Khangund (1-2 hanguls) and in Overa (2 hanguls) (Table 4).

Reconnaissance survey conducted in Upper Dachigam (Leech top to Gunus nar), Sindh Forests – Thajwas Bandipora, Bunakot, Kangan, Wangath, Surpharo Baltal and Harmukh, do suggest the

presence of hangul (Mr. Gh. Mohidin Dar, Mr. A.R.Zargar and Mr. M.S. Bacha). These areas need to be systematically surveyed in order to confirm the occurrence of hangul.

Immediate surveys must be conducted in the aforesaid areas in order to confirm the status of hangul outside Dachigam. Reports suggest that the Hangul populations are isolated in some areas of North Division although some do migrate in and out of Dachigam National Park through linkages and corridors (Table 7, Map).

During the present exercise, the recce party reported having sighted five hangul and indirect evidences in the Sindh (Thajwas) areas namely, Thajwas nalla (Sonmarg)(1), Solanai nalla (2) and Narainnag (Wangath) (2) (Mr. Gh. Mohidin Dar pers. comm.)

Biotic Interference

The Hangul used to move towards alpine pastures in upper Dachigam during summer and descend to lower elevation in winter. Due to competition in upper Dachigam with livestock (mostly sheep & goat), Hanguls no more visit this area (Ahmad K. 2002 and Iqbal S. 2002). Hangul are probably forced to seek refuge in parts of lower Dachigam and outside areas, which need to be addressed for future research. At present Hangul movement in summer is largely unknown. Hangul in wintering areas face considerable disturbance due to the presence of agencies like Sheep Breeding Farm, VIP Guest House, Fisheries, Public Work Department, Security forces, Irrigation Department and Public Health & Engineering Department. The movement of employees of these departments cause disturbance in habitat of Hangul (oak patch, Yachigachi, Mulnar and Pahlipora). There is a possibility of disease transmission due to the presence of livestock inside the National Park. The adjoining areas of Dachigam National Park, like Dara Conservation Reserve, Nishat and Brain Conservation Reserve face heavy biotic interference. Areas of Khrew and Khunmoh face pressure on habitat due to presence of cement factories and stone quarries.

Table 7: List of Corridors for Hangul in Central and South Division

Dachigam -Khonmoh	a) Kawnar – Safedbal b) Phalipora – Sangri c) Check – Gratnar
Dachigam – Khrew	Gratnar – Bathian
Dachigam – Brain Conservation Reserve	a) Badin – Aasthan Mohalla b) Baddin – Cheshmashahi
Dachigam – Nishat Conservation Reserve	Narimulla – Harichandraz
Dachigam – Dara	a) Mulnar – Mamnieth b) Sharzbal- Dara
Khrew – Aaripal (Tral)	a) Wahabkhar – Aaripal b) Buddalav-Aaripal & Khadalav c) Naginder – Satura (b) d) Pokhribal – Satura (a)
Dachigam – Hajin (Summer)	a) Burzwas – Sardalav b) Gunas nar – Hajin nar c) Sangargulu – Zuastan d) Gagyari – Badnar
Shikargah – Khiram	a) Kamla – Dudoo b) Tangpathri – Sangnard c) Chersangri – Sangnard d) Brennar - Sangnard
Dachigam Shankaracharya	a) Dachigam-Cheshmashahi – Shankaracharya
Pannar – Khiram	a) Pannar – Pannyer
Panner – Overa	a) Pannar – Qilla, Poshpathri, Hakerjahi
Upper Dachigam – Sindh Forests	a) Surf pharo
Upper Dachigam – Thajwas	b) Dagwan – Sindh (Hoksar)
Thajwas – Upper Dachigam	Thajwas via Baltal Overa – Aru - Upper Dachigam
Lower Dachigam – Sindh Forests	a) Surpharo – Right of Mahadeo
Dara Conservation Reserve	Dara – Akhal Forests- Khangar/Wangath
Dara Conservation Reserve	Khimber – Najwan

It is important to monitor the effect of grazing (see monitoring section) in upper Dachigam which used to be an important summer grounds for the hangul. Protection in upper Dachigam and its adjoining areas is the most wanted. It is important to have guards and operational *chowkis* during the summer.

Patrolling in lower Dachigam esp. in Mulnar, Gratnar to Bathyen, Kutnar and Kaunar via safedbal to Zawora/Khanmoh and Pahlipora via Sangri-Khanmoh is most wanted.

Control of the dogs which belong to the *Bakkarwals* (Grazier Community) as they might be predated on wild animals. This aspect needs to be studied. There is an urgent need to control the dog population within the conservation area.

There is a possibility of disease transmission to hangul during summer, where their habitat use overlaps with that of livestock. There is a prevalence of diseases like Foot and Mouth, Rinderpest, Anthrax, Tuberculosis, Brucellosis and Johne's disease (Mir Mansoor Per.Comm.). Hangul was affected by Johne's disease (Kurt 1978), Malignant Cattlarhal fever and Tuberculosis in past (Mir Mansoor Per. Comm.).

RECOMMENDATION

A) Habitat monitoring

Exclosures and Preservation plots: Maintaining and monitoring 10 x 10 m plots in Upper Dachigam in order to understand the vegetation recovery from grazing.

The plots should be monitored regularly every 30 days during summer (Appendix B). The preservation plots in different vegetation type in lower Dachigam should be identified, there is no need to erect exclosure for these plots.

These plots would be 100 x 100 m in forested habitat (Conifer and Broad leaved), 50 x 50 m in scrub dominated area (*Parrotiopsis spp.*) and 10 x 10 m in grassland area. In forest and scrubland the external boundary of plots should be marked by marking outer most trees or shrubs at a convenient interval (5- 10 m), while in grassland area which are not grazed by livestock metal or concrete pegs can be fixed on ground. The permanent plots in fire prone areas would need to be protected by creating suitable firelines.

B) Population Monitoring

1. Hangul

- i) **Population estimation:** should be done as per the method described in method section. The sex ratio and female: fawn ratio should be done by observers equipped with binoculars. This exercise should be repeated at least three times (Appendix B).
- ii) **Recruitment:** The fawning grounds should be monitored and fawn: female ratio should be estimated fortnightly from May end to Mid July. For these samples various herds should be observed in a day. More stress should be laid on obtaining good estimate of fawn: female ratio. This sampling will give an idea about fawning success. During this period, it could be mandatory to keep watch on fawn predation and mortality (Appendix B).

2. Other Species

The other herbivore population trends can be monitored using data collected during census (see method section and Appendix B).

Leopard, Black bear, Fox and Jackal: Abundance can be estimated on the basis of secondary signs such as scats and scrapes. The frequency of sighting in different areas will be a useful index. There is an urgent requirement to conduct a detailed population abundance exercise for leopard and jackal.

Black bear abundance can be estimated on the basis of encounter rate, direct counts and indirect signs (droppings and damage to trees). Jackal encounter rate can be done during census time (see method). It is important to monitor the abundance of predators either direct or indirect basis in potential fawning sites.

C) Health Monitoring

The health monitoring would be in post rut (Feb, Mar.) and post fawning (July, Aug.) period. The observer should sample few herds for health assessment. The hangul caracas and faecal pellets should be regularly monitored for prevalence of disease and parasites.

There is a need to inoculate livestock in areas where hangul and livestock range overlaps.

D) Control of Livestock Grazing and Dogs

It is imperative to have chowkis and patrolling parties during the summer in the upper Dachigam which would be able to monitor the fawning grounds and control the livestock movement and thereby reduce the pressure on habitat. A planned movement route for the livestock herders is most wanting, the most important fawning grounds could thus be protected. The dog population of graziers and armed forces need to be monitored and control their entry.

RESEARCH PROGRAMME

Mr. Khurheed Ahmad, and Mr. Shaheen Iqbal are conducting currently two research programmes viz Seasonal feeding preferences of hangul in relation to forage availability in Dachigam National Park and Predator prey relationship with special reference to Hangul in Dachigam National Park respectively in collaboration with J&K Government and Wildlife Institute of India. These studies are going on since 2001. The Department of Wildlife Protection in collaboration with Wildlife Institute of India has taken up a study on hangul movement using GPS collars. Three research studies are currently undertaken by University of Kashmir, Mr. Muzaffar Ahmad Shah on "Feeding Ecology and Status of Himalayan Langur in the National Park", Bilal Ahmad on "Feeding Ecology of Hangul", Zaffar Reshi on "Assessment of anthropogenic impact on Kashmir Himalayan pastures and their sustainable management" Shamim Ahmad is studying Land use pattern in and around Dachigam in collaboration with Forest Research Institute of Dehradun and University of Kashmir. In addition a rescue centre and an enclosure for captive breeding have been established on the eastern periphery of National

Park. Presently there are three common leopards, one brown bear one ladakh urial and two spotted deer in the rescue centre.

Future research can emphasize on the following aspects:

- a. Monitoring recruitment pattern in hangul (fawning grounds, predation on fawns by Leopard, Black Bear, Jackals and Martens).
- b. Long term habitat monitoring programme in Dachigam specifically alpine meadows of upper Dachigam
- c. Vegetation mapping of Central and South Division.
- d. Feasibility study for captive breeding programme for hangul.

□□□□□□□□

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Appendix-A1: Details of Transects walked in Central Division
DACHIGAM NATIONAL PARK

Dachigam Southern Segment

Sector - I Western Boundary upto Draphama (VIP Guest House)

Area	People	Incharge Officer
1.1 Narimulla (Sharbkul to Haider Nar)	5	Dr. Mir Mansoor
1.2 Badin Nala	6	
1.3 Zihil (Gandkadal - Raznari - Zihil) Riverine Tract	5	
1.4 Foothills (Interior Gandakadal Road)	3	
1.5 Sarband - Power House via Maharkha (Along road and nala)	3	

Sector - II VIP Guest House (Draphama) to Phalipora

2.1 Kaw Nar	(3x3) 9	Sh. Rouf Zargar
2.2 Kutnar	3	
2.3 Chandar Nar	(3x3) 9	
2.4 Power House to Phalipora (Between road and nalla)	3	
Sector - III Namblan nar		
3.1 Phalipora to Yachigaji (towards Grat Nar, Luchdund)	3	Sh. M. A. Parse
3.2 Phalipora to Gurpal (Riverine)	3	

Dachigam Northern Segment

Sector - I Western Boundary upto Draphama (VIP Guest House)

4.1 Sheep Breeding Farm to Mul Nar (Towards western boundary)	3	Sh. Intisar Suhail
4.2 Maha deo Nar (Sheep breeding farm to Abchul)	5	
4.3 Padsha Dub to Astha Nar (Hannar & Pannar)	5	
4.4 Reshwadri Riverine	2	
4.5 Plantation/Reshwadri (Gate to VIP lodge)	2	
4.6 Gujji daji	3	

Sector - II Draphama to Phalipora (Northern)

5.1 Drogo Nar	5	Sh. M. M. Baba
5.2 Manyu	5	
5.3 Base of Drogo nar upto beginning of Cholri	5	
5.4 V.I.P. lodgeto Draphama	3	

Sector - III Phalipora to Waskar

6.1 Phalipora to Bran nar to Cholri	3	Sh. M.S Bacha
6.2 Phalipora to Waskhar	3	
Total People Required (Inside Dachigam)	96	

RECCE OF UPPER DACHIGAM (1S & 1L)
NATIONAL PARK (Leesch top to Gunus nar)

2

OUTSIDE DACHIGAM P.A.

	Area Nishat (Harwan) □Brain □Cheshmashahi	People	Incharge Officer
7.1	Nishat upto Brain (Harichandrez) a) Nishat nalla - Harichandrez b) Nishat (Danpora Keere) - Harichandrez	4	
7.2	Brain (Asthan Pora top) a) Kral Sangri - Lal Shahkeri b) Danpora - Takiia Nizam return to Lal Shahkeri c) Lal Shahkeri - Aabpathri to Manden Top d) Astan Bagh (via Gobble) - Khanag (Astanpora Top)	(3x2) 6	Sh. Imtiyaz Ah. Lone
7.3	Cheshmashahi (Rajbawan to Zeithyar) a) Urban Hut - Balai Boninar Nalla II Labruo - Boninar - Cheshmashahi b) Cheshmashahi Milk Supply - Parimahal (Shalimar Park Range) c) Dorbagh □Parimahal d) Oberio Palace to Bathnar nallah e) Rajbavan to Zeithyar	(3x3) 9	
KHUNAMOH CONSERVATION RESERVE			
8.1	Safad bal Staff Quarter to Ringpathri top	2	Sh. Mukhtar Ah.
8.2	Sangri Area a) Staff Quarter to Tul Nar b) Staff Quarter to Aab Nar c) Khunamoh quarter to Luchdund (Sangri)	(3x3) 9	
8.3	Check □Phelchek via Dun nar	3	
8.4	Rakh Khanmoh (Kharhajan) KHREU CONSERVATION RESERVE	2	Sh. Gh. Ah. Sofi
9.1	Bathian Nala	3	
9.2	Nagander	3	
9.3	Pokri Bal	3	
9.4	Baddalv	3	
9.5	Khuddalv	2	
9.6	Wahabkhar	2	
DARA CONSERVATION RESERVE			
10.1	Darwani Nala to Bobjan	3	Sh. Fida Hussain
10.2	Check Dara upto Tulpathri nalla	2	
10.3	Dara to Nagnar	2	
10.4	Khimber to Takiia Sangri	2	
10.5	Dara to Mamnieth	2	
RECCY FOR WINTER GROUNDS-HANGUL REPORTS FROM LOCALS			
	Akhal Forest	3	Sh. Gh. Mohidin Dar
	Najwan		
	Akhal 2		
	Surfpharo Forest		
	Sindh Forest (Thajwas)	3	
	Batal, Wangath, Bandipor, Ajas, Kangan, Bunakot, Harimukh		
	Gurez □Tilel Gurez and Gangbal Gurez	66	

Appendix-A2: Details of Transects walked in South Division.

	Area	People	
I	Area : HAJIN CONSERVATION RESERVE		
	A) Sardalav	2 Staff 1Labour	3
	Hakwan to Astan nar		
	Staff Quarter to Khakpathri		
	B) Hajin Nalla	2S & 2L	4
	Staff Quarter, Bagdouri, Gagari		
	Churyawali (Staff Qrt.) to Bangpathri		
	C) Zuasthan Nalla	2S & 1L	3
	Varumgul to Budwas		
	Darwanyari to Kairwas		
	Panner to Keherwas		
	D) Leech Top to Gunas nar		
	Gunas Nar to Waddalav Top		
II	KHANGUND CONSERVATION RESERVE		
	A) Satura (b) (Dangnar & Serwan)	2S & 1L	3
	B) Satura (a) Kandervan, Aripal & Satherbal	2S & 1L	3
	C) Aripal Nalla + Barninar	2S & 1L	3
III	SHIKARGAH CONSERVATION RESERVE		
	A) Pinglish (Nagwar Nar + Haput Nadgi)	2S & 1L	3
	Zeith nar to Pajwan nar		
	Haput nadji to Pajwan nar		
	Lai nar to Lai nar		
	B) Shikargah (Brain Nar & Haput Nar)	2S & 2L	4
	Tanghar to Chairsangrigul		
	Quiltangi to Chairsangrigul		
	Chairsangrigul to Quiltengi, Wakharkhud		
	C) Tsersangri (Gogji dar)	2S & 1L	3
	Quiltangi to Tangpathri, Kral top		
	Bren nar top to Fakir dalav		
	Pannari to Tangpathri		
	D) Gangwan	1S & 1L	2
	Jandisahib to Chaknad		
	Nilwan to Gangwan Trag		
	Quiltang to Gangwan top to Jandasahib Keri		
	E) Wagangulu (Kamla, Bachugol, Wagumgol)	2S & 1L	3
	Fresnar, Wagangulu to Painar		

	Waldub to Busugulu upto Sarnajhainad		
	Sang to Kral top, Kral top to Zerdagri		
IV	PANYER CONSERVATION RESERVE		
	A) Bathnor (Bathnor nalla, Basmal nalla & Bugamer Nala)	2S & 1L	3
	B) Panner (Hajinar)	2S & 2L	4
	C) Sangnard (Nalchinar, Kathiwar)	2S & 2L	4
	D) Hafoo (Tangnar, Payen)	2S	2
V	KHIRAM CONSERVATION RESERVE		
	A) Dudoo Beat	1S & 1L	2
	B) Sangnard (Pahaj, Brain nar)	2S & 1L	3
	C) Waginar (Dokden, Kazalnari)	2S & 1L	3
	D) Panner (Panner nalla, Dewbawan - Kachnar)	1S & 1L	2
	E) Aashdar Beat (Kolnar, Kokernarij)	1S & 1L	2
	F) Hajidub (Manzim Sali, Chutnakh)	1S & 1L	2
VI	OVERA WILDLIFE SANCTUARY		
	A) Gumri (Gumri nalla upto Rewas)	2S & 1L	3
	B) Kanji kot (Kanjikot upto Maidan)	2S & 2L	4
	C) Haker Haji	2S & 1L	3
	D) Satragi corridor (Posh pathri, Qillar upto connecting Panyar - Tral)	2S & 2L	4
	E) Versaran (Reshnar, Kandali nalla - Raivas)	2S & 2L	4
	F) Langanbal (Quickyari, Launari, Khelannar)	2S & 2L	4
VII	PAHALGAM WILDLIFE SANCTUARY (BLOCK)		
	A) Sarbal (Ziart Shrine, Shinar)	1S & 1L	2
	B) Hodsar Nar (Dunpathri)	1S & 2L	3
	Mandlan Beat		
	C) Gokhiyan Nar (Kukyen)	1S & 1L	2
	D) Munwarsar Nallah (Snow Covered)	1S & 1L	2
	E) Gandpathri	1S & 1L	2
	F) Shashtarchen (Compartment 41-43)	2S & 2L	4
VIII	ARU WILDLIFE SANCTUARY		
	A) Chumbnai (from Ganshibal)	2S & 2L	4
	B) Nanphran nalla (Right side)	2S & 2L	4
IX	DAKSUM (RAJPARIAN) WILDLIFE SANCTUARY		
	A) Khatanpathri (from gate onwards)	2S & 2L	4
	B) Khatanpathri to Buzalbrari	2S & 2L	4
	C) Gate to Bangidar (Right side)	2S & 2L	4
	D) Bangidar to Buzal brari (Covering Mohinambal)	1S & 2L	3
	Total	67S & 54L	121

Appendix B Data Sheet for population, activity pattern
 Government of Jammu & Kashmir, Department of Wildlife Protection
 Annual Animal Census March 2004 Dachigam National Park and Adjoining Buffer Areas

Party Code	Time Start	Date
Member Code	Time End	Weather
Beat/Nallah/Compt.	St.Point	Total Resting Time: =
Block	End Point	Time Taken Per/Km =
Range		Total Distance Covered Km

Species	Time	Direction	Distance	Activity	Habitat					M	F	Y	UI	Total	Indirect Evidences			Remarks
					E	B	R	G							H/P	D/S	O	

Legend1: Habitat: E= Evergreen/Coniferous, B=Broadleaved, R=Riverine, G=Grass/Scrub

Legend2: M: Male, F=Female, Y=Young, UI=Un-identified

Legend3: Indirect Evidences: H/P=Hoof/pugmarks, D=Droppings, S=ScrapMarks, T=Trashes, W=Wallowing, O=Others

Animals likely to be sighted

1. Hangul.
2. Musk Deer.
3. Serow.
4. C. Leopard.
5. Black Bear.
6. Brown Bear.
7. C. Langur.
8. Rhesus Monkey.
9. Yellow Throated Marten.
10. Pine Marten
11. Himalayan Fox
12. Jackal.
13. Leopard Cat.
14. Jungle Cat

1. Monal
2. Koklas
3. Chukar

Government of Jammu & Kashmir, Department of Wildlife Protection, Srinagar.

Age and Sex Ratio Estimation of Hangul

Observers Name

Time Start

Date

Beat/Comptt./Nallah

Time End

Weather

Species (Hangul)	Time	Angular Distance	Total	Male			Female			Young	Unidentified	Activity	Habitat	Remarks
				A	SA	U	A	SA	U					
				A	SA	U	A	SA	U					

Legend

A = Adult

SA = Sub Adult

U = Unidentified Age Class

In remarks note down antler stage, and if possible Lat. - Long.

Vegetation Preservation Plot Monitoring (Woodland (100x100m) and Scrub 25x25m)

Plots No:

Locality

Latitude

Longitude

Date:

Plot #	Species Name	GBH	Canopy Cover	Height	Phenology	Anthropogenic Activity

Appendix - C1: List of Data Collectors in Central Division

S.No	Name	From	Designation
1	Gh. Nabi Wani	Dal	Guard
2	Mohd. Amin	Brain	Guard
3	Ab. Rehman Kathoo	Dachigam	Guard
4	Gh. Mohd. Bhat	Dachigam	Guard
5	Khurshed Ahmad Mir	Dachigam	Guard
6	Gulzar Ahmad Ganie	Khrew	Helper
7	Farooq Ahmad Shiekh	Khrew	Guard
8	Mushtaq Ahmad Sheikh	Khrew	Chowkidar
9	Fida Hussain Shah	Dachigam	Forester
10	Gh. Mohd. Sheikh	Sopore	Guard
11	Shamim Ahmad Mir	Shopain	Helper
12	Nazir Ahmad Naikoo	Tral	Helper
13	Mohd. Ashraf Nangroo	Pahalgam	Guard
14	Ab. Aziz Lone	North	Guard
15	Gh. Nabi Bhat	Dachigam	Watcher
16	Riyaz Ahmad Bhat	Tral	Helper
17	Ab. Ahad Rather	Ganderbal	Guard
18	Farooq Ahmad Dar	Ganderbal	Guard
19	Gh. Mohi-ud-din Ganie	Shopain	Helper
20	Ab. Hamid Mir	Shopain	Helper
21	Mohd. Abdullah Sheikh	Khrew	Watcher
22	Nissar Ahmad Shah	Dachigam	Guard
23	Mohd. Maqbool Sheikh	Dachigam	Guard
24	Bashir Ahmad Ganie	Shopain	Guard
25	Mushtaq Ahmad Ganie	Shopain	Watcher
26	Gh. Nabi Sofi	Gulmarg	Guard
27	S. Amirik Singh	Baramulla	Forester
28	M. Ramzan Mir	Sopore	Daily wager
29	Riyaz Ahmad Lone	Sopore	Orderly
30	Ab. Rahid Dar	Baramulla	Guard
31	Irshad Ahmad Deedar	Gulmarg	Mai
32	Manzoor Ahmad Lone	Social Forestry	Dy. Forester
33	Khurshed Ahmad Bhat	Social Forestry	Dy. Forester
34	Ab. Qayoom Khan	Limber	Guard
35	Surbjit Singh	Limber	Helper
36	Farooq Ahmad Wani	North	Helper
37	Gh. Jeelani	North	Helper
38	Mohd. Ramzan Dar	Dachigam	Forester
39	Ab. Rashid Parray	Khrew	Helper
40	Ab. Rahid Lone	Social Forestry	Dy. Forester
41	Gh. Nabi Thakur	Social Forestry	Dy. Forester
42	Gh. Hassan Parray	Social Forestry	Forester
43	Mohd. Yousuf Rather	Social Forestry	Forester
44	Ab. Ahad Mir	Social Forestry	Dy. Forester
45	Mohd. Latif Shagoo	Social Forestry	Dy. Forester
46	Mohd. Shafi Mir	Social Forestry	Dy. Forester

S.No	Name	From	Designation
47	Khazir Ahmad Malla	Social Forestry	Dy. Forester
48	Nazir Ahmad Malik	Dachigam	Guard
49	Ab. Rehman Mir	Brain	Guard
50	Ab. Rashid Mir	Dachigam	Guard
51	Ab. Rehman Bhat	Dachigam	Guard
52	M. Yaseen Bhat	Dachigam	Guard
53	Gh. Ahmad Bhat	Dachigam	Watcher
54	Farooq Ahmad Peer	North	Guard
55	M. Yousuf Wani	North	Guard
56	Khursheed Ahmad Dar	North	Orderly
57	Nazir Ahmad Dar	North	Orderly
58	Gh. Rasool Malik	North	Guard
59	M. Amin Ganie	North	Guard
60	M. Amin Parray	South Division	Guard
61	Mushtaq Ahmad Mir	South Division	Guard
62	Bashir Ahmad Ganie	South Division	Helper
63	Assadullah Wani	Shopain	Daily wager
64	Mohd. Ismail Mir	Dachigam	Guard
65	Nazir Ahmad	Veterinary	Lab. Asstt
66	Bashir Ahmad Reshi	Veterinary	Attendent
67	Bashir Ahmad Beigh	Veterinary	Helper
68	Rafiq Ahmad Mir	Dachigam	Guard
69	Mohd. Amin Wani	South Division	Guard
70	Gh. Hassan Bhat	Dachigam	Guard
71	M. Hussain Wani	Dachigam	Watcher
72	M. Aslam khan	Dachigam	Guard
73	Shabir Ahmad Matoo	Dachigam	Guard
74	Nazir Ahmad Bhat	North	Guard
75	M. Ismail Lone	North	Guard
76	Hafiz-ullah Dar	North	Orderly
77	Tariq Ahmad Akhoon	North	Daily wager
78	Parvaiz Ahmad Khan	Social Forestry	Dy. Forester
79	Ab. Majid Wani	Social Forestry	Dy. Forester
80	M. Maqbool Lone	Ajas	Guard
81	Ab. Rahid Dar	Dachigam	Guard
82	Ab. Rahid Dar	Dachigam	Guard
83	Farooq Ahmad Jan	North	Guard
84	Manzoor Ahmad Shah	South Division	
85	Mansoor Ahmad Shiekh	South Division	
86	Farooq Ahmad Rafiqe	South Division	

Central Division

1	Shamsudin Shah		Forester
2	Tyoub Shah		Forester
3	Gh. Nabi Bhat		Guard
4	Mohd. Ismail Mir		Guard
5	Ab. Rashid Dar		Guard
6	Nazir Ahmad Malik		Guard
7	Ab. Rehman Rather		Guard

S.No	Name	From	Designation
8	Rafiq Ahmad Mir		Guard
9	Ab. Rashid Mir		Guard
10	Ab. Rehman Bhat		Guard
11	Khursheed Ahmad Mir		Guard
12	Gh. Nabi Bhat		Guard
13	Ab. Rashid Dar		Guard
14	Gh. Ahmad Bhat		Guard
15	M. Jabeen Bhat		Guard
16	M. Hussain Wani		Guard
17	M. Aslam Khan		Guard
18	Ab. Ahad Rather		Guard
19	Farooq Ahmad Dar		Guard
20	M. Maqbool Sheikh		Guard
21	Nissar Hussain Bhat		Guard
22	Nissar Ahmad Shah		Guard
23	Gh. Nabi Wani		Guard
24	Ab. Rehman Mir		Guard
25	M. Ramzan Dar		Guard
26	M. Amin Mir		Guard
27	Gh. Mohd. Bhat		Guard
28	Gh. Hussain Bhat		Guard
29	Gh. Ahmad Dar		Guard
30	Gh. Mohd. Bhat		Guard
31	Fida Hussain Shah		Guard
32	Shabir Ahmad Matoo		Guard
33	M. Shafi Rather		Guard
34	Mushtaq Ahmad Naikoo		Guard
35	Gh. Mohi-ud-din		Guard
36	Gulzar Ahmad Ganie		Guard
37	Farooq Ahmad Sheikh		Guard
38	Mushtaq Ahmad Sheikh		Guard
39	M. Abdullah Sheikh		Guard
40	Ab. Rashid Parray		Guard
41	M. Shafi Mir		Guard
42	M. Ashraf Parray		Guard
43	Gh. Qadir Sheikh		Guard
44	Gh. Mohi-ud-din Sheikh	Khrew	Retired
45	Shabir Ahmad Bhat		Guard
46	Ab. Majid Sheikh		Guard
47	Bashir Ahmad Sheikh		Guard
48	Bashir Ahmad Sheikh		Guard
49	Ab. Hamid Sheikh		Guard
50	Kulwant Singh		Guard
51	Gul Khan	Sangri	Guard
52	Gh. Mohd. Sheikh		Guard
53	Gh. Ahmad Wani		Guard

Appendix - C2: List of Data Collectors in South Division

S.No	Name	Designation
1	Jarnail Singh	Range Officer
2	Manzoor Ahmad Wani	Range Officer
3	Shiekh Javaid Ahmad	I/c Range Officer
4	Gh. Hassan Naikoo	I/c Range Officer
5	Mushtaq Ahmad Sofi	Forester
6	Mohd. Yousuf Nath	Forester
7	Ab. Rashid Gattoo	Dy. Forester
8	Ab. Gaffar Mir	Guard
9	Gh. Qadir Lone	Guard
10	Ali Mohd. Mir	Guard
11	Gh. Rasool Mir	Guard
12	Mohada Lone	Guard
13	Bashir Ahmad Rather	Guard
14	GH. Ahmad Wani	Guard
15	Sona-ullah Naikoo	Guard
16	Jalal-ud-din Shah	Guard
17	Gh. Hassan Sheikh	Guard
18	Ab. Rehman Shah	Guard
19	Souraj Singh	Guard
20	Mohd. Shaban	Guard
21	Assadullah Zargar	Guard
22	Gh. Qadir Naikoo	Guard
23	Ab. Rashid Wani	Guard
24	Gh. Rasool Shah	Guard
25	Habib-ullah Khan	Guard
26	Ab. Aziz Hajam	Guard
27	Mohd. Amin Bhat	Guard
28	Nanak Singh	Guard
29	Gh. Nabi Mandoo	Guard
30	Bashir Ahmad Baba	Guard
31	Bashir Ahmad Rather	Guard
32	Manzoor Ahmad Wani	Guard
33	Safdar Ali Mir	Guard
34	Gh. Mohd. Dar	Guard
35	Mohd. Yousuf Lone	Guard
36	Mushtaq Ahmad Mir	Guard
37	Mohd. Yousuf Dar	Guard
38	Nazir Ahmad Rather	Guard
39	Gh. Ahmad Khan	Guard
40	Rafiq Ahmad Ganie	Guard
41	Gh. Rasool Rather	Guard
42	Jalal-ud-din Khan	Guard
43	Mushtaq Ahmad Rather	Guard

S.No	Name	Designation
44	Jalal-ud-din Bhat	Guard
45	Ab. Majeed Sheikh	Guard
46	Gh. Hassan Mir	Guard
47	Gh. Qadir Khatana	Guard
48	Bashir Ahmad Mir	Guard
49	Sajad Ahmad Shah	Guard
50	Ab. Majeed Shah	Guard
51	Mohd. Amin Rather	Guard
52	Mohd. Yousuf Wani	Guard
53	Gh. Qadir Baba	Guard
54	Mohd. Abdullah Rather	Guard
55	Mohd. Ramzan Mir	Guard
56	Ab. Salam Wani	Guard
57	Mohd. Hussan Khan	Guard
58	Nazir Ahmad Khan	Guard
59	Mohd. Yousuf Bhat	Guard
60	Mohd. Maqbool Ganie	Guard
61	Nazir Ahmad Dar	Guard
62	Mushtaq Ahmad Bhat	Guard
63	Ab. Hamid Sheikh	Watcher
64	Riyaz Ahmad Wani	Watcher
65	An. Rehman Raina	Chowkidar
66	Rafiq Ahmad Ganie	Chowkidar
67	Rajender Singh	Chowkidar
68	Nisar Ahmad Zargar	Orderly
69	Ab. Hamid Bhat	Helper
70	Mohd. Muzaffar Bhat	Helper
71	Ishpal Singh	Helper
72	Bashir Ahmad Ganie-I	Guard
73	Ab. Rashid Hajam	Helper
74	Mohd. Younis Khan	Helper
75	Gh. Hassan Sheikh	Helper
76	Gh. Nabi Mir	Helper
77	Mohd. Shaban	Helper
78	Gh. Nabi Sheikh	Helper
79	Gh. Hassan Bhat	Mali

$$(m_2 + 1)^2 (m_2 + 2)$$

Example: Population estimate based on dates from 4th and 5th March, 2004

$$n_1 = 179, n_2 = 220$$

$$m_2 = 163$$

$$N_{L-P} = \left[\frac{(179 + 1)(220 + 1)}{(163 + 1)} \right]^{-1}$$

$$= \left[\frac{39780}{164} \right]^{-1}$$

$$= 243 \square 1 = 242$$

$$\begin{aligned} \text{Var} &= \frac{(178 + 1)(220 + 1)}{(163 + 1)^2} \frac{(178 \square 163)(220 \square 163)}{(163 + 2)} \\ &= \frac{37343696}{4437840} \\ &= 8.42 \end{aligned}$$

The empirical mean and variance is to be estimated instead of model variance i.e the population estimates of 4th & 5th & 6th March was estimated and its mean & variance is estimated same as that of Appendix D (a). The population mean is calculated as 226 and confidence limits was 17 (lower limit = 221 & upper limit 245)

c) The estimate of detection probability in tantared as given block

$$\hat{\beta} = \frac{m_2}{n_1}$$

$$\hat{\beta} = \text{Detection probability}$$

n_1 = animals seen on day one (1st count)

m_2 = animals seen on day two (IInd count)

which are common with that of day one (based on age, sex composition & location)

$$\begin{aligned} \hat{\beta} &= \frac{163}{179} \\ &= 0.91 \end{aligned}$$

Appendix E1: Encounter rate of animals seen on various transects in Central Division

Transect	distance	time	Hangul	perkm	perhr	Bbear	perkm	perhr	Langur	perkm	perhr	Red Fox	perkm	perhr	Jackal	perkm	perhr	Musk deer	perkm	perhr
1	39.5	46.20	24	10.72	3.14	0.00	0.00	0.00	86.00	12.91	33.68	0.00	0.00	0.00	1.00	0.10	0.16	1.00	0.11	0.19
	38.80	18.15	33.00	4.63	11.36	0.00	0.00	0.00	80.00	11.76	32.65	0.00	0.00	0.00	2.00	0.20	0.47	0.00	0.00	0.00
	40.90	16.85	27.00	4.26	9.76	1.00	0.22	0.43	60.00	7.14	18.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			28.00	6.54	8.09	0.33	0.07	0.14	75.33	10.61	28.36	0.00	0.00	0.00	1.00	0.10	0.21	0.33	0.04	0.06
SD			4.58	3.63	4.36	0.58	0.13	0.25	13.61	3.05	8.34	0.00	0.00	0.00	1.00	0.10	0.24	0.58	0.06	0.11
2	22.9	98.40	12	5.98	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	22.90	58.30	41.00	5.31	4.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	25.70	59.47	29.00	3.49	1.34	2.00	0.24	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			27.33	4.93	1.98	0.67	0.08	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD			14.57	1.29	2.03	1.15	0.14	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	25.98	18.42	5	5.25	0.94	0.00	0.00	0.00	50.00	5.00	8.33	2.00	0.23	0.31	0.00	0.00	0.00	0.00	0.00	0.00
	18.00	12.30	15.00	1.67	2.71	0.00	0.00	0.00	1.00	0.11	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	15.00	12.20	2.00	0.33	0.63	0.00	0.00	0.00	21.00	3.50	6.56	1.00	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00
Avg			7.33	2.42	1.43	0.00	0.00	0.00	24.00	2.87	5.05	1.00	0.11	0.14	0.00	0.00	0.00	0.00	0.00	0.00
SD			6.81	2.55	1.13	0.00	0.00	0.00	24.64	2.50	4.25	1.00	0.11	0.16	0.00	0.00	0.00	0.00	0.00	0.00
4	46.5	30.35	84	16.25	17.68	0.00	0.00	0.00	200.00	14.81	19.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	38.50	18.95	87.00	12.33	24.14	0.00	0.00	0.00	100.00	10.53	24.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	41.50	22.00	79.00	11.64	22.65	0.00	0.00	0.00	300.00	60.00	120.00	0.00	0.00	0.00	1.00	0.20	0.40	0.00	0.00	0.00
Avg			83.33	13.41	21.49	0.00	0.00	0.00	200.00	28.45	54.44	0.00	0.00	0.00	0.33	0.07	0.13	0.00	0.00	0.00
SD			4.04	2.49	3.38	0.00	0.00	0.00	100.00	27.41	56.83	0.00	0.00	0.00	0.58	0.12	0.23	0.00	0.00	0.00
5	24.55	21.10	26	5.75	3.47	0.00	0.00	0.00	50.00	4.63	4.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	16.10	18.00	31.00	7.02	7.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18.00	14.65	17.00	2.48	5.10	1.00	0.14	0.29	55.00	7.86	15.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			24.67	5.09	5.22	0.33	0.05	0.10	35.00	4.16	6.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD			7.09	2.34	1.83	0.58	0.08	0.16	30.41	3.95	8.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	8	3.00	0	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.33	2.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9.50	3.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			0.00	2.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD			0.00	4.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	54.66	35.65	7	2.69	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.15	0.22	0.00	0.00	0.00
	23.83	19.10	14.00	2.01	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	1.07	1.24	0.00	0.00	0.00
	41.50	27.55	9.00	0.57	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.24	0.18	0.00	0.00	0.00
Avg			10.00	1.76	1.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.49	0.55	0.00	0.00	0.00
SD			3.61	1.08	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.46	0.51	0.60	0.00	0.00	0.00
8	44	51.00	0	8.54	0.00	1.00	0.11	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	40.00	37.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	48.00	27.00	0.00	0.00	0.00	0.00	0.00	0.00	37.00	3.85	6.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			0.00	2.85	0.00	0.33	0.04	0.03	12.33	1.28	2.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD			0.00	4.93	0.00	0.58	0.06	0.06	21.36	2.23	3.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	44.92	51.20	12	8.36	1.17	1.00	0.12	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	38.00	43.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	36.00	26.00	0.00	0.00	0.00	1.00	0.10	0.14	12.00	1.38	1.88	1.00	0.13	0.17	7.00	0.88	1.17	0.00	0.00	0.00
Avg			4.00	2.79	0.39	0.67	0.07	0.08	4.00	0.46	0.63	0.33	0.04	0.06	2.33	0.29	0.39	0.00	0.00	0.00
SD			6.93	4.82	0.67	0.58	0.06	0.07	6.93	0.79	1.09	0.58	0.07	0.10	4.04	0.51	0.67	0.00	0.00	0.00
10	44.33	23.65	4	5.42	0.73	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.19	0.37	15.00	1.30	2.48	0.00	0.00	0.00
	46.50	24.90	0.00	0.00	0.00	1.00	0.10	0.19	0.00	0.00	0.00	0.00	0.00	0.00	10.00	1.11	2.00	0.00	0.00	0.00
	44.03	22.60	7.00	0.89	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			3.67	2.10	0.79	0.33	0.03	0.06	0.00	0.00	0.00	0.67	0.06	0.12	8.33	0.81	1.49	0.00	0.00	0.00
SD			3.51	2.91	0.83	0.58	0.06	0.11	0.00	0.00	0.00	1.15	0.11	0.21	7.64	0.70	1.32	0.00	0.00	0.00
Transect	distance	time	koklass	perkm	perhr	Monal	perkm	perhr	Chakur	perkm	perhr	SMartin	perkm	perhr	Leopard	perkm	perhr	PMartin	perkm	perhr

1	39.5	46.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	38.80	18.15	3.00	0.30	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	40.90	16.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			1.00	0.10	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD			1.73	0.17	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	22.9	98.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	22.90	58.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.13	0.02	0.00	0.00
	25.70	59.47	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.24	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.08	0.03	0.00	0.00	0.00	0.33	0.04	0.01	0.33	0.04	0.01
SD			0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.14	0.05	0.00	0.00	0.00	0.58	0.07	0.01	0.58	0.08	0.02
3	25.98	18.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18.00	12.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.22	0.37	0.00	0.00
	15.00	12.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.07	0.12	0.00	0.00
SD			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.13	0.21	0.00	0.00
4	46.5	30.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	38.50	18.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	41.50	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	24.55	21.10	0.00	0.00	0.00	0.00	0.00	0.00	7.00	1.04	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	16.10	18.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18.00	14.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.14	0.29	0.00	0.00
Avg			0.00	0.00	0.00	0.00	0.00	0.00	2.33	0.35	0.32	0.00	0.00	0.00	0.00	0.33	0.05	0.10	0.00	0.00
SD			0.00	0.00	0.00	0.00	0.00	0.00	4.04	0.60	0.55	0.00	0.00	0.00	0.00	0.58	0.08	0.16	0.00	0.00
6	8	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.33	2.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9.50	3.45	6.00	1.20	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			2.00	0.40	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD			3.46	0.69	1.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	54.66	35.65	0.00	0.00	0.00	2.00	0.13	0.24	10.00	0.64	1.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.06
	23.83	19.10	2.00	0.27	0.31	0.00	0.00	0.00	8.00	1.07	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	41.50	27.55	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.58	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.71
Avg			0.67	0.09	0.10	0.67	0.04	0.08	8.33	0.76	1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33	0.26
SD			1.15	0.15	0.18	1.15	0.07	0.14	1.53	0.26	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.21	0.39
8	44	51.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	40.00	37.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	48.00	27.00	0.00	0.00	0.00	0.00	0.00	0.00	154.00	16.04	28.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			0.00	0.00	0.00	0.00	0.00	0.00	51.33	5.35	9.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD			0.00	0.00	0.00	0.00	0.00	0.00	88.91	9.26	16.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	44.92	51.20	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.89	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	38.00	43.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	36.00	26.00	0.00	0.00	0.00	2.00	0.20	0.29	60.00	6.00	8.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			0.00	0.00	0.00	0.67	0.07	0.10	22.67	2.30	3.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD			0.00	0.00	0.00	1.15	0.12	0.16	32.58	3.24	4.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	44.33	23.65	1.00	0.09	0.16	7.00	0.68	1.28	67.00	5.89	11.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	46.50	24.90	0.00	0.00	0.00	37.00	4.38	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	44.03	22.60	0.00	0.00	0.00	0.00	0.00	0.00	48.00	5.80	9.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg			0.33	0.03	0.05	14.67	1.69	3.09	38.33	3.90	6.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD			0.58	0.05	0.09	19.66	2.36	4.30	34.53	3.38	6.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix E2: Encounter rate of animals seen on various transects in South Division

Transect	Distance	Time	Hangul	en/km	en/hr	Muskdeer	en/km	en/hr	Leopard	en/km	en/hr	B. Bear	en/km	en/hr	Jungle cat	en/km	en/hr	Langur	en/km	en/hr
1	56.10	26.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	206.00	11.52	22.92
	57.63	30.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.00	3.30	6.54
	48.16	24.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.00	3.96	7.92
Avg			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	111.00	6.26	12.46
SD			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.24	3.73	7.42
2	48.70	24.00	1.00	0.06	0.13	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.31	0.63	0.00	0.00	0.00	150.00	9.38	18.75
	46.00	23.50	3.00	0.20	0.38	1.00	0.06	0.13	0.00	0.00	0.00	5.00	0.33	0.63	0.00	0.00	0.00	150.00	9.38	18.75
	47.50	23.75	2.00	0.13	0.25	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.13	0.25	0.00	0.00	0.00	180.00	11.35	22.70
Avg			2.00	0.13	0.25	0.33	0.02	0.04	0.00	0.00	0.00	4.00	0.25	0.50	0.00	0.00	0.00	160.00	10.03	20.07
SD			0.82	0.06	0.11	0.47	0.03	0.06	0.00	0.00	0.00	1.41	0.09	0.18	0.00	0.00	0.00	14.14	0.93	1.86
3	83.20	45.39	27.00	1.43	2.77	0.00	0.00	0.00	3.00	0.16	0.31	2.00	0.10	0.19	0.00	0.00	0.00	0.00	0.00	0.00
	94.20	51.24	7.00	0.39	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	94.60	48.48	5.00	0.27	0.50	0.00	0.00	0.00	3.00	0.16	0.30	0.00	0.00	0.00	0.00	0.00	0.00	17.00	0.86	1.72
Avg			13.00	0.70	1.35	0.00	0.00	0.00	2.00	0.10	0.20	0.67	0.03	0.06	0.00	0.00	0.00	5.67	0.29	0.57
SD			9.93	0.52	1.01	0.00	0.00	0.00	1.41	0.07	0.14	0.94	0.05	0.09	0.00	0.00	0.00	8.01	0.41	0.81
4	57.00	26.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.19	0.40	0.00	0.00	0.00	13.00	0.87	1.98
	56.50	29.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.06	0.13	0.00	0.00	0.00	0.00	0.00	0.00
	59.40	28.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.07	0.15	0.00	0.00	0.00	0.00	0.00	0.00
Avg			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.11	0.23	0.00	0.00	0.00	4.33	0.29	0.66
SD			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.06	0.13	0.00	0.00	0.00	6.13	0.41	0.93
5	95.00	47.30	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.06	0.13	3.00	0.20	0.39	13.00	0.79	1.60	0.00	0.00	0.00
	77.60	38.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.17	0.33	6.00	0.50	1.00	0.00	0.00	0.00

Transsect	Distance	Time	Hangul	en/km	en/hr	Muskdeer	en/km	en/hr	Leopard	en/km	en/hr	B. Bear	en/km	en/hr	Jungle cat	en/km	en/hr	Langur	en/km	en/hr
	71.70	35.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.43	0.89	12.00	1.06	2.24	0.00	0.00	0.00
Avg			0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.02	0.04	3.33	0.26	0.54	10.33	0.78	1.61	0.00	0.00	0.00
SD			0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.03	0.06	1.25	0.12	0.25	3.09	0.23	0.51	0.00	0.00	0.00
6	71.70	55.47	2.00	0.10	0.22	3.00	0.16	0.32	7.00	0.37	0.76	0.00	0.00	0.00	0.00	0.00	0.00	22.00	1.17	2.39
	0.00	49.50	0.00	0.00	0.00	3.00	0.18	0.38	2.00	0.12	0.25	0.00	0.00	0.00	0.00	0.00	0.00	56.00	3.41	7.05
	35.85	38.75	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.06	0.12	0.00	0.00	0.00	0.00	0.00	0.00	14.00	1.01	2.02
Avg			0.67	0.03	0.07	2.00	0.11	0.23	3.33	0.18	0.38	0.00	0.00	0.00	0.00	0.00	0.00	30.67	1.86	3.82
SD			0.94	0.05	0.10	1.41	0.08	0.17	2.62	0.13	0.27	0.00	0.00	0.00	0.00	0.00	0.00	18.21	1.09	2.29
7	131.15	45.57	0.00	0.00	0.00	2.00	0.09	0.27	3.00	0.13	0.40	0.00	0.00	0.00	0.00	0.00	0.00	190.00	8.14	25.93
	141.30	43.75	0.00	0.00	0.00	2.00	0.08	0.30	4.00	0.17	0.53	0.00	0.00	0.00	0.00	0.00	0.00	66.00	2.85	9.15
	147.05	45.57	0.00	0.00	0.00	2.00	0.08	0.25	1.00	0.04	0.14	0.00	0.00	0.00	0.00	0.00	0.00	36.00	1.43	4.86
Avg			0.00	0.00	0.00	2.00	0.09	0.27	2.67	0.11	0.36	0.00	0.00	0.00	0.00	0.00	0.00	97.33	4.14	13.31
SD			0.00	0.00	0.00	0.00	0.01	0.02	1.25	0.05	0.16	0.00	0.00	0.00	0.00	0.00	0.00	66.66	2.89	9.09
8	45.00	16.60	0.00	0.00	0.00	3.00	0.13	0.36	3.00	0.13	0.36	0.00	0.00	0.00	0.00	0.00	0.00	32.00	1.42	3.86
	39.60	16.28	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.05	0.12	1.00	0.05	0.12	0.00	0.00	0.00	20.00	1.02	2.46
	43.75	15.80	0.00	0.00	0.00	1.00	0.04	0.12	2.00	0.09	0.25	1.00	0.04	0.12	0.00	0.00	0.00	16.00	0.71	1.93
Avg			0.00	0.00	0.00	1.33	0.06	0.16	2.00	0.09	0.25	0.67	0.03	0.08	0.00	0.00	0.00	22.67	1.05	2.75
SD			0.00	0.00	0.00	1.25	0.06	0.15	0.82	0.04	0.10	0.47	0.02	0.06	0.00	0.00	0.00	6.80	0.29	0.81
9	83.30	28.82	0.00	0.00	0.00	12.00	0.50	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.00	1.23	3.81
	79.80	26.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	3.19	9.11
	79.60	27.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.09	0.28	0.00	0.00	0.00
Avg			0.00	0.00	0.00	4.00	0.17	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.03	0.09	24.67	1.48	4.31
SD			0.00	0.00	0.00	5.66	0.24	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.04	0.13	20.42	1.32	3.74

Avg			200.00	12.60	25.21	2.67	0.17	0.34	16.67	1.06	2.11	15.67	0.98	1.97	0.00	0.00	0.00	158.33	9.99	19.94
SD			70.83	4.17	8.64	1.25	0.08	0.16	7.13	0.48	0.92	5.25	0.31	0.65	0.00	0.00	0.00	61.42	3.71	7.58
3	83.20	45.39	32.00	1.62	3.00	0.00	0.00	0.00	5.00	0.25	0.47	72.00	5.53	8.74	0.00	0.00	0.00	74.00	3.80	7.15
	94.20	51.24	30.00	1.54	2.67	5.00	0.26	0.44	0.00	0.00	0.00	70.00	3.52	6.72	0.00	0.00	0.00	65.00	3.29	6.20
	94.60	48.48	40.00	2.07	4.04	6.00	0.31	0.61	6.00	0.30	0.61	28.00	1.46	2.87	0.00	0.00	0.00	131.00	6.98	13.27
Avg			34.00	1.75	3.23	3.67	0.19	0.35	3.67	0.18	0.36	56.67	3.50	6.11	0.00	0.00	0.00	90.00	4.69	8.87
SD			4.32	0.23	0.58	2.62	0.14	0.26	2.62	0.13	0.26	20.29	1.66	2.43	0.00	0.00	0.00	29.22	1.64	3.13
4	57.00	26.91	15.00	1.15	2.31	1.00	0.06	0.13	0.00	0.00	0.00	6.00	0.44	0.95	0.00	0.00	0.00	75.00	5.26	11.89
	56.50	29.65	15.00	1.11	1.90	1.00	0.07	0.15	0.00	0.00	0.00	3.00	0.21	0.41	0.00	0.00	0.00	31.00	2.24	4.21
	59.40	28.07	5.00	0.36	0.71	0.00	0.00	0.00	5.00	0.29	0.73	5.00	0.38	0.75	0.00	0.00	0.00	22.00	1.41	3.10
Avg			11.67	0.87	1.64	0.67	0.05	0.09	1.67	0.10	0.24	4.67	0.34	0.70	0.00	0.00	0.00	42.67	2.97	6.40
SD			4.71	0.37	0.68	0.47	0.03	0.07	2.36	0.14	0.35	1.25	0.10	0.22	0.00	0.00	0.00	23.16	1.65	3.91
5	95.00	47.30	0.00	0.00	0.00	5.00	0.31	0.63	0.00	0.00	0.00	16.00	1.02	2.04	4.00	0.25	0.50	86.00	5.36	10.78
	77.60	38.50	0.00	0.00	0.00	3.00	0.25	0.50	10.00	0.78	1.58	0.00	0.00	0.00	10.00	0.79	1.58	106.00	7.93	16.04
	71.70	35.00	0.00	0.00	0.00	4.00	0.33	0.67	11.00	0.89	1.87	24.00	2.00	4.00	10.00	0.85	1.75	105.00	8.82	18.28
Avg			0.00	0.00	0.00	4.00	0.30	0.60	7.00	0.56	1.15	13.33	1.01	2.01	8.00	0.63	1.28	99.00	7.37	15.03
SD			0.00	0.00	0.00	0.82	0.04	0.07	4.97	0.40	0.82	9.98	0.82	1.63	2.83	0.27	0.55	9.20	1.46	3.14
6	71.70	55.47	10.00	0.52	1.06	6.00	0.32	0.65	2.00	0.11	0.22	28.00	1.51	3.04	3.00	0.16	0.33	0.00	0.00	0.00
	0.00	49.50	22.00	1.14	2.44	3.00	0.17	0.35	2.00	0.13	0.27	16.00	0.89	1.85	12.00	0.68	1.42	40.00	2.15	4.56
	35.85	38.75	27.00	1.52	3.09	5.00	0.27	0.55	1.00	0.08	0.16	8.00	0.45	0.97	3.00	0.23	0.46	55.00	3.40	7.03
Avg			19.67	1.06	2.20	4.67	0.25	0.52	1.67	0.11	0.22	17.33	0.95	1.95	6.00	0.36	0.74	31.67	1.85	3.86
SD			7.13	0.41	0.84	1.25	0.06	0.12	0.47	0.02	0.05	8.22	0.43	0.85	4.24	0.23	0.49	23.21	1.40	2.91
7	131.15	45.57	180.00	8.47	23.55	7.00	0.33	0.91	0.00	0.00	0.00	27.00	1.21	3.55	1.00	0.04	0.14	0.00	0.00	0.00
	141.30	43.75	230.00	10.22	33.03	7.00	0.30	0.97	0.00	0.00	0.00	33.00	1.46	4.67	4.00	0.16	0.55	0.00	0.00	0.00
	147.05	45.57	50.00	2.09	6.43	5.00	0.20	0.66	0.00	0.00	0.00	18.00	0.74	2.38	4.00	0.17	0.52	9.00	0.34	1.23
Avg			153.33	6.93	21.00	6.33	0.28	0.85	0.00	0.00	0.00	26.00	1.14	3.53	3.00	0.12	0.40	3.00	0.11	0.41
SD			75.87	3.49	11.01	0.94	0.05	0.14	0.00	0.00	0.00	6.16	0.30	0.93	1.41	0.06	0.19	4.24	0.16	0.58
8	45.00	16.60	50.00	2.22	6.02	1.00	0.04	0.12	0.00	0.00	0.00	6.00	0.27	0.72	0.00	0.00	0.00	0.00	0.00	0.00
	39.60	16.28	55.00	2.78	6.76	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.34	0.74	0.00	0.00	0.00	0.00	0.00	0.00
	43.75	15.80	25.00	1.11	3.01	2.00	0.09	0.27	0.00	0.00	0.00	10.00	0.46	1.28	0.00	0.00	0.00	0.00	0.00	0.00
Avg			43.33	2.04	5.26	1.00	0.05	0.13	0.00	0.00	0.00	7.33	0.36	0.91	0.00	0.00	0.00	0.00	0.00	0.00
SD			13.12	0.70	1.62	0.82	0.04	0.11	0.00	0.00	0.00	1.89	0.08	0.26	0.00	0.00	0.00	0.00	0.00	0.00
9	83.30	28.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	79.80	26.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.17	0.44	4.00	0.21	0.60	65.00	3.13	9.69
	79.60	27.90	35.00	1.46	4.38	0.00	0.00	0.00	1.00	0.09	0.18	0.00	0.00	0.00	1.00	0.09	0.18	0.00	0.00	0.00
Avg			11.67	0.49	1.46	0.00	0.00	0.00	0.33	0.03	0.06	0.67	0.06	0.15	1.67	0.10	0.26	21.67	1.04	3.23
SD			16.50	0.69	2.06	0.00	0.00	0.00	0.47	0.04	0.09	0.94	0.08	0.21	1.70	0.09	0.25	30.64	1.47	4.57

Appendix G. Population estimate of hangul over the years

Year	Time	Min	Max	Reference
1900	0	3000	5000	Gee, 1965
1940	40	3000	3000	Gee, 1965
1947	47	1000	2000	Deptt. Of Wildlife Protection
1954	54		300	Gee, 1965
1957	57		400	Gee, 1965
1958	58		550	Deptt. Of Wildlife Protection
1960	60		250	Gee, 1965
1962	62	175	200	Gee, 1965
1965	65	160	280	Gee, 1965
1968	68	180	384	Deptt. Of Wildlife Protection
1969	69	150	200	Schaller, 1969
1970	70	140	170	Halloway, 1971
1972	72	175	200	Deptt. Of Wildlife Protection
1975	75		200	Deptt. Of Wildlife Protection
1977	77		250	Kurt, 1977
1978	78		320	Deptt. Of Wildlife Protection
1980	80	315	380	Deptt. Of Wildlife Protection
1982	82	390	470	Deptt. Of Wildlife Protection
1983	83	440	525	Deptt. Of Wildlife Protection
1984	84	505	605	Deptt. Of Wildlife Protection
1986	86	605	725	Deptt. Of Wildlife Protection
1987	87	680	815	Deptt. Of Wildlife Protection
1988	88		818	Deptt. Of Wildlife Protection
1992	92	120	140	Deptt. Of Wildlife Protection
1994	94	170	200	Deptt. Of Wildlife Protection
1995	95		290	Deptt. Of Wildlife Protection
1996	96		338	Deptt. Of Wildlife Protection
1997	97		373	Deptt. Of Wildlife Protection
1998	98		360	Deptt. Of Wildlife Protection
1999	99	270	325	Deptt. Of Wildlife Protection
2000	100	350	470	Deptt. Of Wildlife Protection
2001	101	372	483	Deptt. Of Wildlife Protection
2002	102	375	500	Deptt. Of Wildlife Protection
2003	103	170	195	Deptt. Of Wildlife Protection