EXPEDITION SNOW LEOPARD 1992

FIELD STUDY IN

SHEY-PHOKSUNDO NATIONAL PARK

by Anders Priemé & Bo Øksnebjerg

A World Wide Fund for Nature (WWF) report submitted to His Majesty's Government of Nepal, the Department of National Parks and Wildlife Conservation, Kathmandu, September 1992.

WWF

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by Anders Priemé & Bo Øksnebjerg
c/o WWF-Denmark
Ryesgade 3F
2200 Copenhagen N
Denmark

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SUMMARY.

From March 27 to May 17 1992 700 km^2 of Shey-Phoksundo National Park were surveyed for wildlife, vegetation and human impact on the environment. The survey was carried out for World Wide Fund for Nature - Denmark in cooperation with the Department of National Parks and Wildlife Conservation (DNPWC), Kathmandu.

Within its 3555 km2 Shey-Phoksundo N.P. holds a unique wilderness of Himalayan and trans-Himalayan habitats. The national park is a stronghold for several globally endangered mammals including the magnificent snow leopard (*Panthera uncia*).

We estimate that 5-7 snow leopards frequent the study area giving a tentative density of 1 individual per 100-140 km^2. The snow leopards main prey in the study area is bharal (*Pseudois nayaur*). The average density of bharal was found to be 1.4 individual per km^2.

26 species of birds including the rare wood snipe (*Gallinago nemericola*) were recorded for the first time within the national park bringing the total recordings in the national park up to 173 species of birds.

Livestock grazing is intense in all parts of the study area. Vegetation analysis showed similar grazing intensities in two surveyed valleys, Pani Palta Khola and Garpung Khola. Grazing by domestic yaks and goats is in direct competition with the wild herbivores like bharal. It is likely that livestock grazing has already displaced bharals in some areas and that intensified livestock grazing will displace more bharals. Any displacement of bharals is likely to affect the local population of snow leopards.

We suggest that numbers of livestock grazing within the national park are monitored, especially in the southern (Himalayan) part of the national park. In the northern (trans-Himalayan) part livestock numbers are more likely to be in accordance with the carrying capacity of pastures and in this part man and wildlife seem to co-exist.

We also suggest that the DNPWC in cooperation with an international donor promotes income-generating activities in the Himalayan part of the national park and in the villages just outside the park to create an alternative to livestock for the local people.

All people within the national park are dependent on fuelwood and some areas like Jagdula Khola suffer from forest degradation. In order to reduce the pressure on existing forests we suggest that simple heat-efficient stoves are introduced in all villages within and just outside the national park. We also suggest that kerosene stoves are installed in national park and army posts.

Generally, hunting is not a severe problem within the national park, but in Jagdula Khola trapping of musk deer (*Moschus moschiferus*), Himalayan Monal (*Lophophorus impeyanus*), and bharal is quite widespread. Intensified patrolling of army and national park staff in the remote parts of Jagdula Khola would probably reduce trapping.

The northern part of the national park is currently restricted to tourists. We expect that tourism will have severe impacts on the fragile trans-Himalayan ecosystems found there. We suggest that a detailed study on the impact of tourism is conducted before any area in the trans-Himalayan part of the national park is opened to tourists. This study should also include socio-economic impacts.

To reduce the impact of existing tourism we suggest that park regulations prohibit the collection of waste wood by tourist groups and thus demand these groups to be wholly self-sufficient in fuel.

The DNPWC has very limited financial resources. We suggest the department to take contact to one or several international development agencies which are able to finance the implementation of the recommendations from this and other studies.

ABSTRACT.

Wildlife, vegetation, and human impact were studied in 700 km^2 of Shey-Phoksundo National Park, western Nepal. Average population densities of snow leopard (*Panthera uncia*) and of bharal (*Pseudois nayaur*) in the study area are estimated to 1 individual per 100-140 km^2 respectively 1.4 km^2. 26 species of birds were recorded for the first time within the national park. Heavy, though not destructive, grazing by livestock is found in many places within the study area. In some areas an intensified grazing by livestock is likely to displace wild herbivores and consequently the local snow leopards. A light to medium degree of forest degradation is taking place. Other conservation issues like hunting and tourism are also discussed and recommendations for the future management of the national park are proposed.

FOREWORD.

The study was carried out for World Wide Fund for Nature (WWF) Denmark in cooperation with His Majesty's Government, the Department of National Parks and Wildlife Conservation (DNPWC), Kathmandu. The study was financed by WWF-Denmark thanks to a very generous donation from the Beckett Foundation.

We would like to thank the following persons, institutions, and authorities, who/which helped and supported us during the study. The study could not have been successful without any of them:

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1. PROJECT DESCRIPTION.

1.1. Objectives.

The primary objective of this project is to provide biological data from parts of Shey-Phoksundo National Park to be used by the Department of National Parks and Wildlife Conservation (DNPWC), Kathmandu, to carry out a management plan for the national park. As the national park is supposed to be a stronghold for the snow leopard (*Panthera uncia*) in Nepal and are thought to represent the area where the species stands the best chance for longterm survival in Nepal, parts of the field work concentrate on the status of this species and the threats to its habitat.

The objectives of the project is to carry out the following activities in cooperation with the DNPWC in Kathmandu:

1. Collect detailed information on the major herbivores regarding population densities, herd structure, and habitat choice,

2. collect information on the snow leopard regarding estimates of population densities,

3. collect detailed information on all species of mammals and birds in order to up-date the species-list for the national park,

4. collect information on vegetation type and quality,

5. collect information on the human impact on wildlife and vegetation, and

6. develop recommandations in cooperation with the DNPWC for the longterm management of the surveyed parts of the national park.

1.2. Justification.

The snow leopard is a rare species with a world population numbering perhaps only a few thousands (Green, 1987). But generally very little data exist on its status. If we are not to loose this magnificient cat appropiate measures to secure the cat and its remote mountain habitat are badly needed.

Shey-Phoksundo National Park is one of the very few protected areas in the Himalaya big enough to secure a viable population of snow leopards on a long-term basis. But the national park is remote, little-known, and generally considered under pressure from a steadily growing population of subsistence farmers and their livestock.

A supposedly increasing number of livestock espcially in the southern part of the national park might push the carrying capacity of alpine pastures to their limit and hence displace the native blue sheep (*Pseudois nayaur*) and himalayan tahr (*Hemitragus jemlahicus*) which is expected to form the major prey of the resident snow leopards.

1.3. Background information.

His Majesty's Government of Nepal showed great foresight when it gazetted Shey-Phoksundo National Park in 1984. Comprising 3555 km^2 of rugged mountains covering an altitude from 2200 to 6800 meter Shey-Phoksundo National Park is the biggest national park in Nepal. The national park now protects a unique wilderness of Himalayan and trans-Himalayan habitats with a fairly unspoilt fauna including a viable population of snow leopards.

Situated in the generally dry western part of Nepal and partly in shadow of the great Dhaulagiri Range and the Kanjiroba Himal the national park receives only little rainfall - less than 1000 mm annually.

The Kanjiroba Himal divides the national park into a southern Himalayan part and a northern trans-Himalayan part. South of the Kanjiroba Himal the landscabe is typical of the high Himalaya with steep mountain sides and deep valleys. In the southernmost parts of the national park different kinds of forests flourish: E.g. in Jagdula Khola forests of blue pine (*Pinus wallichiana*) and evergreen oak (*Quercus semecarcipolia*), and along Suli Gad River mixed deciduous forests. But the dominant habitat in the Himalayan part is alpine meadows.

The landscape north of the Kanjiroba Himal is typical of the trans-Himalayan or Tibetan region. This part receives very limited rainfall which allows only a steppe or desert-like society of *Caragana sp.* and dwarf juniper (*Juniperus sp.*) to survive.

About 2000 people live within the park mainly as subsistence farmers and herders. But the national park is also used by villagers outside the park as grazing ground for their livestock. Furthermore, a number of soldiers are stationed within the park mainly at Sumduwa Army Checkpost. In May 1989 the southern part of the national park was opened to foreigners and since then an increasing number of tourists has visited the national park.

Only little biological work has been done on Shey-Phoksundo National Park and its wildlife. The work is restricted to the studies by Dr. George B. Schaller in the southwestern part of the national park (Schaller, 1977, 1980), by Rodney Jackson and Gary Ahlborn in Langu Valley in the northwestern corner (Jackson, 1979b; Jackson & Hillard, 1986; Ahlborn & Jackson, 1988; Jackson & Ahlborn, 1988, 1989), and by Dr. Pralad Yonzon in the eastern part, together with the data collected by the DNPWC.

1.4. Execution of the study.

The study was carried out in spring 1992. We worked in the southern part of the national park focusing on the south-western part which was unexplored by biologists. We started the field work when arriving at Toijam Rangerpost on March 27. From March 30 to May 2 Senior Game Scout Sakka Bahadur Rokaya and Game Scout Dhayr participated in the field work. From May 3 to May 6 Chief Warden Lal Bihari Yadav joined the expedition while Game Scout Dawa Tenzing joined the expedition from May 3 to May 15. The field work was completed on May 17.

The following camp sites were used during the field work (also see map on figure 1):
Toijam Rangerpost (27/3-3/4), Jagdula Khola (5 km up-stream from Toijam Rangerpost) (3-6/4), Pani Palta Khola (6-15/4), Toijam Rangerpost (15-17/4), Garpung Khola (5 km up-stream from Toijam Rangerpost) (17-20/4), Garpung Khola (below Kagmara La) (20-25/4), Pungmi Khola (3 km upsteam from Daju summer village) (26/4-1/5), Palam Park Head Quarter (2-4/5), Ringmo (4-6/5), Phoksundo Khola (6-7/5), south of Kanga La (7-8/5), Shey (8-11/5), north of Kanga La (11-12/5), north end of Phoksundo Lake (12-13/5), Ringmo (13-15/5), Régi (15-16/5), Ankhe Check Post (16-17/5).

A total of approximately 700 km^2 were surveyed, but due to logistic problems in Pungmi Khola and time limitations in Shey (our permit to the restricted area north of Phoksundo Lake was valid for one week only) we had to limit our work in these areas and thus exclude plant and snow leopard transects.

Originally it was planned to work further up the Jagdula Khola than the Pani Palta Khola but contrary to the information provided by our trekking agency it proved too difficult to venture further on than Pani Palta Khola where the last trail stops.

Generally, the weather was amazingly bad during the whole study period. About every third day snow fall combined with very restricted visibility stopped any attempt to do field work. Night temperatures dropped to minus 30°C in the initial phases of study and to a more "moderate" minus 16°C as late as May 11.

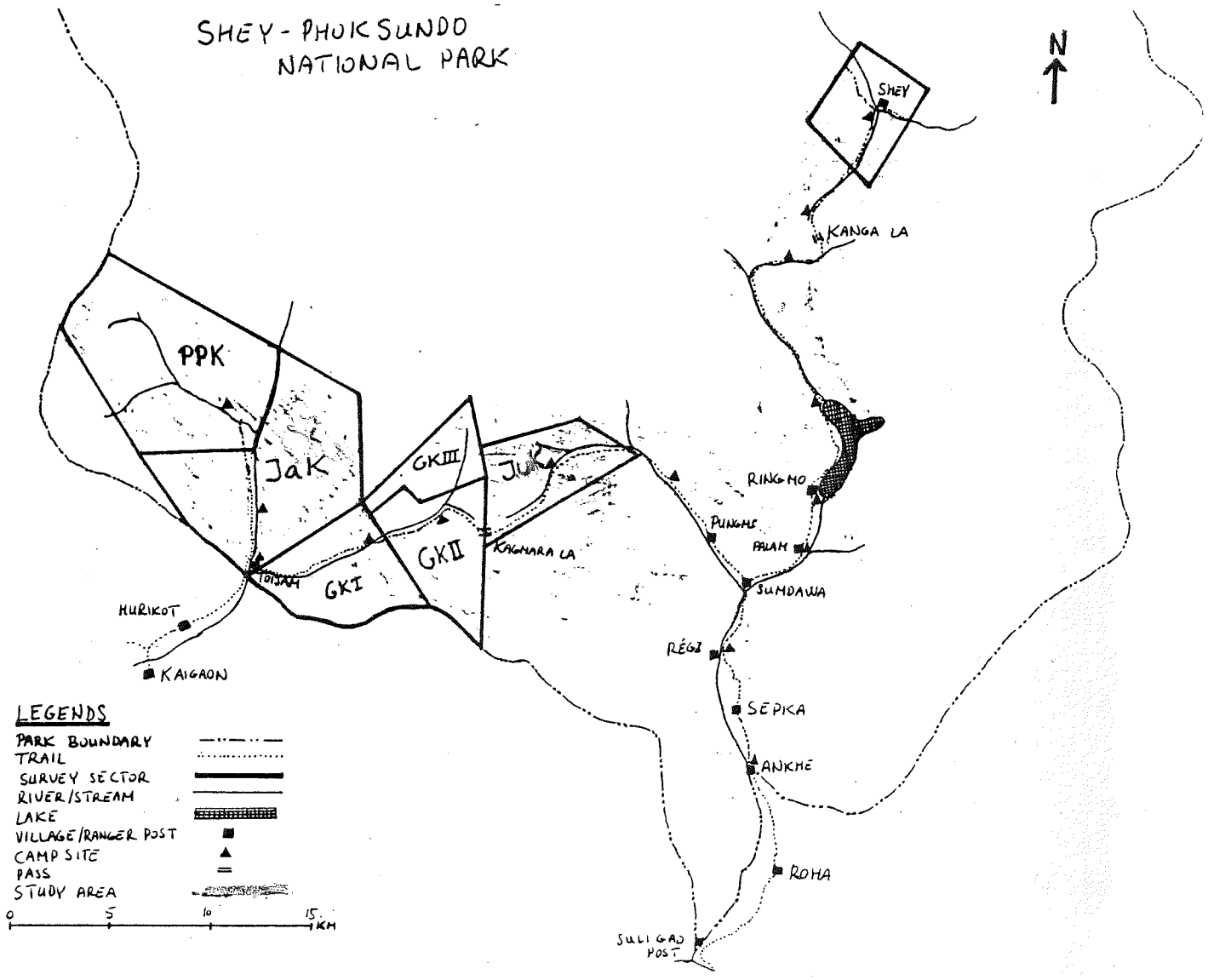

Figure 1: Map showing the study area including thouroughly surveyed areas (survey sectors). Survey sectors: PPK=Pani Palta Khola, JaK=Jagdula Khola, GKI+GKII+GKIII=Garpung Khola Sector I-III, JuK=Julung Khola.

1.5. Public awareness.

Parallel to the field work we have launched a publicity campaign in Denmark involving pressconferences, articles to popular magazines, public speeches etc. The publicity campaign is launched in cooperation with World Wide Fund for Nature (Denmark) and will use the snow leopard as a symbol of the threatened mountain ecosystems of the Himalaya.

2. METHODS.

2.1. Major herbivores.

All mountain slopes in main valleys, side-valleys, as well as all accesible plateaus in the vicinity of our route was inspected by 10x42 binoculars and 20x/40x spotting scope for all major herbivores. Observation distance varied from 300 meter to 3 km, except in Shey area where the blue sheep could be approached as close as 5-20 meters.

The age and sex composition of the herds of blue sheep were classified based on the criteria presented by Wilson (1981) into:
- Class III males: Fully adult males usually older than seven years, with horns curving noticeably backwards at an estimated length of 45 to 50 cm.
- Class II males: Slightly smaller males at an age of 4-6 years, with horns curving slightly backwards and horn length varying from 30 to 45 cm.
- Class I males: Small males, two or three years old, with a horn length between 15 and 35 cm.
- Adult females.
- Yearlings.
- Last-year lambs.

All observations of major herbivores are related to altitude (measured by Thommen Classic altimeter - 0-6000 meter), degree of slope (5° intervals measured by Silva Ranger Type 15 compass), aspect (45° intervals measured by Silva Ranger Type 15 compass), and habitat type.

Habitat type is classified into three major categories:
A) Grass covered meadows,
B) distinctly undulated or broken terrain, including ravines and gulleys, and
C) precipitous cliffs.

Category A) and B) are subdivided into:
1) Slopes with less than 25% rock and boulder cover,
2) slopes with 25 to 75% rock and boulder cover, and
3) slopes with more than 75% rock and boulder cover.

Category C) is not subdivided into further categories.

2.2. Survey for signs of snow leopard activity.

As the snow leopard is notoriously shy, nocturnal, well-camouflaged and rare, it is extremely time-consuming to reliably estimate the number of snow leopards in a given area (see e.g. Jackson & Hillard, 1986; Ahlborn & Jackson, 1988; Jackson & Ahlborn, 1988, 1989).

On the other hand, a tentative estimate of snow leopard density can be determined from a survey for scrapes, footprints and other signs of snow leopard activity. This method, which has been developed by Ahlborn and Jackson (1988) is described by Fox (1989) and has previously been used in e.g. Indian Himalaya (Fox et al., 1988).

During the whole expedition period we made a long-distance survey and recorded all signs of snow leopard activity. In a few places we looked along transects for signs of snow leopard activity. Transects were 250 meters long and were typically situated along valley bottoms. Along these transects a thorough search for snow leopard signs was made within a 10 meter wide belt.

The transects were divided into four categories:
1) Transects along valley bottoms,
2) transects which are located along well defined ridgelines that divides perennial stream watersheds,
3) transects located along ridges which can not be classified as either major ridge or confluence transects, and
4) other types of transects.

At 50 meters intervals the transects were categorized by habitat variables. Habitat variables noted were: Terrain slope angle (5° intervals), aspect (45° intervals), distance from cliffs or other breaks in the terrain, vegetation type from five Raunkiær rings (see chapter 2.4.), percent ground covered by vegetation (no vegetation, less than 10%, 10-50%, 50-90%, more than 90%, from five Raunkiær rings), and meter ground covered by rocks along the transect line.

Factors like livestock presence and abundance, weather conditions, and the prevalence of protected scrape locations (e.g. under rock overhangs) which influence sign longivity were also noted.

2.3. Other mammals and birds.

All mammals and birds observed were recorded and related to location, altitude, and habitat type.

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2.3. Other mammals and birds.

All mammals and birds observed were recorded and related to location, altitude, and habitat type.

2.4. Assessment of vegetation type and quality.

Three types of vegetation analysis were carried out:
1) An analysis for vegetation type,
2) an analysis for percent ground covered by vegetation, and/or
3) an analysis for the quality of the vegetation.
All analysis, except analysis involving trees, were carried out with the use of Raunkiær rings (according to Vestergaard *et al.*, 1988), which are 0.1 m^2 metal rings. The principle of the Raunkiær ring is to throw the ring in a random manner in the survey area and then note the appropiate data from the plants completely or partially covered by the ring. This has to be repeated as found appropiate for the study involved.

Forest habitat: At a preselected altitude a transect is made. 50 trees or tree stumps within 2.5 meter of the transect line is investigated. Any woody plant with a diameter at breast height (dbh.) of more than 5 cm is defined as a tree. The following is noted: Species, dbh. (more or less than 20 cm), and quality of the tree. The quality of each tree is measured by rating the trees:
4= Totally felled tree leaving only the cutover stump, or tree burned down.
3= Severely damaged tree with signs of more than 15 minor branches or more than one major branch removed by cutting, or with severe signs of burning.
2= Damaged tree with 5-14 minor branches or one major branch removed by cutting, or with minor signs of burning.
1= Lightly damaged tree with 1-4 minor branches removed by cutting, and no signs of burning.
0= Tree with no apparent signs of cutting or burning.

For each transect a Coefficient of Deforestation (CD) is computed as the average rating of the trees. The CD estimates the extent of tree-cutting and burning cumulated during the previous years as the fragments left on the tree after a branch has been cut off can easily be seen from one to several years after the cutting has taken place. Likewise, the stump of a felled tree or the remains from burnings can be observed for several to many years.

The following parameters are also noted: Length of transect, total length of cliffs or rocks along the transect line, slope, aspect, altitude, and distance from nearest man-made trail.

Parallel to the tree analysis an analysis of the understorey of the forest is made on the basis of data from 25 Raunkiær rings put at an equal interval along the transect. The vegetation in each ring is classified according to the dominant lifeform within the ring: Herbs, grasses/sedges, mosses, half bushes, bushes, or no vegetation within the ring. The total vegetation cover in each ring is noted as: no vegetation, less than 10% cover, 10-50% cover, 50-90% cover, or more than 90% cover.

The quality of bushes (defined as woody plants with dbh.<5 cm) in the forest understorey is measured by rating the bushes according to the following categories:
0= Bushes with no indications of livestock grazing or burning.
1= Bushes with clear indications of livestock grazing or burning.
2= Bushes burned or cut completely down.

A Quality Coefficient (QC) is computed from the rating of the bushes. As bushes were often few in each transect, QD for bushes were only computed as an average of all bushes within a survey sector or a subdivision of a sector.

Scrub habitat and meadows: The procedure involves 25 Raunkiær rings which are put out at a 3 meter interval along a transect at a preselected altitude. The data from the rings are classified as the data from the forest understorey (see above).

When this method is applied on slopes excluding rocks, cliff, scree, and trails the ground covered with vegetation gives a tentative estimate of the quality of the meadow (because non-vegetated areas are supposed to have resulted from livestock trampling and/or over-grazing by livestock). This method is not applicable in very dry or desert-like areas as in trans-Himalayan habitat.

2.5. Human impact.

Our own observations on the human impact are supplemented by interviews with local villagers/village spokesmen. The interviews typically involve the following questions:
- how much livestock (specified on species) are owned by the villager/whole village?
- approximately how much livestock (specified on species) did the villager/whole village owe 2, 5, and 10 years ago?
- where and when do the livestock (specified on species) graze?
- when and from where do the villager/village collect fodder for the livestock?
- is there any complaints about traditional grazing areas not being as good today as in past years?
- are their any attacts on livestock by predators? If yes, specify livestock species, presumed predator, and annual loss in number of livestock and lost value.
- has there been any recent sightings of snow leopards? Is there more, the same, or less sightings of snow leopards today than in past years?

Besides the data from the interviews we will make notes on livestock observed away from villages.

3. RESULTS AND DISCUSSION.

3.1. Mammals.

3.1.1. Snow leopard.

Sign surveys: The long distance sign survey and the sign transects were in many places hampered by snow cover and/or by livestock trampling. Mainly because of the snow cover but also because of time limitations (in Phoksundo Khola and Shey) we only did very few sign transects.

Long-distance survey: Signs of snow leopard activity were found in four locations: Pani Palta Khola, Kagmara La, Phoksundo Khola, and Shey. Table 1 and 2 summarize the frequency of snow leopard signs in these areas.

Survey sector	Km of survey	Scrapes per km	Scats per km	Track sets per km	Signs per km
Pani Palta Khola	19	0.053	0.11	0	0.16
Kagmara La	6	0	0	0.17	0.17
Phoksundo Khola	7	0.86	0.71	0.71	2.29
Shey	12	1.17	1.00	0.75	2.92
Other areas	80	0	0	0	0
Total	124	0.17	0.15	0.12	0.44

Table 1. Frequency of snow leopard signs in the different survey sectors.

Pani Palta Khola: Besides the single individual we heard (see later "Notes on possible hunting technique") the following signs were found when walking 19 km along the valley bottom: Three scates and one scrape. But the sign survey was hampered by snow covering about 70% of the valley bottom, thus hiding old scrapes and scats. Thus, the snow free survey distance is only 5.7 km.

From the above observations we estimate that one, or maybe two, snow leopards frequent Pani Palta Khola but it is likely that this or these snow leopard(s) are not resident.

Kagmara La: One set of fresh footprints was found in the deep snow just below Kagmara La at 4950 meter. No other signs of snow leopard activity was found in neither Garpung Khola nor Julung Khola. Thus, we expect that the footprints were made by a transient individual.

Survey sector	Snow cover along route (%)	Snow free survey (km)	Scrapes per snow free km	Estimated number of snow leopards
Pani Palta Khola	70	5.7	0.18	1-2
Kagmara La	95	0.30	0	0-1
Phoksundo Khola	0	7	0.86	2
Shey	0	12	1.17	2
Other areas	40	48	0	0
Total	59	73	0.29	5-7

Table 2. Frequency of snow leopard signs in snow free terrain in the different survey sectors. The number of snow leopards is estimated from the sign survey as well as from interviews with local villagers.

Phoksundo Khola: A total of 16 signs were found in Phoksundo Khola. The total frequency of all types of signs is 2.3 per km surveyed. The frequency of scrapes per km travelled in snow free conditions is 0.9. This is somewhat lower than found by Fox *et al.* (1988) in central Ladakh, India, but higher than the frequencies found by the same authors in three other places in Indian Himalaya.

It is very difficult to compare frequencies from different studies as factors like time of year (which can affect snow leopard scraping frequency (Fox *et al.*, 1991), livestock presence, and weather conditions must be considered in evaluating the frequencies. In addition, the combination of terrain geomorphics and path loaction may determine whether the actual travel route coincides with the travel routes and marking sites for snow leopards.

Still, the order of magnitude in differences in sign frequency often suggest real differences in snow leopard presence. Thus, on the basis of the high frequency of signs we estimate that two snow leopards frequent Phoksundo Khola probably on a regular basis.

Shey: The highest frequency of signs were found in this location. A single individual actually used the area during our stay as fresh tracks were encoutered on a several occasions. From the high frequency and from the interviews with the local lamas we estimate that two snow leopards frequent Shey. Even though the lamas often see snow leopards, we presume that none of the two snow leopards are wholly resident at Shey. This is also the conclusion made by Schaller (1980) from his study in 1973.

Sign transects: We made sign transects in Pani Palta Khola and Garpung Khola. In Pani Palta Khola we did six transects: One along a minor ridgeline (altitude 3850-3910 meter, slope 40-60° (avg. 49°), aspect E, eight meter cliff or rock per 250 meter transect line, 17 meter to nearest cliff or rock outcrop, and 53.3% vegetation ground cover on alpine meadow consisting of 40% grass and 40% bushes) and five transects on the valley bottom (altitude 3800-3940 meter, slope 10-60° (avg. 36°), aspect S, no cliffs along transect line, >50 meter to nearest cliff or rock outcrop, and 58.4% vegetation ground cover on alpine meadow consisting of 44% grass and 36% herbs).

In Garpung Khola (above Toijam Rangerpost) we made two transects along a hillside (altitude 3150-3210 meter, slope 25-65° (avg. 41°), aspect S, no cliffs along transect line, avg. 4 meter to nearest cliff or rock outcrop, and 66.8% vegetation ground cover on alpine meadow consisting of 68% grass).

Along none of the above-mentioned transects did we find any signs of snow leopard activity.

Population density: On the basis of our sign surveys and from the interview with villagers we estimate that 5-7 snow leopards frequent the surveyed areas (which amount to about 700 km^2 - see table 2). Although these snow leopards probably also use areas outside the surveyed locations a tentative snow leopard density of 1/100-1/140 km^2 is suggested.

This density is comparable to some other estimates of snow leopard densities: Schaller (1977) estimated 1/80 km^2 i Shey and Phoksundo; Schaller *et al.* (1988b) suggest a general snow leopard density of 1/100 km^2 in better-than-average areas in western China; and Fox *et al.* (1991) give 1/110 km^2 for relatively good snow leopard habitat in Ladakh, India.

Our estimated overall density of snow leopards probably covers great differences among the surveyed parts of the national park: From probably no snow leopards e.g. along Suli Gad River to a probable high density around Shey and Phoksundo Khola. But the high density areas probably do not have as high densities as the maximum densities estimated in areas of prime habitat like 1/10-1/20 km^2 in Langu Gorge (Jackson & Ahlborn, 1988); 1/23 km^2 in Nar-Phu area in central Nepal (Sherpa & Oli, cited in Jackson & Ahlborn, 1989); up to 1/23 km^2 in central Tien Shan, Kirgizia (Spitzin & Koshkarev, 1988); up to 1/25-1/50 km^2 locally in Ladakh, India; and up to 1/25-1/35 km^2 in some areas of western China (Schaller *et al.*, 1988b).

Snow leopard density may also be estimated on the basis of wild ungulate density and the estimate that mountain ungulate populations of about 200-250 individuals are required to support one adult snow leopard on an annual basis (Schaller, 1980; Wemmer & Sunquist, 1988; Jackson & Ahlborn, 1989).

Bharal is by far the most common wild ungulate in the surveyed area. Extrapolating the average ungulate density of 1.4 ungulates per km^2 in the thouroughly surveyed areas (see table 3) to all the surveyed areas gives a total of 980 ungulates. This restricts total snow leopard population to 4-5 individuals and the density to 1/140-1/180 km^2.

However, as Schaller *et al.* (1988b) point out, smaller mammals such as marmots (*Marmota spp.*) can contribute as much as 30% of the annual requirements of a snow leopard. Where marmots are abundant as in Shey, where Schaller (1977) found remains of marmots in 31% of snow leopard droppings, and constitute a significant proportion of snow leopard diet, the number of wild ungulates needed to support a snow leopard is consequently lowered.

Livestock must also be considered as diminishing snow leopard dependence on wild ungulates (see e.g. Schaller, 1977). On the basis of interviews with local villagers and herders we suspect that livestock make up only a small part of the snow leopard diet in the surveyed areas. If wild ungulates were required for estimated 70% of the snow leopard diet (see Fox *et al.*, 1991) the predicted snow leopard density becomes 1/100-1/125 km^2 which compares well to the density estimated from the sign surveys.

These figures, though, do not take into acconut the competition from other large predators, mainly wolves (*Canis lupus*) in Shey, and leopard (*Panthera pardus*) in e.g. Jagdula Khola, which often have a diet similar to that of snow leopards (Schaller, 1977; Schaller *et al.*, 1988a, 1988b).

<u>Notes on possible hunting technique:</u> In Pani Palta Khola a single snow leopard was heard on the night of April 6 10-15 meter from our camp site. This snow leopard had just killed a full-grown yak by chasing it down a small vertical cliff. However, two dogs owned by the herders detected the killing and managed to chase off the snow leopard after a heavy fight.

This incidence might be coupled to the finding of two bharals presumably killed by a snow leopard (snow leopard scats were found at both kills). The bharals were found on the stony valley bottom of Pani Palta Khola at the base of near-vertical cliffs above which excellent bharal terrain are found and several bharal herds were observed. It can be speculated if the local snow leopard(s) in Pani Palta Khola deliberately tries to chase bharals (and yaks) down deadly cliffs.

Koshkarev (1988) describes a hunt in some respects similar to the expected hunting events described above. Koshkarev describes an incident where an adult ibex (*Capra ibex*) is deadly injured when falling down a steep during an attempt to escape a snow leopard. After the fall the snow leopard easily walks to its "kill".

3.1.2. Bharal.

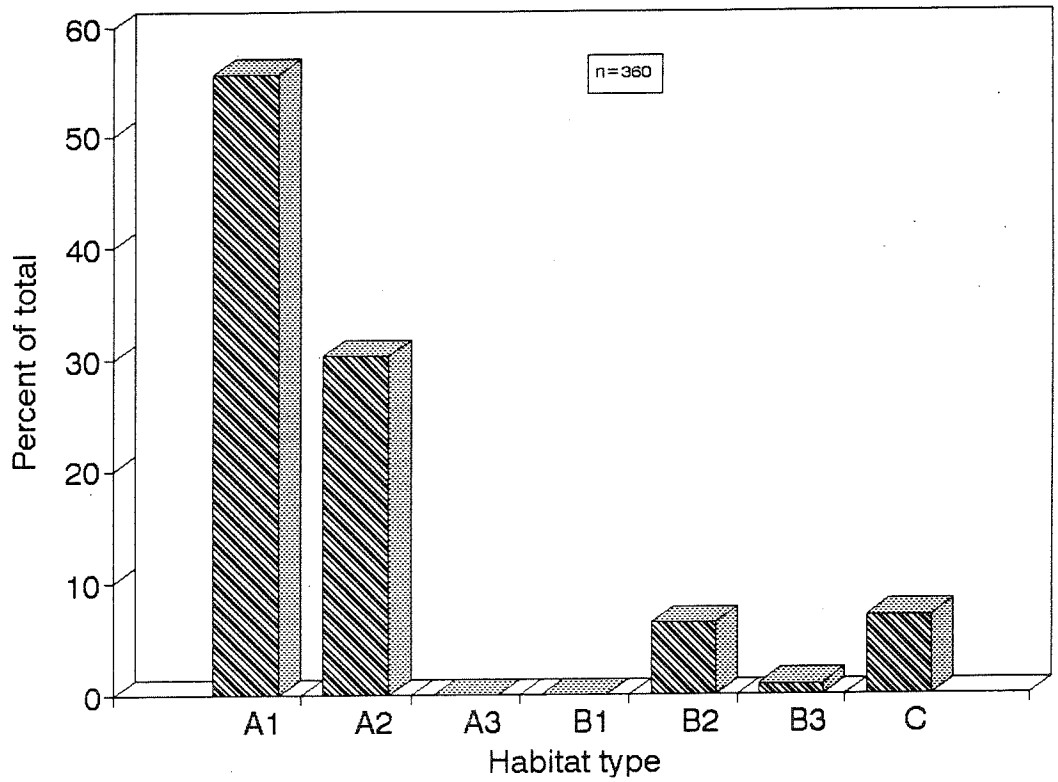

Figure 2: Distribution of bharal observations across seven habitat types.

Habitat utilization: A1 and A2 habitats (see chapter 2.1. for explanation on habitat categories) are preferred by bharals (fig. 2). The distribution of bharal observations across the seven habitat types compares well with the distribution found by Wilson (1981) in similar habitat in the present Dhorpatan Hunting Reserve except for the A2 and B1 habitat types which are found at a lower respectively higher frequency by Wilson.

The majority of feeding observations were in A1 and A2 habitats while B2, B3, and C habitats were important as bedding sites.

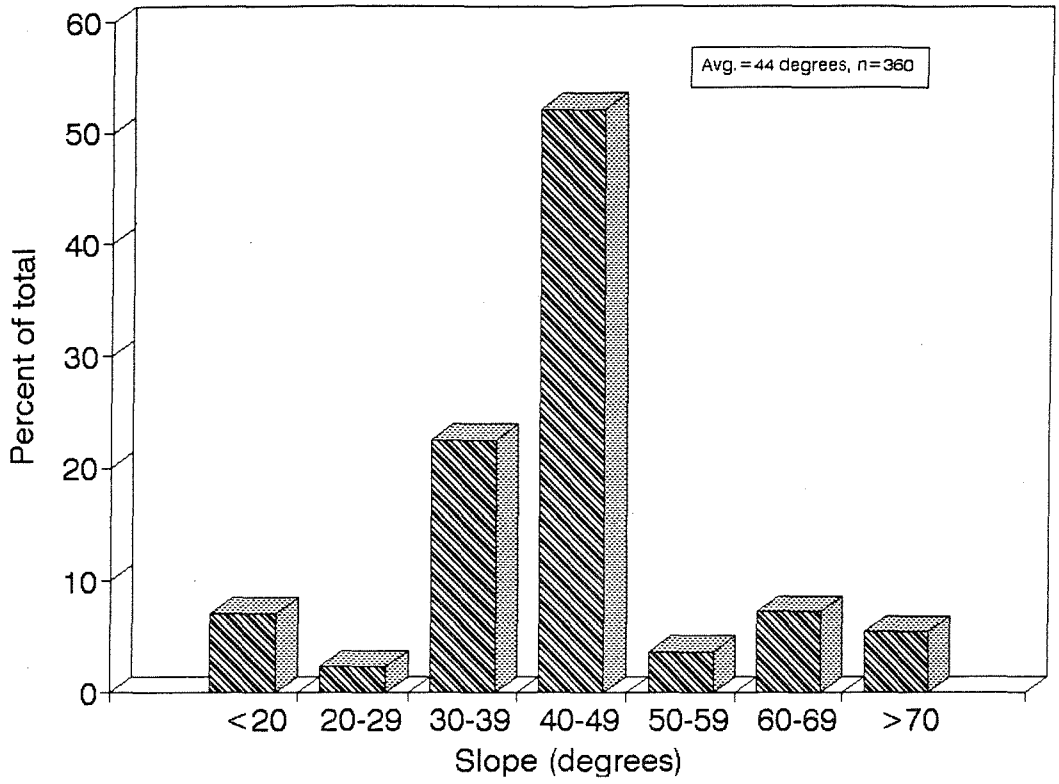

Figure 3: Distribution of bharal observations according to steepness of slope.

Slope: Figure 3 shows the distribution of bharal observations across seven classes of slope steepness. The data indicate that bharals prefer medium (30-49°) compared to gentle (<30°) and steep (>50°) slopes. The steep slopes are usually used as a method of escape or when moving to other grazing areas.

Aspect: Figure 4 illustrates the seasonal distribution of bharals according to aspect. During April and May bharals show a preference for slopes facing south, southwest, and southeast (82.5% of all observations). After the heavy snows during the previous winter the slopes with southerly aspects were the first to experience snow free conditions.

Wilson (1981) also found a preference for southerly aspects during April and May (53.9% of his April-May observations), while Wegge (1976) reported 89% of his March-April observations on slopes with southerly aspects. Thus, during April and May the bharals seem to move from southerly aspects to east-facing slopes and to a lesser extent to west-facing slopes.

The strong preference for slopes with a southerly aspect during early spring indicates that these slopes could be important for the bharals during this time of year, especially after a winter with heavy snowfall. After severe winters the availability of snow free grazing grounds could be critical to bharal survival.

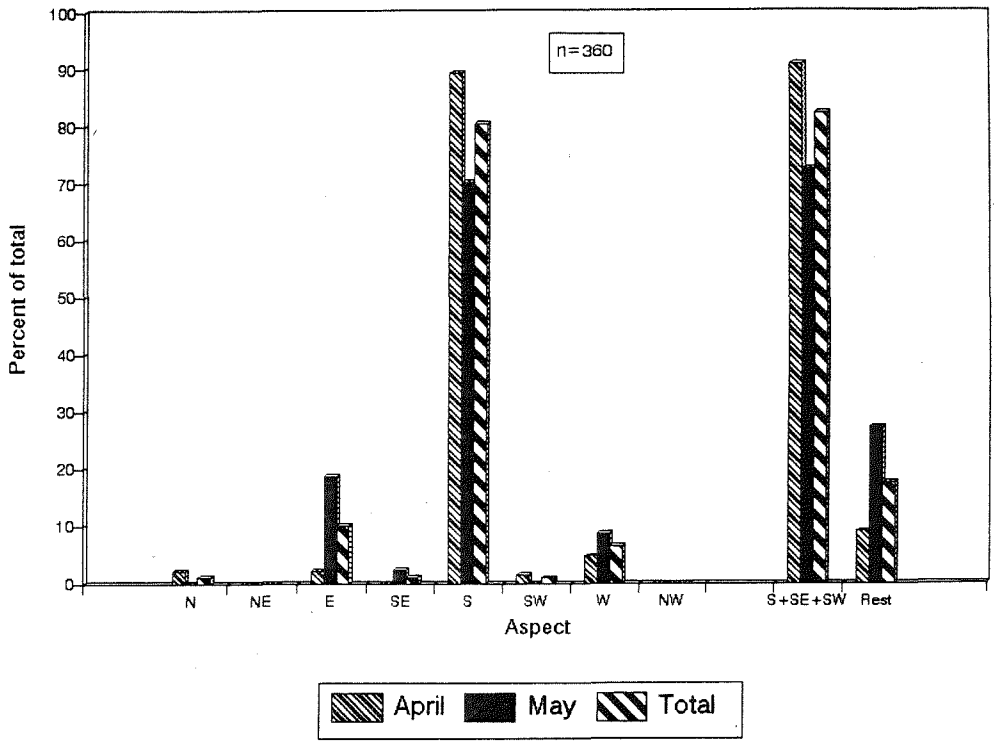

Figure 4: April, May and average spring distributions of bharal observations according to aspect.

In some areas, like Pani Palta Khola, herders come with their livestock in late March or early April. In early April we found that the 260 yaks in Pani Palta Khola occupied a large part of the snow free grazing grounds and that the yaks moved on to new grazing grounds as soon as the snow melted. It can be speculated if the intense grazing from the yaks in Pani Palta Khola and other areas excludes the local herds of bharals from critical snow free grazing grounds during early spring.

Altitude: Figure 5 illustrates the altitudinal distribution of bharals in Himalayan (all locations except Shey) respectively trans-Himalayan habitat (Shey). A T-test (Campbell, 1981) of the means indicates a significant difference ($P<<0.001$) in the distribution between the Himalayan and trans-Himalayan habitats. This is hardly surprising as the trans-Himalayan haitat (Shey) is generally situated at a higher altitude than the surveyed Himalayan habitats. Our data are not analyzed for any difference between April and May observations as the latter is strongly biased towards the high altitude observations in Shey.

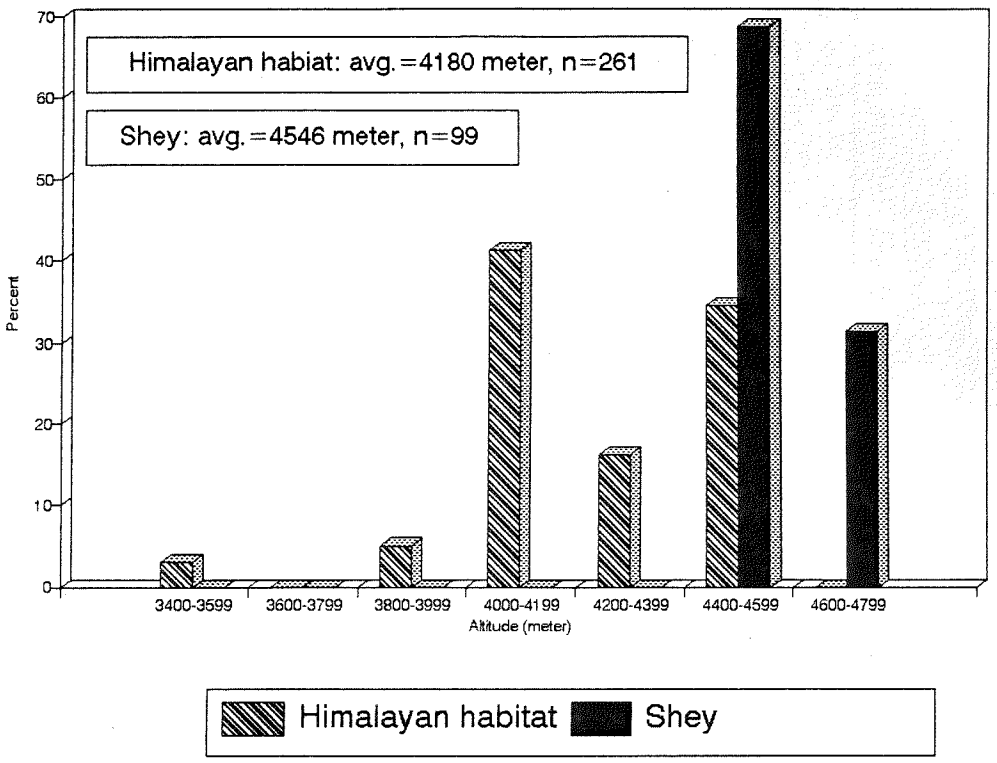

Figure 5: Altitudinal distibution of bharal observations in Himalayan habitat and trans-Himalayan habitat.

Survey sector	No. of bharal	Area (km^2)	Density (no./km^2)
Jagdula Khola	13	70	0.19
Pani Palta Khola	43	71	0.61
Total (JK+PPK)	**56**	**141**	**0.40**
Garpung Khola I	8	21	0.38
Garpung Khola II	66	21	3.10
Garpung Khola III	32	18	1.77
Total (GK I+II+III)	**106**	**61**	**1.75**
Julung Khola	60	25	2.44
Total (JK+PPK+GK+JK)	**222**	**226**	**0.98**
Shey	119	21	5.59
Total (all)	**341**	**248**	**1.38**

Table 3. Number of bharal in thoroughly surveyed sectors, size of the sectors, and population density of bharal in these sectors.

Population density: A total of 354 bharals was observed in the surveyed areas. Table 3 shows the apparent population density of bharals in the localities that were surveyed thouroughly (=survey sectors). It is estimated that 75-95% of the bharals present in the surveyed sectors have actually been recorded. Thus, actual population density is 5-33% higher than the apparent population density.

Table 3 gives the apparent population densities of bharals in the surveyed sectors (see map on figure 1 for the location of thoroughly surveyed areas). Apparent population densities vary from 0.19 bharals per km^2 in Jagdula Khola to 5.59 per km^2 in Shey.

The average apparent population density for all the surveyed sectors is 1.38 per km^2 and 0.98 per km^2 in Himalayan habitat. The last figure compares well to the density of 0.8-0.9 bharals per km^2 found by Wilson (1981) in similar habitat in the present Dhorpatan Hunting Reserve. In the original (non-expanded) Hemis National Park in Ladakh, India, population density is approximately 1.25 bharals per km^2 (Fox & Nurbu, 1990).

The very high density of bharals in Shey is probably due to the fact that up to 200 bharals traditionally gather here during the December rut and stay for the rest of the winter protected by a religious ban on hunting (Schaller, 1977, 1980). Some of the bharals observed at Shey by the present study might disperse to other feeding grounds during summer and autumn thus leaving a lower population density than found by us in May.

The low densities of bharals in Jagdula Khola and Garpung Khola Sector I are partly due to the fact that parts of these sectors are covered in forests; are situated below the usual altitudinal range of bharal; or otherwise unsuitable for bharals for natural reasons. Bharals usually live above timberline, from 3400 meter upward to the limit of vegetation around 5500 meter (or even 6500 meter (Roberts, 1977)), except in the eastern part of their range where some populations descend to 2600 meter (Schäfer, 1937).

Wegge (1976) and Wilson (1981) also calculated population densities from the total surface of potential bharal habitat in the present Dhorpatan Hunting Reserve. These densities varied from 1.9 to 3.3 bharals per km^2. These values compare well to our apparent densities in Garpung Khola Sector II and III as well as in Julung Khola (3.10, 1.77, and 2.44 per km^2, respectively). Within these three sectors most habitat is potential bharal habitat. In good areas not influenced by man bharal densities may be higher, like the 4-8 bharals per km^2 found by Jackson and Ahlborn (1989) in Langu Gorge where densities in prime bharal areas may even have exceeded 15 to 20 per km^2 after the rut.

Survey sector	Males class			Females	Year-	Lambs	Total no.	Lambs/	Yearlings/	Ad. males/
	III	II	I		lings		classed	100 fem.	100 fem.	100 fem.
Jagdula Khola	0	33.3	8.3	33.3	8.3	16.7	12	50.0	71.4	114.3
Pani Palta Khola	4.4	21.7	8.7	30.4	21.7	13.0	23	42.9	25.0	125.0
Total (JK+PPK)	**2.9**	**25.7**	**8.6**	**31.4**	**17.1**	**14.3**	**35**	**45.6**	**54.6**	**118.2**
Garpung Khola I	0	12.5	0	50.0	12.5	25.0	8	50.0	25.0	25.0
Garpung Khola II	7.8	7.8	13.7	31.4	27.5	11.8	51	37.5	87.5	93.8
Total (GK I+II)	**6.8**	**8.5**	**11.9**	**33.9**	**25.4**	**13.6**	**59**	**40.0**	**75.0**	**80.0**
Julung Khola	9.3	11.6	7.0	37.2	14.0	20.9	43	56.3	37.5	75.0
Total (all)	**6.6**	**13.9**	**9.5**	**34.3**	**19.7**	**16.1**	**137**	**46.8**	**57.5**	**87.2**

Table 4. Bharal herd composition data (in %), ratios of number of subadults to adult females, and adult sex ratio.

Herd composition: Eighteen herd composition counts in Himalayan habitat showed that the average ratio of adult male to adult female is below parity - 41 males to 47 females or 87 males per 100 females (see table 4). This low ratio is well below other bharal populations in Nepal. Schaller (1973, 1977) reports adult male to female ratios of 116 (Lapche, east Nepal), 134 (Shey), and 128 (Phoksundo), and Wilson (1981) reports ratios from 59 to 123 (average 102) from the present Dhorpatan Hunting Reserve.

Generally the preponderance of adult males may be indicative of more natural - i.e. less disturbed - populations. Populations of other Asian Caprinae often show a preponderance of adult males. Thus, the adult sex ratio in most populations of bharal, ibex (Capra ibex), wild goat (Capra aegagrus), and urial (Ovis orientalis) is 1:1 or favours males slightly (Schaller, 1977). Even though snow leopards and wolves (Canis lupus) kill a disproportionately large number of males, most bharal populations retain a preponderance of males (Schaller, 1977).

Adult males are selectively hunted by humans for the large amount of meat on a 60 kg ram (Wilson, 1981). Also, adult males are probably selectively trapped by poisoned bamboo spears in the ground especially during the rut as they race between herds of ewes. Ewes with young are more wary in their movements and appear to be less frequently trapped by local villagers (Jackson, 1979, cited in Wilson, 1981).

The data (table 4) indicate poor recruitment in subadult bharals. These data suggest lower survival or lower reproduction in the surveyed populations of bharal than in Dhorpatan where Wilson (1981) found lamb/female and yearling/female ratios of about 80, and than in Lapche, east Nepal, where Schaller (1973) found ratios of 82-88. The ratios of subadult to adult females are comparable to Schaller's (1977) data from Shey and Phoksundo (ratios 29-57).

The winter 91/92 was very severe in Shey-Phoksundo N.P. with unusual deep snow cover which lasted well into April and May depending on altitude and aspect. Weather conditions especially during winter are presumed to affect lamb and yearling survival. Thus, the rather poor recruitment of subadult bharals observed in the surveyed populations might be attributed to the severity of the preceeding winter. It also explains why average lamb/female ratio is lower than average yearling/female ratio. But as Schaller (1977) notes, low ratios of lambs and yearlings to adult females might also be due to range deterioration and predation.

One female in Garpung Khola Sector II seemed to be accompanied by twins. This is our only record of apparent twins and even though Schaller (1977) also reports a female from Lapche, east Nepal, this confirms Schäfer's (1937) observation that a single young represents the usual number.

3.1.3.Other mammals.

Eleven species of mammals were recorded during the present study. Six of these are included on Appendix I of the Convention on International Trade in Endangered Species (CITES): Grey langur (*Presbytis entellus*), leopard (*Panthera pardus*), snow leopard (*Panthera uncia*), wolf (*Canis lupus*), goral (*Nemorhaedus goral*), and musk deer (*Moschus moschiferus*).

Mammals recorded during the present study (the nomenclature and systematics follow Prater (1980)):
Grey Langur (*Presbytis entellus*): Three flocks of respectively 15, 9 and 10-12 individuals recorded near Toijam Rangerpost at 2900 to 3500 meter. The flocks frequented mixed forests and alpine meadows. The species is included on CITES Appendix I.
Leopard (*Panthera pardus*): Tracks of presumably four diffent individuals were found in Jagdula Khola: One big animal (presumably a male), a female with a big cub, and a medium sized animal. Most tracks, scrapes, and scats were found in forests, but the leopards also seem to frequent the alpine meadows up to at least 3700 meter. In nearby Dhorpatan leopards has been found up to 4115 meter (Wegge, 1976) and most probably even up to 4570 meter (Wilson, 1981).

We estimate that 4-8 leopards frequent Jagdula Khola between the national park entrance and Pani Palta Khola. These leopards also seem to frequent areas outside the national park as the people of Hurikot and Kaigaon complain about frequent attacts from this species on their livestock. We had the opportunity to inspect a recently killed adult yak which on the night of April 25 1992 was killed presumably by a leopard. Apparently leopards are also found in Pungmi Khola as the people of Pungmi complains about regular attacts on their livestock by a specific leopard. The species is included on CITES Appendix I.

Snow Leopard (*Panthera uncia*): From sign surveys an estimated 5-7 snow leopards frequent the surveyed areas of 700 km^2. The species is included on CITES Appendix I. Also, see chapter 3.1.1.
Small cat sp. (*Felis sp.*): Tracks noted near Toijam Rangerpost at 3100 meter. The size of the tracks (paw pad: width 2.3 cm, height 1.2 cm, and distance from back of paw pad to front end of foremost toe: 3.0 cm) indicates either jungle cat (*Felis chaus*) or golden cat (*Felis temmincki*).
Wolf (*Canis lupus*): Tracks and scats noted in Shey area. According to the local lamas two packs frequent this area. Wolfs from the Indian Subcontinent are included on CITES Appendix I.
Himalayan Weasel (*Mustela sibirica*): One noted near Pungmi at 3700 meter.
Long-tailed Marmot (*Marmota caudata*): Common around Shey at 4500 to 4800 meter. At least 30 individuals recorded around Shey.
Pika sp. (*Ochotona sp.*): A total of three individuals noted: One near Toijam Rangerpost at 2900 meter, one in Garpung Khola at 3700 meter, and one near Ringmo at 3800 meter.
Bharal (*Pseudois nayaur*): A total of 354 individuals recorded. Also, see chapter 3.1.2.
Goral (*Nemorhaedus goral*): One male noted near Toijam Rangerpost on alpine meadow at 3200 meter. Also, many tracks presumably from this species noted in the forests above Toijam Rangerpost. The species is included on CITES Appendix I.
Musk Deer (*Moschus moschiferus*): Many tracks and bedding sites noted in birch (*Betula utilis*) forest in Jagdula Khola at 3200-3700 meter. The species is included on CITES Appendix I.

3.2. Birds.

The following check list lists the species of birds seen in the area covered by Shey-Phoksundo National Park. The present study recorded 125 species of birds of which 26 were recorded for the first time within the park, thus bringing the total number of species recorded within the national park to 173 species.

Commments are given on all species recorded by the present study (these species are typed with bold types), while for species not seen by this study we only make reference to the source of information. The systematics and nomenclature follow Inskipp (1988), except for Asian house martin (*Delichon dasypus*).

There are 124 bird species which may have significant world populations in Nepal; their breeding distributions are restricted to an area encompassing the Himalaya, north-east India, northern South-East Asia and south-west China (Inskipp & Inskipp, 1986; Inskipp, 1989). The high number of 37 of these (30% of the total species with a significant world population in Nepal or 21% of the species recorded within the national park) has been recorded within Shey-Phoksundo National Park and most of them probably breed within the park (see appendix 1).

Nepal may be especially important for 36 breeding bird species because they either have particular restricted ranges within the general area under consideration or have been described as uncommon or rare in the Indian subcontinent (Inskipp & Inskipp 1986; Inskipp, 1989). Two of these has been recorded within the park: Wood snipe (*Gallinago nemericola*) whose breeding status in the park is unknown and white-throated tit (*Aegithalos niveogularis*) which breed in the national park. The Wood Snipe is also listed as a breeding species at risk in Nepal (Inskipp, 1989).

Key to the checklist:
* = Species for which Nepal may hold internationally significant breeding populations according to Inskipp & Inskipp (1986) and Inskipp (1989).
+ = Species for which Nepal may hold internationally significant breeding populations and for which the country may be especially important according to Inskipp & Inskipp (1986) and Inskipp (1989).

Place abbrevations:
T = Toijam Checkpost
JK = Jagdula Khola
PP = Pani Palta Khola
GK = Garpung Khola
KmL= Kagmara La
PuK= Pungmi Khola including Julung Khola
Su = Sumduwa (Army Checkpost)
Pl = Palam (Park Headquarter)
Ri = Ringmo
PhK= Phoksundo Khola
KnL= Kanga La
Sh = Shey Gompa
Re = Régi
A = Ankhe Checkpost

Source of information (for species not recorded by this study):
a) Schaller (1980)
b) Inskipp (1989)
c) Yonzon (1991b)
d) Hillard (1989)

Check list to the avifauna of Shey-Phoksundo National Park:
Ruddy Shelduck (*Tadorna ferruginea*): New to the national park. A flock of 6 noted flying over Phoksundo Lake (3600 meter) on 6/5-92.
Tufted Duck (*Aythya fuligula*) a)
Black Kite (*Milvus migrans*) b)
Egyptian Vulture (*Neophron percnopterus*) c)
Lammergeier (*Gypaetus barbatus*): Common between 3000 and 4800 meter mainly seen patrolling over alpine meadows. 1-3 individuals seen at all locations.
Himalayan Griffon Vulture (*Gyps himalayensis*): The following were noted: JK 7; Ri 3; Sh 1; and A 2. Seen between 3200 and 4900 meter mainly over alpine meadows.

Hen Harrier (*Circus cyaneus*): 1 adult male noted 29/3-92 above T at 3100 meter.
Northern Goshawk (*Accipiter gentilis*): Three different individuals noted in JK at 3000-3800 meter above alpine meadow and above birch forest.
Northern Sparrowhawk (*Accipiter nisus*): Three different individuals noted in JK at 3000-4000 meter above alpine meadow and in birch and pine forest.
Common Buzzard (*Buteo buteo*): A single individual noted in JK above alpine meadow at 3400 meter.
Upland Buzzard (*Buteo hemilasius*): A total of six individuals noted at 3300-4700 meter above alpine meadow: JK 3; GK 2; and Sh 1.
Steppe Eagle (*Aquila rapax*) c)
Golden Eagle (*Aquila chrysaetos*): 6 individuals noted at 3500-4700 meter above alpine meadow: JK 1 pair and 1 subadult; GK 1 pair; and Sh 1 adult.
Booted Eagle (*Hieraaetus pennatus*): New to the national park. One individual, light fase, flying west along Bheri River above Suli Gad Rangerpost (2200 meter) on 18/5-92.
Common Kestrel (*Falco tinnunculus*): Single individuals noted at most locations at 2800-4800 meter over alpine meadow.
Amur Falcon (*Falco amurensis*) b)
Merlin (*Falco columbarius*) b)
Snow Partridge (*Lerwa lerwa*)* b)
Tibetan Snowcock (*Tetraogallus tibetanus*): Two noted in PuK at 4400 meter on alpine meadow. The species is listed on CITES Appendix I.
Himalayan Snowcock (*Tetraogallus himalayensis*): Common around Shey where at least five pairs were noted at 4600-4800 meter on alpine meadows and on steep cliffs. Also, 4-8 individuals noted in PP at 3800 meter; 1 at KmL at 4400 meter; and 2 near Ri at 4000 meter - all on alpine meadows.
Chukar Partridge (*Alectoris chukar*): Two noted between Pl and Ri on alpine meadow at 3600 meter.
Tibetan Partridge (*Perdix hodgsoniae*) b)
Koklass Pheasant (*Pucrasia macrolopha*) c)
Himalayan Monal (*Lophophorus impejanus*)*: Common in JK where at least 13 different individuals were noted between 3000 and 3900 meter mainly in birch forest but also in pine and mixed oak/pine forest. Also, a single individual noted in PuK at 3500 meter in birch forest. The species is listed on CITES Appendix I.
Common Coot (*Fulica atra*) c)
Common Crane (*Grus grus*): New to the national park. A flock of three individuals were seen flying north on 3/4-92 along JK presumably on migration.
Ibisbill (*Ibidorhyncha struthersii*): New to the national park. A single individual noted on 14/4-92 in PP at 3800 meter feeding among the stones at the edge of a small stream.

Wood Snipe (*Gallinago nemericola*)+: New to the national park. Two flushed from scrub near stream on 12/4-92 in PP at 4100 meter. The species is listed as a breeding species at risk in Nepal by Inskipp (1989), and there is only very few records of the species in Nepal during recent years (Inskipp & Inskipp, 1991). The species is also recognised as internationally threatened (Collar & Andrew, 1988).
Rock Pigeon (*Columba livia*) b)
Hill Pigeon (*Columba rupestris*): 15 noted at Sh and on surrounding fields. A single individual noted in Ri.
Snow Pigeon (*Columba leuconota*): Common, with flocks of 2-55 seen at all locations between 3100 and 4800 meter, often near cliffs.
Speckled Woodpigeon (*Columba hodgsonii*)*: One noted at A at 2700 meter in open stand on *Pinus wallichiana*.
Oriental Turtle Dove (*Streptopelia orientalis*): The following individuals were noted: T 1; PuK 4; Ri 4; Re-A 2. Seen at 3000-3600 meter in pine forest or in the vicinity of fields.
Common Cuckoo (*Cuculus canorus*) b)
Lesser Cuckoo (*Cuculus poliocephalus*) c)
Northern Little Owl (*Athene noctua*) b)
Tawny Owl (*Strix aluco*): Single individuals heard in pine forest at T, PuK, and PhK between 3000 and 3700 meter.
Short-eared Owl (*Asio flammeus*) b)
Large-tailed Nightjahr (*Caprimulgus macrurus*): New to the national park. A single individual seen on 1/4-92 at 3100 meter in mixed oak/pine forest above T. This is the highest altitude record for the species in Nepal (Inskipp & Inskipp, 1991). Though this species is found up to 2200 meter in western Himalaya and 2400 in north-eastern India (Ali & Ripley, 1983) this individual was probably "over-shooting" while migrating. This is not the only lowland species recorded at unusual high altitude within the national park: This study also found a Little Green Beeeater at 2900 meter, and Robert L. Fleming (Fleming *et al.*, 1979) recorded a Spangled Drongo (*Dicrurus hottentottus*) at 4100 meter, both of them after a probable spring migration "over-shoot".
Himalayan Swiftlet (*Collocalia brevirostris*) b)
Common Swift (*Apus apus*): A total of five individuals seen near Sh at 4500-4800 meter.
Alpine Swift (*Apus melba*) b)
Little Green Bee-eater (*Merops orientalis*): New to the national park. On 16/4-92 one seen near T at 2900 meter at clearing in oak forest. This is the highest altitude for the species in Nepal (Inskipp & Inskipp, 1991). The bird was probably "over-shooting" when on spring migration as April 16 falls within the migration period of the species (Inskipp & Inskipp, 1991). Also, see notes about large-tailed nightjahr (*Caprimulgus macrurus*).
Hoopoe (*Upupa epops*) b)
Scaly-bellied Green Woodpecker (*Picus squamatus*): New to the national park. A total of three individuals noted near T between 2900 and 3100 meter in pine forest.

Himalayan Pied Woodpecker (*Dendrocopos himalayensis*)*: New to the national park. A total of three individuals noted near T between 2900 and 3000 meter in pine forest.
Greater Short-toed Lark (*Calandrella brachydactyla*) b)
Hume's Short-toed Lark (*Calandrella acutirostris*) b)
Oriental Skylark (*Alauda gulgula*): Two noted at PP, and one in GK on alpine meadows at 3600-3800 meter.
Horned Lark (*Eremophila alpestris*): A total of four noted at Sh at 4700-4800 meter on alpine meadow.
Crag Martin (*Ptyonoprogne rupestris*): The following small flocks noted: T 2; JK 4; Pl 2; PhK 3; and SH 10. Noted between 3100 and 4700 meter.
Asian House Martin (*Delichon dasypus*): Common. Noted in flocks of 8-25 individuals in most locations between 3100 and 4500 meter.
Olive-backed Pipit (*Anthus hodgsoni*): A total of 12 individuals noted in JK between 2900 and 3800 meter on alpine meadows and in pine forest.
Rosy Pipit (*Anthus roseatus*): Common on alpine meadows at all locations between 3600 and 4800 meter.
Upland Pipit (*Anthus sylvanus*): One noted in PuK at 3500 meter, and one at A at 2700 meter, both on alpine meadows.
Citrine Wagtail (*Motacilla citreola*): New to the national park. One male noted at Phoksundo Lake (3600 meter) on 6/5-92.
Grey Wagtail (*Motacilla cinerea*): One noted at stream near Ri and one at Phoksundo Lake, both at 3600 meter.
White Wagtail (*Motacilla alba*): One near Su at 3000 meter; four at Phoksundo Lake at 3600 meter; and four at stream near Ri at 3600 meter.
Long-tailed Minivet (*Pericrocotus ethologus*): 1-4 individuals noted between 2600 and 3500 meter, mainly in brush and mixed deciduous forest, at the following locations: T, PuK, Re, and A.
White-cheeked Bulbul (*Pycnonotus leucogenys*): c)
Black Bulbul (*Hypsipetes madagascariensis*): Eight seen at A in open stand of *Pinus wallichiana* at 2700 meter.
White-breasted Dipper (*Cinclus cinclus*): One at Phuksundo Lake (3600 meter).
Brown Dipper (*Cinclus pallasii*): Noted near streams: Two in PP at 3800 meter, and one near Re at 3000 meter.
Northern Wren (*Troglodytes troglodytes*): Noted in most locations between 2900 and 4300 meter mainly on alpine meadows or in scrub.
Rufous-breasted Accentor (*Prunella strophiata*)*: Common in GK on alpine meadows with scrub at 4000-4300 meter. 1-4 individuals noted in scrub or on alpine meadows at 3600-4600 meter at PP, Ri, PhK, and Sh.
Brown Accentor (*Prunella fulvescens*): A total of nine noted near Sh at 4400-4700 meter often near habitation or on fields.
Blackthroated Accentor (*Prunella atrogularis*): b)
Robin Accentor (*Prunella rubeculoides*)*: A total of ten noted near Sh at 4400-4800 meter in scrub or on alpine meadows.
Altai Accentor (*Prunella himalayana*): New to the national park. A flock of 35 noted in PP from 8/4 to 12/4-92 at 3900 meter feeding on an alpine meadow with scattered bushes.

Alpine Accentor (*Prunella collaris*): A total of eight noted near T at 3000-3200 meter, ten noted at KmL at 4500-5000 meter, and one noted near Sh at 4700 meter - all on alpine meadows.
White-tailed Rubythroat (*Luscinia pectoralis*): Common at Sh at 4400-4700 meter in scrub with up to 25 noted in one day. Also, one noted south of KnL in scrub at 4500 meter.
Indian Blue Robin (*Luscinia brunnea*)*: A total of six noted near Re at 3000 meter in scrub.
Orange-flanked Bush-Robin (*Tarsiger cyanurus*): Common in forests between 2900 and 4000 meter.
Golden Bush-Robin (*Tarsiger chrysaeus*)*: b)
White-browed Bush-Robin (*Tarsiger indicus*)*: c)
Rufous-backed Redstart (*Phoenicurus erythronotus*): New to the national park. A single male noted on 1/4-92 at 3200 meter on alpine meadow.
Blue-capped Redstart (*Phoenicurus caeruleocephalus*): Common in PuK and near Ri at 3000-3600 meter mainly in pine forests and in scrub. Also, single individuals seen in JK, T, Su, and Re at 2900-3200 meter.
Black Redstart (*Phoenicurus ochruros*): Common near Sh at 4400-4800 meter mainly in scrub and near habitation. Also, single individuals noted in T and PuK at 3100-3200 meter.
Hodgson's Redstart (*Phoenicurus hodgsoni*): New to the national park. One male noted on 5/5-92 at edge of pine forest near Ri at 3600 meter.
Blue-fronted Redstart (*Phoenicurus frontalis*)*: Common on most locations between 2900 and 4700 meter mainly in scrubby habitat.
White-throated Redstart (*Phoenicurus schisticeps*)*: One pair noted near Ri at 3800 meter in scrub on rocky hillside.
Güldenstädt's Redstart (*Phoenicurus erythrogaster*): Two pairs noted near KnL at 4800-5000 meter on boulders near stream.
Plumbeous Redstart (*Rhyacornis fuliginosus*): Two males noted along Suli Gad River between Pl and Re at 2900-3000 meter.
White-bellied Redstart (*Hodgsonius phoenicuroides*)*: One noted at Sh at 4600 meter in scrub of *Juniperus sp.*
Grandala (*Grandala coelicolor*): A flock of 16 noted on open meadow above T at 3200 after a very cold night.
Common Stonechat (*Saxicola torquata*): Common near Sh at 4500-4700 meter especially in scrub.
Grey Bushchat (*Saxicola ferrea*): Three noted near T at 2900 meter at abandoned fields.
Desert Wheatear (*Oenanthe deserti*): One pair noted near Sh at old yak-hut at 4600 meter.
White-capped Redstart (*Chaimorrornis leucocephalus*): 1-4 individuals noted near streams between 3400 and 4700 meter at PP, GK, PuK, and Sh.
Chestnut-bellied Rock-Thrush (*Monticola rufiventris*): New to the national park. One pair noted on 16/4-92 above T at 3100 meter at edge of pine forest.
Blue Rock-Thrush (*Monticola solitarius*): b)
Blue Whistling Thrush (*Myiophoneus caeruleus*): Common between 2600 and 4100 meter mostly in open habitat near stream or river.

Plain-backed Mountain Thrush (*Zoothera mollissima*)*: New to the national park. Two noted at T (2900 meter) on 16/4-92. Also, two noted in GK on 22/4-92 at 4100 meter on alpine meadow.
Tickell's Thrush (*Turdus unicolor*)*: New to the national park. One pair noted near Ri on 5/5-92 at edge of pine forest at 3600 meter.
White-collared Blackbird (*Turdus albocinctus*)*: c)
Dark-throated Thrush (*Turdus ruficollis*): *T. r. artrogularis*: One male noted in JK at 3200 meter and one male noted in PuK at 3500, both in pine forest. *T. r. ruficollis*: One male noted near Sh at 4400 meter on field.
Mistle Thrush (*Turdus viscivorus*): b)
Little Forktail (*Enicurus scouleri*): b)
Grey-sided Bush Warbler (*Cettia brunnifrons*)*: b)
Striated Prinia (*Prinia criniger*): Two noted at A on open meadow at 2700 meter.
Booted Warbler (*Hippolais caligata*): New to the national park. A single individual skulking in small *Juniperus sp.* and *Caragana sp.* near Ri at 3600 meter on 5/5-92.
Golden-spectacled Warbler (*Seicercus burkii*): b)
Grey-hooded Warbler (*Seicercus xanthoschistos*)*: One noted at A (2700 meter) in scrub.
Blyth's Crowned Warbler (*Phylloscopus reguloides*): One noted near Re at 3000 meter in mixed deciduous forest.
Greenish Warbler (*Phylloscopus trochiloides*): Four noted near T in scrub and in oak forest at 2900 meter.
Large-billed Leaf Warbler (*Phylloscopus magnirostris*)*: Two noted near Re at 3000 meter in pine forest resp. mixed deciduous forest.
Orange-barred Leaf Warbler (*Phylloscopus maculipennis*)*: c)
Pallas' Leaf Warbler (*Phylloscopus proregulus*): Common in oak, pine, and mixed deciduous forest between 2600 and 3600 meter.
Yellow-browed Warbler (*Phylloscopus inornatus*): The following individuals noted between 2900 and 3600 meter mainly in mixed forest: T 6, Ri 2, Re 2, and Re-A 2.
Sulphur-bellied Warbler (*Phylloscopus griseolus*): New to the national park. One noted between Re and A on 16/5-92 in a dense stand of small deciduous trees at 2700 meter.
Tickell's Warbler (*Phylloscopus affinis*): Common near Sh at 4400-4700 meter in low scrub of *Juniperus sp.* and *Caragana sp.* Also, two noted in PuK at 3000 meter, and two near Ri at 3600 meter.
Goldcrest (*Regulus regulus*): Four noted in JK at 2900-3500 in mixed oak/pine forest.
Stoliczka's Tit-warbler (*Leptopoecile sophiae*): One noted near Sh in low scrub of *Caragana sp.* at 4500 meter.
Verditer Flycatcher (*Muscicapa thalassina*): c)
Asian Sooty Flycatcher (*Muscicapa sibirica*): 10 noted at A at 2600-2700 meter.
Rufous-tailed Flycatcher (*Muscicapa ruficauda*)*: New to the national park. One noted near T on 16/4-92 in bushes on abandoned fields at 2900 meter.
Slaty-blue Flycatcher (*Ficedula tricolor*): c)
Ultramarine Flycatcher (*Ficedula superciliaris*)*: One noted between Re and A in dense bushes at 2800 meter.

Orange-gorgetted Flycatcher (*Ficedula strophiata*): Four noted in JK in mixed forest at 2900-3400 meter.
Yellow-bellied Fantail (*Rhipidura hypoxantha*)*: Common in JK in mixed and oak forest between 2900 and 3500 meter.
Variegated Laughing-thrush (*Garrulax variegatus*)*: Eight noted near T at 3000 meter in scrub, one in PuK in birch forest at 4000 meter, and three near Ri in pine forest at 3600 meter.
Streaked Laughing-thrush (*Garrulax lineatus*): Common in PuK in bushes and near fields at 3000-3700 meter. Also, three noted near T at 3000 meter in bushes.
Green Shrike-Babbler (*Pteruthius xanthochloris*)*: New to the national park. Two individuals noted near T at 2900-3000 in oak forest and in mixed pine/oak forest.
White-browed Fulvetta (*Alcippe vinipectus*)*: Three noted near T in oak forest at 3000 meter.
White-throated Tit (*Aegithalos niveogularis*)+: A total of eight noted in JK between 2900 and 3400 in mixed oak/pine forest, in birch forest and in bushes. Also, single individuals noted in PuK in bushes at 3500 meter, near Ri in pine forest at 3600 meter, and near A in mixed deciduous forest at 2600 meter.
Black-throated Tit (*Aegithalos concinnus*): New to the national park. Two noted near T in bushes at 3000 meter.
Grey-crested Tit (*Parus dichrous*)*: Three noted in JK in mixed oak/pine forest at 3200 meter.
Rufous-naped Black Tit (*Parus rufonuchalis*): Two noted in JK in mixed oak/pine forest at 3300 meter.
Rufous-vented Black Tit (*Parus rubidiventris*)*: Common between 3200 and 4000 meter in pine, birch, and mixed pine/oak forest.
Spot-winged Black Tit (*Parus melanolophus*)*: Common between 2900 and 3900 meter in pine, oak, birch, and mixed pine/oak forest.
Green-backed Tit (*Parus monticolus*): 1-2 individuals noted in oak and mixed deciduous forest at 2900-3800 meter near T, PuK, Re, and A.
White-cheeked Nuthatch (*Sitta leucopsis*)*: b)
Kashmir Nuthatch (*Sitta cashmirensis*)*: b)
Wallcreeper (*Tichodroma muraria*): Two noted on cliffs between Pl and Ri at 3600 meter.
Bar-tailed Treecreeper (*Certhia himalayana*): A total of four noted in JK in pine, and mixed pine/oak forest at 2900-3300 meter.
Common Treecreeper (*Certhia familiaris*): New to the national park. A total of three noted in JK in mixed oak/pine forest at 3000-3400 meter and one noted in GK in birch forest at 3600 meter.
Mrs. Gould's Sunbird (*Aethopyga gouldiae*): One pair noted near A at 2600 meter.
Green-tailed Sunbird (*Aethopyga nipalensis*): c)
Buff-bellied Flowerpecker (*Dicaeum ignipectus*): c)
Oriental White-eye (*Zosterops palpebrosa*): c)
Long-tailed Shrike (*Lanius schach*): New to the national park. One noted at Pl in bushes at 3100 meter.
Grey-backed Shrike (*Lanius tephronotus*)*: Single individuals noted in bushes in open habitat between 2700 and 3700 meter in PuK, Pl-Ri, Ri, and A.

Ashy Drongo (*Dicrurus leucophaeus*): c)
Spangled Drongo (*Dicrurus hottentottus*): b)
Hume's Ground Jay (*Pseudopodoces humilis*): b)
Eurasian Nutcracker (*Nucifraga caryocatactes*): One noted near T in pine forest at 3200 meter, and two noted in PhK in pine forest at 3800 meter.
Alpine Chough (*Pyrrhocorax graculus*): Common in open habitat on all localities between 3400 and 5300 meter.
Red-billed Chough (*Pyrrhocorax pyrrhocorax*): A total of three noted near Sh in open habitat at 4400-4800 meter.
Chough sp. (*Pyrrhocorax sp.*): A flock of 300 roosting in PhK at 4000 meter.
Jungle Crow (*Corvus macrorhynchos*): Common between 2900 and 3900 meter especially near habitation.
Common Raven (*Corvus corax*): One noted near Sh above alpine meadow at 4800 meter.
Common Mynah (*Acridotheres tristis*): d)
House Sparrow (*Passer domesticus*): b)
Cinnamon Sparrow (*Passer rutilans*): One pair noted at Sh at 4400 meter.
Eurasian Tree Sparrow (*Passer montanus*): b)
Tibetan Snowfinch (*Montifringilla adamsi*): A total of three noted near Sh on alpine meadow at 4600-4800.
Common Chaffinch (*Fringilla coelebs*): New to the national park. A flock of six noted on 15/4-92 feeding together with 15 Plain Mountain Finches in birch forest at 3700 meter.
Red-fronted Serin (*Serinus pusillus*): b)
Yellow-breasted Greenfinch (*Carduelis spinoides*): c)
Twite (*Carduelis flavirostris*): b)
Plain Mountain Finch (*Leucosticte nemoricola*): Common in open habitat at 4000-4800 meter. Also, a flock of 15 noted in birch forest in JK at 3700 meter.
Brandt's Mountain Finch (*Leucosticte brandti*): A flock of four noted near Sh on alpine meadow at 4800 meter.
Common Rosefinch (*Carpodachus erythrinus*): One pair noted near T in bushes at 3000 meter, and two noted in PuK in bushes at 3600 meter.
Beautiful Rosefinch (*Carpodachus pulcherrimus*): Common in open habitat with scrub or bushes between 3000 and 4800 meter.
Pink-browed Rosefinch (*Carpodachus rhodochrous*)*: One noted in JK in birch forest at 3700 meter, and one in PuK in bushes at 3500 meter.
White-browed Rosefinch (*Carpodachus thura*)*: New to the national park. One female noted in JK on 15/4-92 in *Juniperus sp.* at 3700 meter.
Crimson-eared Rosefinch (*Carpodachus rubicilloides*)*: A total of seven individuals noted near Sh on boulders or on alpine meadow at 4500-4800 meter.
Spot-crowned Rosefinch (*Carpodachus rubicilla*): b)
Red-breasted Rosefinch (*Carpodachus puniceus*): A total of 15 noted around KmL on alpine meadow at 4500-4900 meter.

Red-headed Bullfinch (*Pyrrhula erythrocephala*)*: A flock of four noted in JK in mixed pine and oak forest at 3300 meter, and one noted at A (2700 meter) in bushes.
White-winged Grosbeak (*Mycerobas carnipes*): A total of 19 noted near Ri at 3600-3700 meter mainly in pine forest.
Pine Bunting (*Emberiza leucocephalos*): A flock of seven noted near T in bushes at 3000 meter.
Rock Bunting (*Emberiza cia*): Common in open habitat between 2700 and 3800 meter.
Little Bunting (*Emberiza pusilla*): New to the national park. One female noted near T in bushes at abandoned fields at 2900 meter.

3.3. Reptiles.

Three species of reptiles were recorded during the present study. All of them are apparently common and/or widespread species.

Reptiles recorded during the present study (the nomenclature and systematics follow Daniel (1983)):
Lizard sp. (*Agamidae sp.*): One observed April 2 above Toijam Rangerpost on alpine meadow at 3100 meter.
Skink sp. (*Scincidae sp.*): Probably *Leiolopisma sikkimense* (named *Scincella sikkimensis* by Inskipp (1988)). Common in Pani Palta Khola at 3700-3900 meter.
Himalayan Pit Viper (*Agkistrodon himalayanus*): One mature (length 80 cm) and two immature (length 18-20 cm) individuals observed near Ankhe Checkpost at 2800 meter.

3.4. Vegetation analysis.

The Jagdula Khola and Pani Palta Khola Survey Sectors are subdivided according to the distance from the national park entry point, respectively, the distance from the confluence with Jagdula Khola. All systematics and nomenclature follow Polunin & Stainton (1984) and Stainton (1988).

3.4.1. Forests.

Forest transects were made in Jagdula Khola, Pani Palta Khola and Garpung Khola. Data from each forest transect are summarized in Appendix 2.

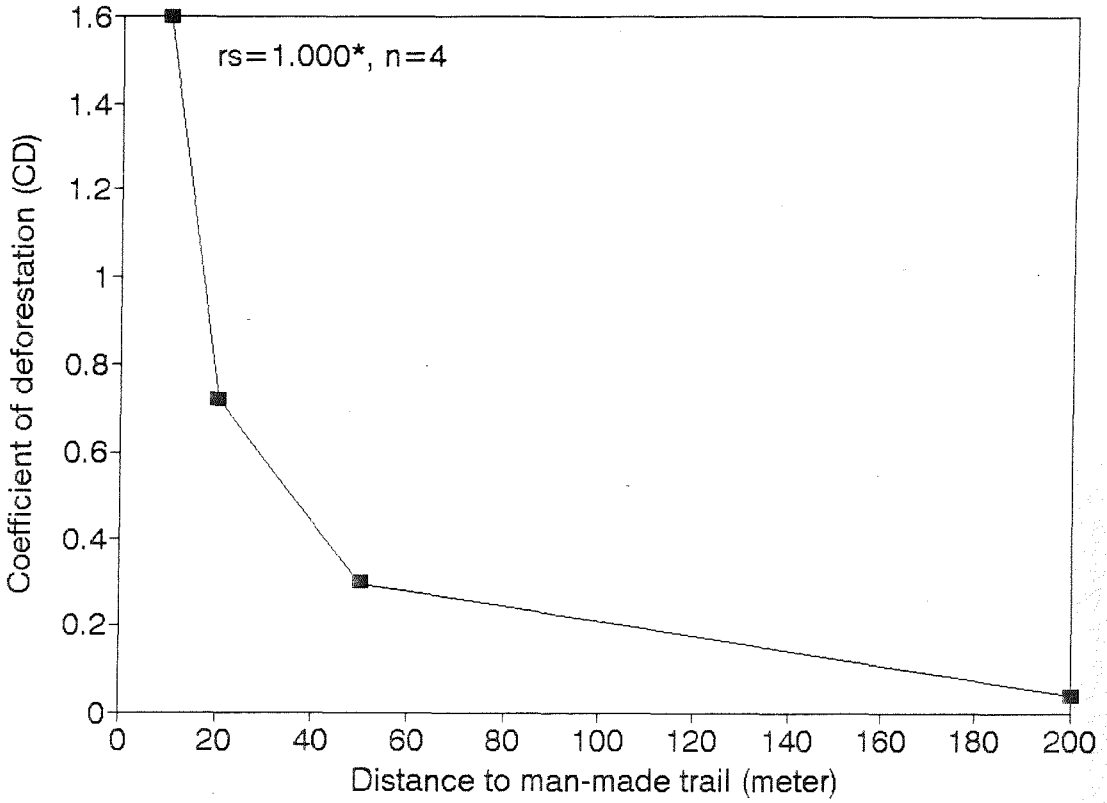

Figure 6: Coefficient of deforestation (CD) according to the distance to nearest man-made trail in Jagdula Khola near Toijam Rangerpost. rs=Spearman rank correlation coefficient (Campbell, 1981); *=P<0.05; n=number of observations.

In Jagdula Khola near Toijam Rangerpost the forests are dominated by oak (*Quercus semecarpefolia*) interspersed with conifers, mainly west Himalayan spruce (*Picea smithiana*), Himalayan silver fir (*Abies spectabilis*) and Himalayan blue pine (*Pinus wallichiana*). All these species are typical of the Humla-Jumla region (Stainton, 1972; Shrestha, 1982; Shrestha 1989). Further up along Jagdula Khola and in Pani Palta Khola birch (*Betula utilis*) dominates until the tree limit at about 3900 meter. In Garpung Khola forests are mainly confined to slopes with a northerly aspect. These forests are dominated by birch (*Betula utilis*) and rhododendron (*Rhododendron spp.*).

Figure 6 shows that the distance to nearest man-made trail is an important factor when making forest transects. These data from Jagdula Khola indicate that forest degradation relatively quickly falls to a lower level further inside a forest. But this might only be true in forests on very steep and hardly accessible hillsides like most of the forest in Jagdula Khola - elsewhere in Nepal on more gentle ground forest degradation often seems not to be affected by the distance to the nearest trail (pers. obs.).

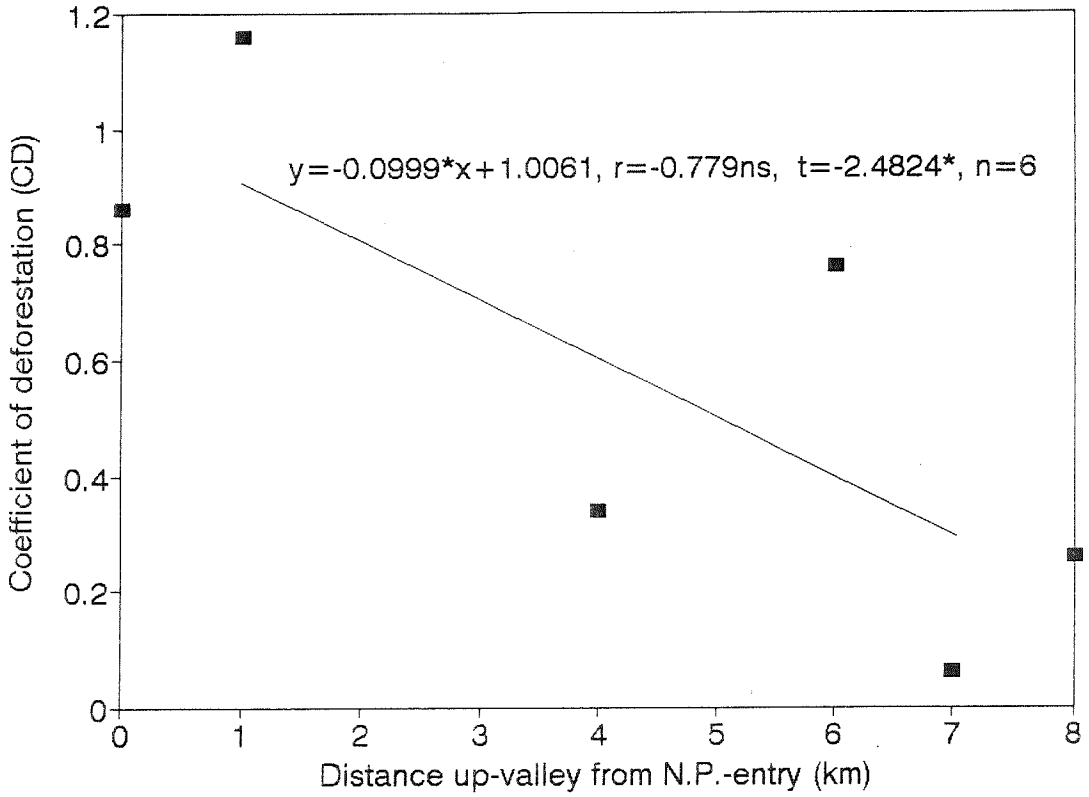

Figure 7: Coefficient of deforestation (CD) in Jagdula Khola according to distance up-stream from the national park entry point. r=correlation coefficient (linear regression (Hewlett-Packard A/S, 1989)); *=P<0.05; n=number of observations.

As the surveyed forests were mainly situated on very steep slopes (half of the transects were on slopes with more than 45° inclination) transects were made at a fixed distance of 10 meter from nearest man-made trail (except in Pani Palta Khola where trails are non-existing).

The distance from permanent human habitation also influences on forest degradation (figure 7). The further away from permanent human habitation the lower is the coefficient of deforestation.

It is not only trees that suffer from forest degradation. Bushes and saplings are also affected either from collection of firewood, from lopping of fodder or from livestock grazing. Forests with a high coefficient of deforestation have a low percentage of bushes and saplings in the understorey (figure 8).

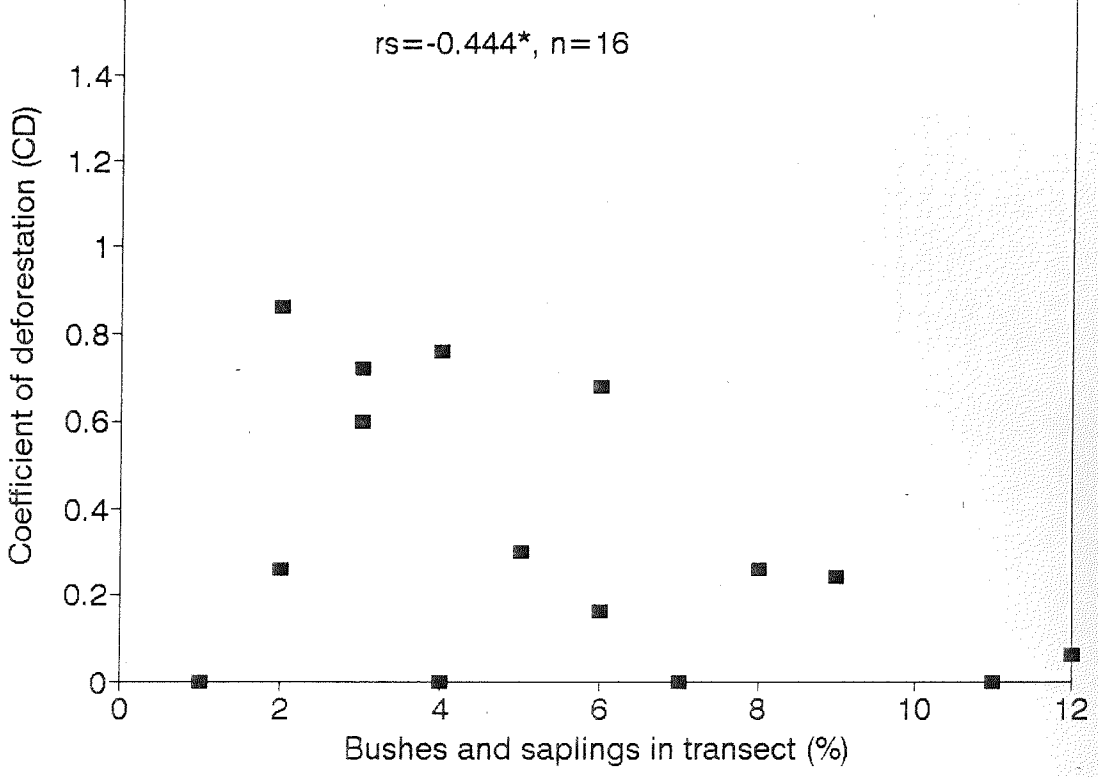

Figure 8: Coefficient of deforestation (CD) according to percentage of bushes and saplings in understorey. rs=Spearman rank correlation coefficient (Campbell, 1981); *=P<0.05; n=number of observations.

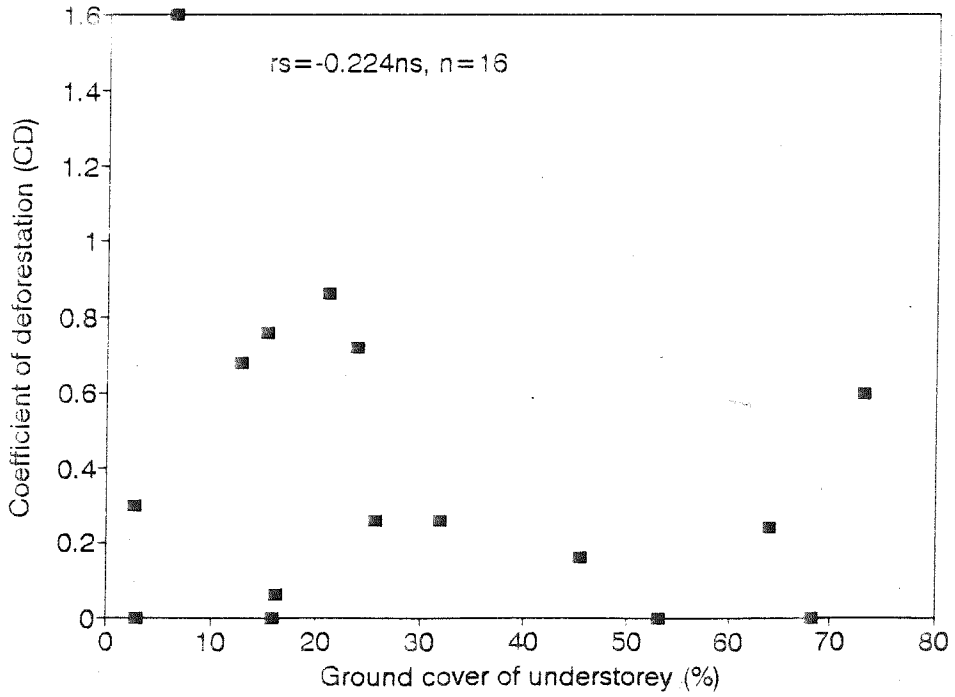

Figure 9: Coefficient of deforestation (CD) according to percentage ground cover in understorey. rs=Spearman rank correlation coefficient (Campbell, 1981); *=P<0.05; n=number of observations.

Subdivision /sector	Forest habitat	n	Scrub/bush habitat	n	Meadow habitat	n
JK 0-2 km	0.87^{b}	200	nd.	-	nd.	-
JK 3-7 km	0.37^{a}	200	nd.	-	nd.	-
JK Average	**0.62^{y}**	**400**	**nd.**	**-**	**nd.**	**-**
PPK 0-1 km	0.13	100	0.20^{b}	59	49.7^{a}	115
PPK 2-3 km	nd.	-	1.19^{c}	32	58.4^{b}	272
PPK 4-6 km	nd.	-	0^{c}	44	64.6^{b}	170
PPK average	**0.13^{x}**	**100**	**0.37^{y}**	**135**	**58.5^{x}**	**557**
GK I	nd.	-	0^{a}	21	60.0^{ab}	228
GK II	0.20	250	0.0022^{a}	134	64.4^{b}	241
GK III	nd.	-	0^{a}	79	57.8^{a}	195
GK average	**0.20^{x}**	**250**	**0.013^{x}**	**234**	**60.9^{x}**	**664**

Table 5. Coefficients of deforestation (forest habitat), quality coefficient (scrub/bush habitat), and ground covered with vegetation (meadow habitat) in the following survey sectors/subdivisions: Jagdula Khola (JK), Pani Palta Khola (PPK), and Garpung Khola (GK). Distance from the national park boundary (JK) or from confluence with Jagdula Khola (PPK) denotes each subdivision. Differing letters denote significant different coefficients of deforestation, quality coefficient of scrub/bushes, respectively, ground covered with vegetation between subdivisions (a,b,c) or between survey sectors (x,y). nd.=no data.

We did not find any correlation between CD and percentage ground cover in the understorey (figure 9). Nor did we find a significant different CD between trees with diameter at breast hight (dbh.) less than 20 cm and trees with dbh. greater than 20 cm (see data in Appendix 2).

Forest degradation is more serious in Jagdula Khola than in Garpung Khola and Pani Palta Khola (table 5). The high CD in Jagdula Khola is probably mainly a result of firewood collection, and to some extent lopping of fodder from oak (*Quercus semecarpefolia*).

Collection of firewood seems to be a major problem mainly around villages, near Sumduwa Army Post, and along the main trekking route (along Suli Gad River to Ringmo, and across Kagmara La). Despite the fact that trekking groups are only allowed to collect dead wood from the forest floor, on several occasions we observed trekking crew up-rooting bushes, cutting down small trees, or breaking off live branches even high up in trees.

3.4.2. Scrub/bush habitat.

In Himalayan habitat in e.g. Jagdula Khola, Pani Palta Khola, and Garpung Khola the scrub mainly consists of *Cotoneaster spp.*, while between Sumduwa and Ringmo *Caragana spp* are an important component. In the dry trans-Himalayan habitat in Shey *Caragana spp.* and dwarf juniper (*Juniperus spp.*) dominate.

In Pani Palta Khola, Garpung Khola and Shey we observed that extensive areas covered by bushes had been burned apparently by herders in order to improve the grazing grounds for livestock. In our transects bushes suffered more from this type of burning than from cutting for firewood. Thus, 26 out of 32 (81%) degraded bushes were affected by burnings, the rest was affected by cutting. The extent of up-rooting is very difficult to assess as only little evidence can be found after the up-rooting has taken place.

In Jagdula Khola only small tracts of scrub-land exist. Thus, transects in this habitat were only made in Pani Palta Khola and Garpung Khola. The quality coefficient is significantly higher in Pani Palta Khola than in Garpung Khola (table 5). Especially the subdivision 2-3 km from Jagdula Khola is severely affected by burning and to a lesser extent cutting. This subdivision is used intensively for livestock grazing and is situated next to the herders camp and the place where livestock is gathered for the night.

The percentage of alpine meadows covered by scrub/bushes does not differ significantly between Pani Palta Khola (19.3%) and Garpung Khola (26.0%) (T-test (Campbell, 1981): t=1.29, n=36, m=28).

3.4.3. Alpine meadows.

This is the most prevalent habitat in the study area. It has to be noted that our transects are biased towards slopes with a southerly aspect (40 out of 64 (62.5%) transects have southerly aspects). This is due to deep snow cover on slopes with other aspects especially in the beginning of the study.

Transects on alpine meadows were only made in Pani Palta Khola and Garpung Khola. During the survey period only few species of herbs were blooming and thus ready for proper identification - no attempts were made to identify grasses and sedges. Therefore, it was not possible to make any thourough floristic inventory.

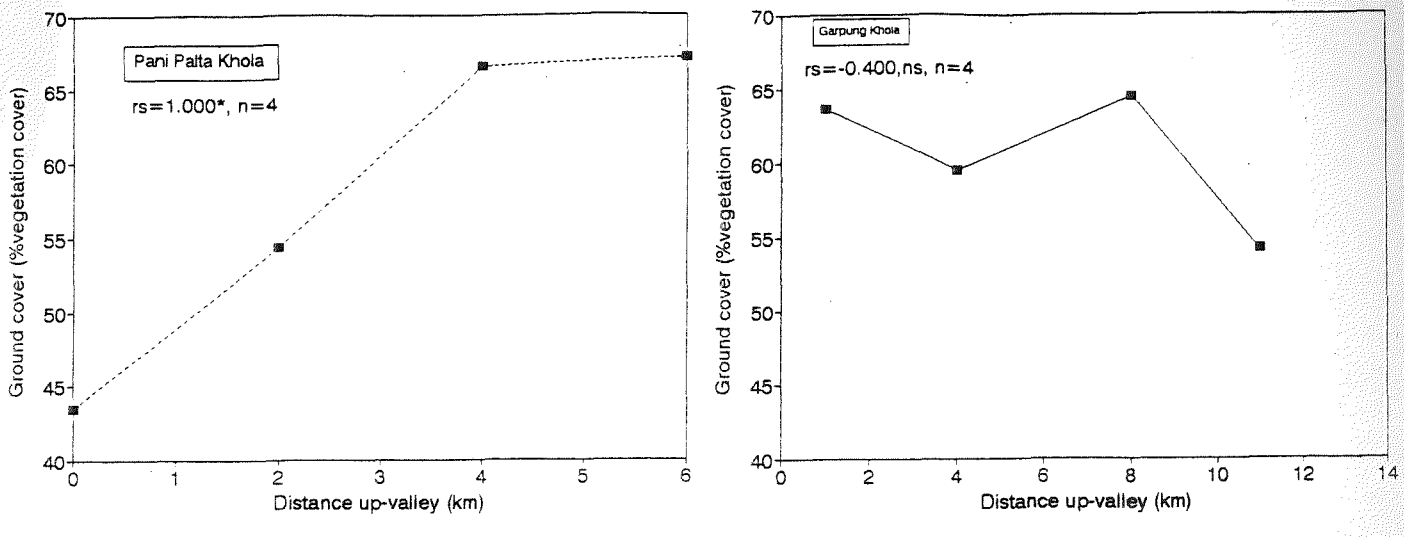

Figure 10: Percentage ground cover on alpine meadows in Pani Palta Khola and Garpung Khola according to the distance up-stream from the confluence with Jagdula Khola, respectively the distance up-stream from Toijam Ranger Post. rs=Spearman rank correlation coefficient; *=P<0.05; n=number of observations.

In Pani Palta Khola the percentage of ground covered by vegetation rises with the distance up-stream (figure 10). This is hardly surprising as the grazing intensity from the 260 yaks is highest in the beginning of the valley where all the yaks are gathered each night (at least at this time of the year). A similar relationship is not found in Garpung Khola. Livestock had not arrived in Garpung Khola at the time of our study but we gather that livestock are more evenly distributed in this valley compared to Pani Palta Khola.

The average ground cover is similar in Pani Palta Khola and Garpung Khola (table 5) (T-test (Campbell, 1981): t=1.21, n=557, m=664).

3.4.4. Habitat use index (HUI).

From the data in table 5 a habitat use index (HUI) is computed. In HUI the least disturbed situation, e.g. lowest coefficient of deforestation (CD), among survey sectors or subdivisions concerned, is given the HUI-value 1. If another sector/subdivision has a *significantly* higher CD this location is given the HUI-value 2. Thus, in regard of forests Pani Palta Khola and Garpung Khola are each given a HUI of 1 and Jagdula Khola a HUI of 2 (according to table 5). The HUI is also applied to quality coefficient of scrub/bushes and to ground cover on meadows.

Sector/ subdivision	Forest habitat	Scrub/bush habitat	Meadow habitat	Average
JK 0-2 km	2	nd.	nd.	2
JK 3-7 km	1	nd.	nd.	1
PPK 0-1 km	nd.	2	1	1.5
PPK 2-3 km	nd.	3	2	2.5
PPK 4-6 km	nd.	1	2	1.5
GK I	nd.	1	1/2	1.25
GK II	nd.	1	2	1.5
GK III	nd.	1	1	1

Table 6. Habitat use index (HUI) in the following survey sectors: Jagdula Khola (JK), Pani Palta Khola (PPK), and Garpung Khola (GK). Jagdula Khola is subdivided according to the distance from the national park boundary, while Pani Palta Khola is subdivided according to the distance from the confluence with Jagdula Khola. See text for explanation on HUI. Differing HUI-values between survey sectors/subdivisions denote significant different coefficients of deforestation, quality coefficient of scrub/bushes, respectively, ground covered with vegetation. A HUI-value of 1 denotes the least disturbed of the subdivisions. nd.=no data.

Valley	Forest habitat	Scrub/bush habitat	Meadow habitat	Average
Jagdula Khola	2	nd.	nd.	2
Pani Palta Khola	1	2	1	1.33
Garpung Khola	1	1	1	1

Table 7. Habitat use index (HUI) in the surveyed valleys. See text for explanation on HUI. Differing HUI-values between survey sectors denote significant different coefficients of deforestation (forest habitat), quality coefficient (scrub/bush habitat), respectively, ground covered with vegetation (meadow habitat). A HUI-value of 1 denotes the least disturbed of the valleys. nd.=no data.

Table 6 gives HUI-values for the different survey sectors and subdivisions while table 7 gives HUI-values for the surveyed valleys. The average HUI-value gives an idea of the degree of human impact on forests, scrub-land and meadows in the specific area. It seems that the human impact is highest in JK which is closer to human habitation than the two other surveyed valleys.

3.5. Interviews with local villagers.

These interviews can provide valuable information but can also lead to mis-information or hardly any information at all as the people of western Nepal are often very suspicious to outsiders asking "strange" questions. Still, we believe that the following information which was kindly given to us by the people of Hurikot, Kaigaon and Pungmi as well as several herders are very likely to be correct.

3.5.1. Livestock.

A total of about 500 people live in the three villages of Hurikot, Kaigaon, and Rimi just outside the national park. Much of their livestock graze within the national park during summer and autumn. The people of Hurikot bring their 200 yaks and cattle and 200 goats to summer grazing grounds in Garpung Khola. During summer the people of Kaigaon bring their 900 goats, 400 cattle and 30 horses to either Garpung Khola or Jagdula Khola. The people of Pungmi bring their 80 yaks, 140 yak/cattle-hybrids and 80 goats to Julung Khola for grazing during summer.

Due to impoverished grazing grounds and/or restricted access to the traditional grazing grounds in Tibet the people of some villages take their livestock far away to find good pastures. Thus, the 260 yaks in Pani Palta Khola had been brought all the way from Saldang.

None of the interviewed people complained about competition for good pastures from neighbouring villages or alien herders.

3.5.2. Livestock depredation.

Leopards seem to be the most notorious livestock depredator in and around the national park. The people of Pungmi complained heavily about a presumed leopard which regularly prey on their goats and occasionally also on yaks and yak/cattle-hybrids. Around Hurikot leopards annually kill about ten yaks/cows and 15-20 goats. The interviewed people only told about minor losses to snow leopards and in some years to wild dogs (*Cuon alpinus*).

During our survey we had the opportunity to inspect the following killed livestock: An adult cow presumably killed by leopard near Hurikot, an adult yak killed by snow leopard in Pani Palta Khola (see chapter 3.1.1.), and a yak-calf killed near Ringmo by snow leopard or leopard.

The people of Pungmi are strict buddhists and do not hunt any livestock depredator, but they have asked the DNPWC for help on the problems with the specific leopard and the irregular wild dogs. In Hurikot and Kaigaon hindus and buddhists live side by side and apparently these people practise some hunting (see chapter 3.6.1.). Even though snow leopards occasionally prey on their livestock the people of these villages claim that they do not hunt the snow leopards, because "it is too smart".

3.5.3. Observations of snow leopards.

Except for Shey, people only rarely encounter a snow leopard. Though, in severe winters an odd snow leopard might venture into Hurikot. Only on rare occasions do local people actually see a snow leopard and then virtually only high up in the mountains.

3.6. Hunting.

3.6.1. Hunting inside the national park.

Except for Jagdula Khola hunting seems to be very limited within the study area. The presence of DNPWC-staff and soldiers along Suli Gad River and in Toijam seems to have stopped virtually all hunting by guns. But in Jagdula Khola trapping is a problem.

We found many traps mainly in remote areas of the valley. Two types of traps were found: Snares and poisoned bamboo spears. The snares were found in high-altitude birch (*Betula utilis*) forest and were put up mainly to trap musk deer, Himalayan monal and an occasional goral, but the snares are not strong enough to hold back a snow leopard. The snares are usually put up in narrow strips of forest on steep slopes. Elaborate barriers made by branches and twigs cover the full width of the forest and the only possible passage for e.g. a musk deer through these barriers is the gates where the snares are found.

It has to be noted that the musk-less females and youngs as well as the males are killed in these traps and this might affect the breeding potential of the local populations. Most snares were non-functioning during the study and are apparently only used during summer and autumn when herders are nearby to check the traps daily to minimize losses of musk glands to scavengers.

The poisoned bamboo spears are usually placed in very steep terrain near rivers or streams where bharals or gorals frequently come to drink. In these places the animals often follow certain routes or ledges to come to their drinking source.

The 60-100 cm long spears are put well into the ground with the sharp, poisoned tip hidden in the vegetation. The poison is made from aconites (*Aconitum sp.*) and after entering the victims bloodstream it kills quickly. Thus, Jackson (1979b) observed an adult 40 kg bharal that had collapsed and died 35 meter from where it had been stuck by a poisoned spear. On rare occasions snow leopards are also killed by these traps.

It is difficult to assess the impact of the traps. But apparently the bharals in Jagdula Khola, Pani Palta Khola and Garpung Khola have had recent experiences with hunting as these bharals are much more shy than in other areas of the national park. In Pani Palta Khola and Jagdula Khola the bharals have a flight distance of 200-400 meter while the bharals in Julung Khola where only very little hunting take place take flight at a distance of 50-100 meter. In Shey where a traditional ban on hunting exists, the bharals can be approached within 5-20 meter.

3.6.2. Hunting outside the national park.

Hunting is one of the great taboos of western Nepal - nobody talks about it but everybody seem to practise it. Thus, many houses in Hurikot possess a gun, but only one man admitted to actually use his gun.

During our trek from Jumla to the national park we were offered several "products" from the widespread hunting in the area. Despite the fact that export of musk from musk deer was banned by the Nepal National Park and Wildlife Conservation Act of 1973, musk deer seems to be the preferred animal to hunt. The musk gland or "pod" is highly prized and used in cosmetics and oriental medicines. In e.g. Churta it is possible to leave an order on a specified number of glands which you will then get later on. According to our information most musk glands are sold to travelling Tibetans or brought by the hunter himself to the Tibetan border.

Himalayan black bear (*Selenarctos thibetanus*) are also popular among hunters. In Chaurikot a Himalayan black bear was shot the previous October in order to stop its habit of raiding crops. The bones and the pelt were thrown away, some of the meat sold to passers-by, and the gall bladder was sold to Tibetans for 9000 rupees. In this area people offer to shoot a bear and give you the gall bladder provided you pay in advance.

We were also offered the pelts and the complete skeletons of two "mountain lions" (leopards or snow leopards) which had been shot near the village of Navakuna. But the hunter never showed us the skins and no price was given. He told us that he would try to sell the skins and skeletons to tourists. If he did not succeed in this he would go to the Tibetan border and trade the objects to goats which he would then sell in Jumla.

The price on snow leopard pelts has dropped since the internationally trade ban on these pelts became effective in the mid-seventies (Jackson, 1979b), and now the bones are probably worth just as much as the pelt.

In Chaurikot the skeleton of a wild dog was offered to us for 2000 rupees. Originally, the wild dog was shot to protect livestock. If the hunter could not sell the skeleton to a tourist he would sell it to travelling Tibetans.

These incidences indicate the existence of a sort of "Tibetan connection" for animal parts originating in Nepal. Trading has always been an important part of life for the people of western Nepal and indeed for the people of Dolpo and Tibet. Today, the trading in animal parts appears to be quite widespread involving musk deer and all major predators.

The bones of leopards, snow leopards and wild dogs are valued by many Chinese for their perceived madicinal properties. The Tibetan buyers probably sell the bones on to Chinese who hope to sell them in a Chinese city and make a profit. Thus, Rodney Jackson (1991) observed a Chinese engineer buying the remains of a snow leopard in a remote part of Tibet. The engineer wanted to sell the bones in Lhasa, Chengdu or Beijing.

This trade is difficult to stop because of the good profits involved on both sides of the border and because policing in these remote border regions is extremely difficult.

However, all animal parts do not go to Tibet. Some of them apparently end up in Kathmandu. In the major shopping areas of Kathmandu fur coats and other fur products involving endangered species are easily available (pers. obs.). A recent survey in these areas (Yonzon, 1991a) counted 1225 fur coats of which 8 were of snow leopard, 25 of leopard, and 20 of
wolf. The presence of these fur coats also represents a negative image to tourists and to the international community.

3.7. Tourism.

With only the southern part of the national park opened to foreigners in May 1989, tourism has as yet not had a great impact on the national park. In 1990 35 foreign tourists visited the national park. This number raised to 291 in 1991, and until May 16 60 foreigners had visited the park during 1992. In the near future numbers are expected to raise substantially though they will probably never reach the level of the most popular destinations in Nepal like Khumbu, Annapurna-region and Langtang.

In accordance with park regulations visitors should be self-sufficient in fuel supply, but park regulations also allow trekking groups to gather dead wood from the forest floor. To our knowledge there has not been any study on the effect of this wood gathering on Himalayan forest ecosystems. But it is highly possible that intense wood gathering will change the insect fauna towards a lower diversity and a lower total biomass. The same scenario possibly also applies to fungi and perhaps to the avifauna, even though the forests in the national park have and probably always have had a low diversity of birds species like many babblers (*Timaliidae*) which are dependent on a rich forest floor litter.

The other problem with this wood gathering is that the borderline between dead wood and live wood is apparently easily crossed. Thus, on several occasions we observed trekking crews cutting down branches from live trees or up-rooting entire live bushes for fuelwood.

Rubbish often follow the tracks of tourism but the park management has already done an excellent work by establishing camp sites at Ringmo and Toijam Checkpost with toilet facilities and rubbish bins. The park management is planning to make similar camp sites in other places along the main trekking route. The idea of fixed camp sites can only be approved as it would efficiently restrict the negative impact of tourist groups.

Currently, tourists are restricted to the Himalayan parts of the national park, but within some years the trans-Himalayan parts might also be opened. With its combination of unique buddhist culture and remote wilderness the trans-Himalayan parts of the national park will act as a new "Shangri-La" on foreign tourists. Especially the monasteries at Shey are very appealing to foreigners after becoming world famous through the books of David L. Snellgrove (1981) and Peter Mathiessen (1978).

When (or if) this area is opened to foreigners a boom of visitors are anticipated. If this boom is not under strict control we expect it to have severe impacts on the fragile ecosystems in the northern part of the national park. Trees are very rare in this desert-like area and the regeration of the *Caragana*-juniper scrub is extremely slow. It will take years to replace any bush taken by trekking groups for fuelwood.

Trekking groups are often very big and easily total more than one hundred persons. These big and very conspicious groups might have a disturbing effect on the very shy snow leopard and also on its prey by disrupting the grazing of bharals which at Shey can be approached within 5-20 meter.

It is neither the scope of this study nor within the academic capacity of the authors to investigate the socio-economic impact of tourism, but it seems obvious that a steady flow of tourists will have a great impact on the culture and economy of the remote villages in the northern part of the national park.

4. Recommendations.

Local people within the study area make wide use of the natural resources for grazing of livestock, for collection of fuelwood, fodder, and building material and for hunting. These activities have an inevitable impact on the environment and on wildlife, both directly and indirectly through disturbances which increase the energy demands and may drive wild animals away to areas of suboptimal habitat.

Despite widespread human activities in the study area wildlife still abounds in many areas and forests and pastures are, albeit used, by no means destroyed. Thus, there is still plenty to protect but active management is needed if Nepal is not to loose one of her finest natural treasures.

The following paragraphs contain our recommendations for management practices to be established and for further studies to be carried out.

4.1. Livestock grazing.

The most important human activity in the study area is livestock grazing. All grazing by livestock is in direct competition with wild herbivores (Wilson, 1981; Fox *et al.*, 1988; Mallon, 1991). Although heavy grazing is evident in Pani Palta Khola and Garpung Khola and signs of grazing were seen on virtually all potential grazing grounds in the study area, no badly degraded pastures were found.

The fact that bharals in some areas occur on pastures also used by livestock indicate that co-existence between wild and domestic animals is possible at low to medium levels of livestock grazing pressure. But in the most heavily grazed areas bharals are more or less displaced by livestock and in many areas any increase in livestock grazing will probably result in decreasing bharal numbers and ultimately decreasing snow leopard numbers.

In e.g. Hurikot numbers of domestic animals have increased substantially during the last decade. Thus, it is important that future trends in livestock numbers are monitored closely. If numbers give rise to extensive competition with wild herbivores or exceed the carrying capacity of pastures it should be considered to redirect livestock to alternative areas. This must be done in close cooperation with the people involved as restricted exploitation of traditional pastures could be economically disastrous to these people. Planned utilization of alpine pastures, i.e. rest rotation grazing, may be the ideal for management of livestock grazing in the national park.

But given the limited resources of DNPWC; the traditional reluctance of the people of western Nepal to submit to new restrictions in their traditional way of life; and all the administrative problems of keeping this type of management functioning it is probably easier and cheaper to provide the local people with alternatives to their livestock.

In some places in Ladakh, India, livestock numbers decreased as people were able to rely on wage-earning to provide a livelihood (Mallon, 1991). Wage-earning is realistic as an alternative mainly in the Himalayan part of the national park and in the villages just south of the park. Sustainable tourism, cottage industries and handicrafts are all income- generating activities which are realistic in this area, and they should all be encouraged.

We suggest that a study is initiated that in participation with the villages will establish the needs and wishes of the people dependent on the national park as well as the possibilities of promoting income-generating activities which are in accordance with the goals of the national park. A part of the study should be to find a donor, e.g. an international development agency, which agrees to finance the initial expences of e.g. a new cottage industry including the establishing of a distribution net and a market for the new products.

However, in the trans-Himalayan part wage-earning is more unlikely as an alternative to livestock. Tourism is non-existing and might be that for years to come, and the villages are so remote that all industries and handicrafts must inevitably be based on local raw material, which would mainly origin from livestock!

Clearly, management of the trans-Himalayan part of the national park is difficult. The area is very remote, and no obvious alternatives to the traditional way of life for the local people exist. But several facts make management less urgent here than in the Himalayana part: Population density is very low, changes take place at a very low speed, the traditional way of life seems to be intimately adjusted to the natural resources, and man and wildlife have co-existed for centuries.

Instead of initiating resource demanding management practices in the trans-Himalayan part, we suggest that an interdisciplinary study is conducted in this area with a clear priority on the impact of tourism on scrub-land, wildlife and the socio-economy of the local communities.

4.2. Fuelwood collection.

All people within the national park including soldiers and DNPWC staff are dependent on fuelwood. Locally this puts a heavy load on forests and/or scrub-land.

In order to restrict the use of fuelwood in villages we suggest that heat-efficient stoves are introduced in all villages within and just outside the national park. The stoves should be easy to make and repair from easily available materials or materials donated by the park mangement on request. We suggest that the stoves are introduced free of charge by the park management to three or four households in each village and hopefully the stoves soon prove themselves to be worth imitating by other households in the village.

To save fuel wood the installation of micro hydro-electric power plants near certain villages should be considered especially if the power plant could be connected to some kind of local industry. The people of Hurikot are actually very eager to get a hydro-electric power plant. The installation of a power plant would probably also help to overcome the negative attitude towards the national park often found by people whose lives depend on the park.

We also suggest that kerosene stoves are installed in every national park and army post starting with the park head quarter at Palam and that regular transportation of kerosene to the area is organized. This would also create a more positive image to foreigners visiting the park.

The 150 soldiers at Sumduwa Army Checkpost take a heavy toll on the nearby forests. We suggest that the DNPWC starts negotiations with the appropiate authorities in order to reduce this large number of soldiers to a more moderate level. It might be suggested that some of the soldiers are removed to Dunai. This would reduce the pressure on the nearby forests considerably.

4.3. Tourism.

We suggest that park regulations demand tourist groups to be wholly self-sufficient in fuel and thus prohibit the collection of dead wood by these groups.

We suggest that a detailed study on the impact of tourism is conducted before Shey or any other destination in the trans-Himalayan part the national park are opened to tourists. This study should include environmental as well as socio-economic considerations.

If the trans-Himalayan part is opened we suggest that the use of fuel wood by tourist groups is strictly prohibited and that a game scout or senior game scout from the national park staff is accompanying the trekking group as a liaison officer. The trekking group should pay the appropiate salary and field allowance of the liaison officer.

4.4. Park management.

Currently, the park management has only few possibilities to survey or patrol any part of the national park more than a few hours from Suli Gad River or from Toijam Rangerpost simply because it has no field equipment at all. We suggest that the park management is provided with field equipment like tents, sleeping backs, binoculars, etc.

More patrolling would probably reduce trapping, reduce burning of scrub-land, and make it easier for the park management to manage the park. To strengthen the management of the park we suggest that game scouts and senior game scouts are offered more education like extensive field courses.

4.5. Implementation.

The DNPWC has very limited financial resources so the recommendations of this and other studies stands a better chance of implementation if one or several external institutions offer to act as donors. We suggest that the DNPWC present their final recommendations for the management of the national park to one or several of the many international development agencies operating in Nepal.

Most of the national park will remain subject to the competing needs of local people and wildlife. The local population will continue to seek the increased prosperity, better transport, education and other facilities which most of us take for granted. Any management strategy for the protection of the environment and the wildlife in the national park will have to take into account the needs of the people and their development, and ensure an equitable sharing out of resources between their needs and those of the wildlife. Thus, we sincerely hope that any financial donor will acknowledge that environmental protection is successful only when paying respect to the needs and wishes of the local people involved.

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APPENDICES.

Appendix 1: Bird species with special significance.
Appendix 2: Data from forest transects.

APPENDIX 1. Bird species recorded within Shey-Phoksundo National Park for which Nepal may have significant world populations according to Inskipp & Inskipp (1986) and Inskipp (1989).

Snow Partridge (*Lerwa lerwa*)
Himalayan Monal (*Lophophorus impejanus*)
Wood Snipe (*Gallinago nemericola*)
Speckled Woodpigeon (*Columba hodgsonii*)
Himalayan Pied Woodpecker (*Dendrocopos himalayensis*)
Rufous-breasted Accentor (*Prunella strophiata*)
Robin Accentor (*Prunella rubeculoides*)
Indian Blue Robin (*Luscinia brunnea*)
Golden Bush-Robin (*Tarsiger chrysaeus*)
White-browed Bush-Robin (*Tarsiger indicus*)
Blue-fronted Redstart (*Phoenicurus frontalis*)
White-throated Redstart (*Phoenicurus schisticeps*)
White-bellied Redstart (*Hodgsonius phoenicuroides*)
Plain-backed Mountain Thrush (*Zoothera mollissima*)
Tickell's Thrush (*Turdus unicolor*)
White-collared Blackbird (*Turdus albocinctus*)
Grey-sided Bush Warbler (*Cettia brunnifrons*)
Grey-hooded Warbler (*Seicercus xanthoschistos*)
Large-billed Leaf Warbler (*Phylloscopus magnirostris*)
Orange-barred Leaf Warbler (*Phylloscopus maculipennis*)
Rufous-tailed Flycatcher (*Muscicapa ruficauda*)
Ultramarine Flycatcher (*Ficedula superciliaris*)
Yellow-bellied Fantail (*Rhipidura hypoxantha*)
Variegated Laughing-thrush (*Garrulax variegatus*)
Green Shrike-Babbler (*Pteruthius xanthochloris*)
White-browed Fulvetta (*Alcippe vinipectus*)
White-throated Tit (*Aegithalos niveogularis*)
Grey-crested Tit (*Parus dichrous*)
Rufous-vented Black Tit (*Parus rubidiventris*)
Spot-winged Black Tit (*Parus melanolophus*)
White-cheeked Nuthatch (*Sitta leucopsis*)
Kashmir Nuthatch (*Sitta cashmirensis*)
Grey-backed Shrike (*Lanius tephronotus*)
Pink-browed Rosefinch (*Carpodachus rhodochrous*)
White-browed Rosefinch (*Carpodachus thura*)
Crimson-eared Rosefinch (*Carpodachus rubicilloides*)
Red-headed Bullfinch (*Pyrrhula erythrocephala*)

APPENDIX 2. Data from forest transects.

Sector	Distance up-valley (km)	Altitude (meter)	Aspect	Slope (°)	Distance from trail(m)	Forest type
JK	0	3120	SW	40	20	Q/c
JK	1	2890	E	40	10	Q/ps
JK	1	2960	E	20	50	Q
JK	1	3550	E	50	200	B/q
JK	1	2960	W	45	20	ps/d
JK	3	3045	E	50	10	M
JK	3	3035	W	40	10	B/d
JK	5	3190	E	40	10	b/a
JK	6	3350	E	45	10	b/d
JK	7	3480	W	45	10	b/d
PPK	0	3820	E	55	3000	B/d
PPK	0	3750	E	50	3000	D/b
GK	4	3570	N	25	10	R/d
GK	4	3620	N	10	10	R
GK	5	3550	N	40	10	B/r
GK	5	3570	N	45	20	B/r
GK	6	3720	N	35	10	B

Explanations. Sector: JK=Jagdula Khola, PPK=Pani Palta Khola, GK=Garpung Khola. Forest type: Capital letters denotes species/genera with >50% occurance in transect, small letter denotes 20-50% occurance. A=*Abies spectabilis*, B=*Betula etulis*, C=mixed conifers, D=mixed deciduous trees, M=mixed trees, Q=*Quercus semecarpefolia*, PS=*Picea smithiana*, R=*Rhododendron spp.* Percent bushes: Percentage of bushes in understorey. Coefficient of deforestation: See explanation in chapter 2.4. dbh=diameter at breast height. n.d.=no data.

Trees per m^2	Bushes (%)	Coeff. of deforest. (CD)			Trees dbh>20cm (%)	Ground cover (%)
		dbh<20cm	dbh>20cm	All		
0.15	4	0.33	1.48	0.86	46	21.1
0.19	2	1.57	1.75	1.60	16	6.4
0.11	6	0.14	0.50	0.30	44	2.8
0.14	n.d.	0.05	0	0.04	14	n.d.
0.055	6	0.50	1.00	0.72	44	23.9
0.066	12	1.07	0.36	0.68	44	12.7
0.086	22	0	0	0	36	2.9
0.15	8	0.85	0.65	0.76	46	15.2
0.21	24	0.08	0	0.06	26	16.2
0.16	16	0.13	0.47	0.26	38	31.8
0.12	14	0	0	0	46	15.8
0.078	4	0.29	0.21	0.26	38	25.7
0.21	8	0	0	0	12	53.1
0.19	2	0	0	0	34	68.1
0.18	12	0	0.42	0.16	38	45.4
0.14	6	0.34	1.06	0.60	36	73.0
0.12	18	0.08	0.69	0.24	26	63.8