A Survey of Snow Leopard and Associated Species in the Himalaya of Northwestern India, Project Completion Report

SUMMARY

A representative blogeographic cross-section of snow leopard habitat in northwestern India was surveyed over a nine month period to determine relative presence of the snow leopard and its prey and to assess the degree and impact of hum.in interaction with these species. The surveys were conducted predominantly at elevations between 3000m and 4500m, and Included approximately 1100 km along major and minor valley routes, plus another 850 km of side-slope surveys and foot travel to access survey sites. Snow leopard sign was found to be most abundant in central Ladakh (Jammu and Kashmir), less so In southern Ladakh, and least abundant on the southern side of the Himalaya in northern Utcar Pradesh and the Pir Panjal Range in Himachal Pradesh. The relative distribution and status of snow leopard as compared with common leopard needs to be more fully investigated in these latter two areas. More than 100 km of individual snow leopard tracks were followed in Ladakh, yielding substantial data on movements and habitat use. Snow leopards were found to use habitats closely associated with sharp breaks in terrain such as cliffs and river bluffs. Two observations of snow leopards near villages and numerous interviews with local people have produced some Insight into both negative and positive interactions between man and wildlife In the high altitude region of snow leopard habitat.

More than 500 Ibex were observed during the surveys In southern Ladakh and northern Himachal Pradesh, and about 7bO blue sheep were counted In all survey areas, mostly In the region of central Ladakh. Ot.her large mammals observed included the Tibetan argali, Ladakh urial, Himalayan tahr, brown bear, and wolf. Some areas appear to have healthy populations of ungulate prey species, whereas others are being degraded by excessive hunting and competition with livestock. It is clear however, that if adequnte and consistent efforts are made to manage wildlife and habitat in Ladakh, there should be sufficient resources for a viable population of snow leopard in this region.

The surveys were conducted in proposed or existing National Parks and Wildlife Sanctuaries, thus making the results applicable in formulating recommendations for conservation site location and management in these areas. For example, the current consideration given by the Government of Jammu and Kashmir toward extending the boundaries of the Herals High Altitude National Park southward to include the Khurnak catchment as a core area (as recommended in this report) should be Instrumental in providing the basis for protection of a good population of snow leopard. Continuation of high altitude ecological studies stressing the comprehensive examination of snow leopard ecology and wildlife - man interrelationships in snow leopard habitat of central Ladakh is recommended for initiation by the Wildlife Institute of India in 1987.

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INTRODUCTION

The snow leopard (Panthera uncia) inhabits the high mountains of central Asia and is considered endangered in every region in wt~ich it is found (Simon, 1UCN Red Data Book 1970), Within India, the enow leopard occurs along the northern border regions in Arunachal Pradesh, Sikkim, Uttar Pradesh, Himachal Pradesh, and Jammu and Kashmir (Prater 1980, Dang 191)7, Osborne et al. 19B3, Mallon 1984). The decline of enow leopard populations in the wild has been attributed to three major factors. First, the snow leopard is hunted by indigenous people for itE valuable pelt and to protect livestock (Jackson 197y04ib, Osborne et al. 1983). Second, ungulate prey of the snow leopard, primarily wild sheep and goats, have been reduced by hunting for human consumption (Schaller 1977). Third, domestic livestock have displaced wild ungulates from preferred grazing areas (Schaller 1977, Osborne et al. 1983). If these trends continue it is doubtful that the snou leopard will survive except in a few isolated areas or in captivity.

The snow leopard's endangered status reflects the human pressures being put on the highlands it inhabits. However, little is known of this secretive animal's behaviour, habitat use, and interaction with human activities. Snow leopard status in IndJ a has not been estimated recently or in a systematic manner, although some initial surveys of its habitat have been conducted (Osborne et al. 19B3, Mallon 1984). The objectives of the present survey project were to ascertain the relative abundance of snow leopard and its associated prey species in several areas of northwestern India, determine factors affecting the conservation of these species and their habitat, and select sites for more intensive ecological investigation of the snow leopard and its high altitude habitat.

The sites chosen for survey were all under consideration, proposed or established as National Parks and Wildlife Reserves. Therefore, results of the surveys will provide input in the selection of appropriate conservation areas and in the development of management plans for these sites. Although the objectives outlined above were the primary ones, corollary information was also gathered on all large mammal species and human natural resource uses within the survey areas. It is hoped that this information will provide a base for developing further wildlife conservation research and management programs in India's high altitude region.

SURVEY AREAS

The areas covered during Che survey include a comprehensive array o£ representative enow leopard habitats throughout northwestern India. Portions of the states of Jamrau & Kashmir (Jf-K), Himachal Pradesh t H . P .) , and Uttar Pradesh (U.P.) were surveyed. The survey sites were all within the alpine, subalplne, and arid desert zones of Himalayan and trans-Himalayan mountains. They ranged from Che high desert Zanskar mountains of central Ladakh, through the somewhat moister alpine Himalayan crest region, to the moist alpine meadows and subalpine foresCs of the southern slopes of the Himalaya in norChern and Uttar Pradesh and the Fir Panjal Range in Himachal Pradesh. The elevation of survey areas ranged from 2000m to 5000ra, with work concentrated between 3000m and 4500ra. Survey locations are indicated on the map in Figure 1.

Initial surveys (9 November-22 December 1985) were located in the upper Suru Valley, (3V 5 'N , 7&^{0}40^{1}E), south of Kargil in Ladakh, Jammu and Kashmir. Further surveys in this general location, and over Pens! La to Padum in Zanskar, were conducted from 26 June to 15 July 1986. This area includes Che proposed Rangdum Wildlife Reserve. The Markha Valley region (33^{B}45'N, 77°30'E), south of Leh, Ladakh, was surveyed 1-15 January 1986, from 23 February to 2H March 19S6-, and during 4-8 July 1986. -^k^s region includes the proposed Herais National Park. The Shang wildlife Sanctuary, northeast of and adjacent to Harkha Valley, was surveyed from 31 December 19B5 to 6 January 1986, and again during 8-11 July 1986. Areas to the south of Markha Valley and under consideration for protecCed status, were surveyed from 26 June to 4 July 1986. The Himalayan crest region in Che vicinity of Shingo La (33^{P}0'N, 77°5'E) was

surveyed from 12-21 June 1986 a? far as Jispa in Lahul, Hlraachal Pradesh and Padum in Zanskar, Jammu and Kashmir.

The upper Supin and beech Kopri valleys of the TonSjRlver catchment Ol'O'N, 78°25'E), within the Govj.nd Pasliu Vihar Wildlife Sanctuary of northwestern Uttar Pradesh, were surveyed from 7-30 April 1986. In Himachal Pradesh, western and southern drainages from Che Deo Tibba massif east of Manali, the upper Parbaci River catchment southeast of Manall, and the Solan nallah northwest of Hanali (32° 10'N, 77°30'E), in Himachal Pradesh were surveyed from 8 Hay to ^ June 1986. This area is just north of the proposed Great Himalayan National Park, arid under consideration as a possible extension of the park. A full field work itinerary for the research team Is provided in Appendix I.

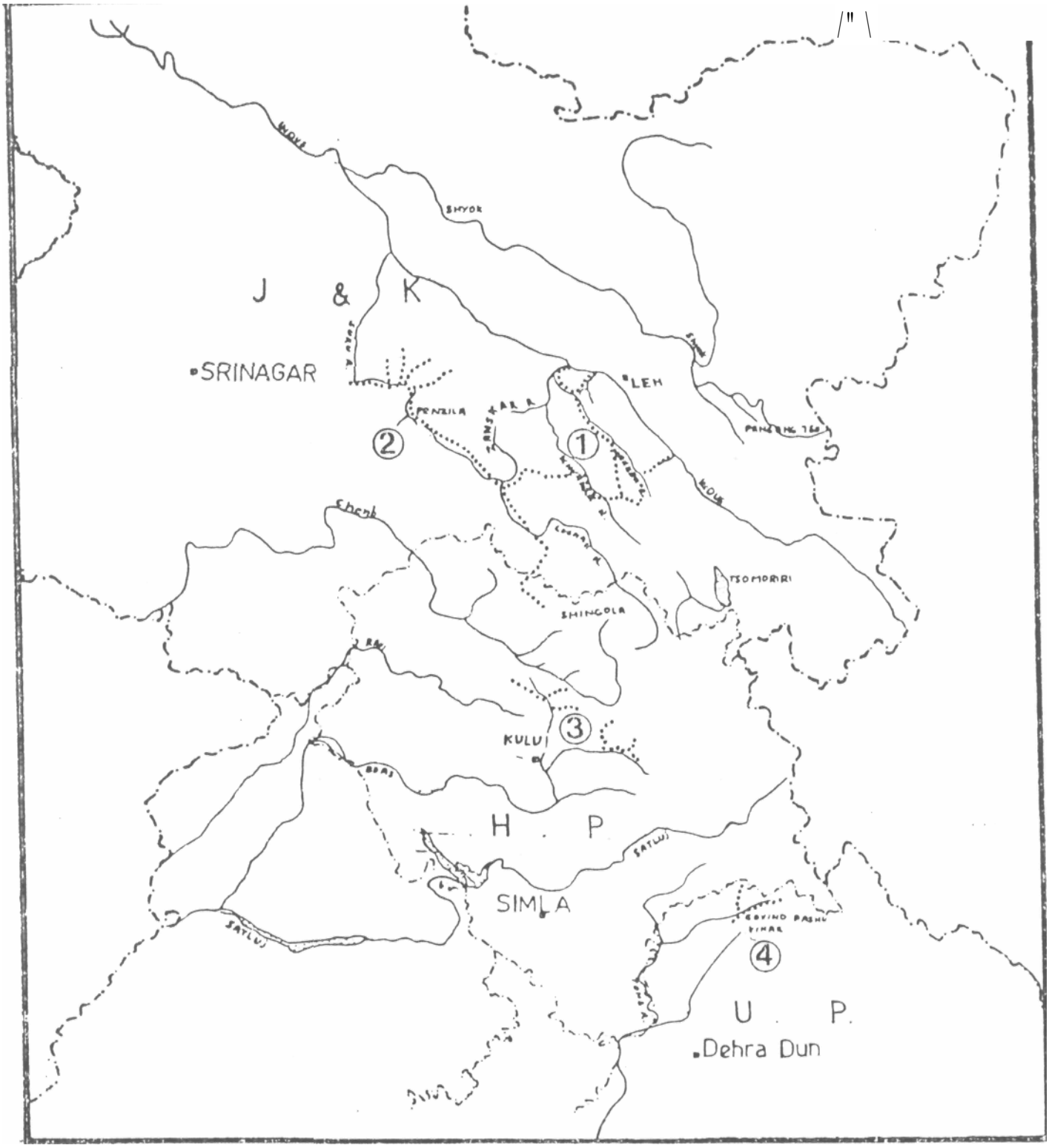

Figure 1. Map of snow leopard survey areas in northwestern India: 1) Central Ladakh (J&K) - Harkha and Khurnak regions, 2) Southern Ladakh (.J&K) - Upper Suru and Zanskar regions, 3) Kulu-Manall region (H.P.) - Upper Beas and Parbatl catchirents, 4} Govind Pashu Vih'ar Wildlife Sanctuary (U.P.) - Upper Tons Valley. The main survey routes are shown with dotted lines.

The surveys were conducted on foot, travelling major and minor valley systems within the areas concerned. Tributary valleys (nallahs) and, occasionally, ridges were also Inspected along most of the survey routes. Evidence of snow leopard presence was based primarily on the existence of tracks and scrape markings, whereas the ungulate prey species could usually be located visually. Counts of enow leopard sign and ungulate numbers were tabulated for 5 km sections (characterised by habitat data) along the valley survey routes (Table 1). Evidence of other mammalian species was determined from sightings, tracks, and droppings. The surveys were conducted through the winter to early summer to take advantage of snowfalls for tracking. The survey routes were scanned visually using Bx23 binoculars and 15-60 power spotting scopes.

When a set or sets of snow leopard tracks were encountered, they were followed as long as visible, or as long as time and terrain permitted. Along these track routes at lUOra intervals, data was collected on habitat characteristics (Table 2). The number of fresh scrapes, spray sites, and droppings within each 100 m interval was recorded.

A randomly selected subset of all scrapes and spray sites encountered in the surveys was used to collect descriptive data on physical dimension and associated habitat characteristics for these marking sites (Tables 3 *f*> 4). Measurements and photographs of representative snow leopard pugmarks were taken where there were good impressions in each track-set. Snow leopard scats were collected for later analysis of food habits. When visual observations were possible, a detailed account of the snow leopard's behaviour was recorded.

Evidence of the large alpine and subalpine ungulates was obtained primarily from visual observation. Tracks and droppings were used to supplement this information, and provided important evidence for presence of the high elevation forest ungulates. When visual observations were made, data was recorded on habitat use, activity, and group compos 1tion whenever an ungulate group was first encountered. The data collected is outlined In Table 5. In the case of ibex in the upper Suru Valley (because of a relatively permanent camp in this area), the data outlined in Tab]e 5 were recorded at *1/2* hour intervale to provide information on daily patterns for these parameters.

For large carnivores other than the snow leopard, (i.e., wolf, lynx, brown bear, black bear), habitat data as outlined in Table 2 for snow leopard was collected whenever tracks were encountered or animals observed. If time permitted extended observation or the following of tracks, then behaviour and/or the habitat over the route of tracks was described. Scats were collected for food habits analysis.

(Tables and charts have not been included)

Visual observation, presence of tracks, droppings or other evidence were recorded whenever mammals were encountered in a survey area. A general description of habitat was prepared when such

evidence of a species presence was found. When extended visual observations were possible, description of behaviour and habitat use was recorded.

Within the survey areas, data was gathered on human population size, land ownership, numbers of livestock, grazing land rights, human use of natural resources, and interactions with and attitudes toward wildlife. Much of the information was obtained through interviews with local village leaders or government officials. In addition, inhabitants of the survey areas were questioned regarding their experience with and attitude toward the snow leopard and other wildlife. The general questions put to local inhabitants are outlined in Table 6. During the surveys, the research team was accompanied by local wildlife officials or guards from each area. These individuals were questioned thoroughly regarding their knowledge of local land use practices, hunting activities, and attitudes toward wildlife. They also acted as interpreters and were invaluable in the interviewing of local villagers.

Vegetation identification and description was carried out concoramittant with the survey transeccs. Whereas vegetation classification relevant to large mammal habitat use was a primary concern, application of vegetation types described by previous workers was made wherever possible. In general, the vegetation was separated into major physiognomic groups: forest, shrubland, and herbaceous or graminaceous meadows. Within these groups vegetation types were identified and categorized by dominant species.

Table 6. Interview questions posed to villagers living within the area of the snow leopard surveys.

1. Name
2. Village
3. Occupation
4. Have you ever seen a snow leopard? If so, when, where and how many?
5. Do you know of any snow leopard kills of livestock? Yours or others? When? What type of livestock? How many?

b. Do wolves, lynx, bear, eagles or other animals kill your livestock? If so, to what extent? *1*. Are wild animals depriving your livestock of food, or eating/ destroying your crops? If so, wliich ones and to what extent? 8. Do you or people you know hunt or trap? Do other people in the area do so? If so, what, how, when and where? y. What does your religion dictate about man's relationship to his surroundings (e.g. wildlife)? 10. Do you know that the government is Interested in protecting/ maintaining the wildlife of your area? Is this necessary? How will it affect your lifestyle?

Survey conditions^

Winter surveys proved feasible in the Himalayan crest region until mid-December 1965, after which heavy snows made travel very difficult until the following April. Travel in central Ladakh was possible in some areas throughout raid-winter, allowing surveys in this region. During November and early December, snowfall was sparse throughout the western Himalayan region and not sufficient for productive tracking. In late December a light snowfall C»-6 cm) in central Ladakh provided excellent tracking conditions during *a* subsequent dry spell in January. During February and March in central Ladakh, frequent light snowfalls provided good but short-lived tracking substrates. April and Hay on

the southern slopes of the Himalaya were characterized by frequent light snowfalls that also provided good but short-lived tracking conditions, similar to that on the deep but fast melting snowpacks in this region. In June and July the best tracking substrate was on the rapidly disappearing snowpacks, with markedly less suitable substrates on trails and open slopes.

Temperatures during winter in Ladakh typically dropped to -15 degrees C to *-20* degrees C at night and warmed to near freezing on sunny days. The lowest temperature we recorded was -24 degrees C. Weather and snow condItlons precluded at tempts at surveys in the upper Suru Valley in February and the Khurnak Valley {south of Harkha) in March. However, during the rest of the survey work, only occasionally did adverse weather conditions prevent planned survey work.

On the southern side of the Himalaya Jn Uttar Pradesh and the Pir Panjal in Hiraach.il Pradesh, the snowllne in April was about 2750m on north aspects and 3y50ro on south aspects and rose by about 25Um by the end of May. These conditions limited the upper range of survey work to within about 200m elevation of snowline. After late June, the snowline was above 4500 m in northern Lahul and southern Zanskar, and was above 5200m in central Ladakh.

Distances surveyed

The research team conducted approximately 1100 km of surveys along major and minor valley systems, including the resurvey of several areas. Work conducted above the valley-bottom travel routes contributed an additional 450 kra to the survey effort. A further 125 km of foot travel was required simply to reach or depart from the survey locations, and in some areas the survey routes had to be retraced on return. The total distance travelled during the nine months of survey was nearly 2000 km.

Ninety-five kilometers of Che main upper Sum valley and an additional b5 km of tributary nallahs were surveyed several times in November-December. In the Markha region during January, 30 km of the Shang valleys, 60 km of the Harkha valley, 35 km in the Rumbok and Shingo nallahs, and 25 km Jn the Alam and other tributary nallahs were surveyed. During February-March the 60 km main Harkha valley and 35 km in the Rumbok and Shingo nallahs were resurveyed along with an additional 50 km in tributary nallahs.

The April survey in Govind Pashu Vlhar encompassed BO km in the main valleys of the Supin and Beech Kopri rivers, and an additional A5 km in tributary nallahs. In the Manali region during May, 95 km were surveyed in the upper ParbatL catchment and the Jagutsukh, Hampta and Solan nallahs, with an additional 25 km in sIde-nallahs.

During June, 36 km of the upper Bhaga and Jankar valleys in northern Lahul were surveyed enroute to southern Zanskar where another 1UO km along tlie main Kurgtakh-Lung Nag Cliu valley and 35 km in side-nallahs were covered. Late June-July surveys included 95 km of the

upper Zanskar valley, a resurvey of 60 km in the upper Suru valley, and 75 km of main valley (plus *2")* km in side-nallahs) along the route through Khurnak valley between Zangla and the Harkha valley in central Ladakh. Twenty-five kilometers in the upper Harkha valley and 40 km in the Shang valleys were also resurveyed in July.

The approximent areal extent of the region surveyed was 1450 sq km in central Ladakh, 2150 sq km in southern Ladakh, 265 sq km in Lahul, 4yO sq km in Kulu-Manali region, and 5JU sq km in Govind Pashu Vlhar.

Vegetation

The areas traversed in the "Snow leopard surveys included a wide range of vegetation types, from moist temperate forest, sub-alpine scrub, and alpine meadows, through Himalayan dry temperate forest and alpine types to the high elevation steppes and desert herb communities on the north side of the main Himalaya Range. Previous vegetation work in the survey regions includes classifications by Champion and Seth (1960), Heusel and Schubert (1371), R_au (1974), Kachroo et al. (1977), Puri et al. (19a3> and Uhar and Kachroo (1983), which are referred to where appropriate.

Central Ladakh

The Markha, Khurnak, Rumbok and Alum valleys of central Ladakh are high elevation desert habitats (Utiar and Kachroo 19H3). They are characterised by very sparse grassland and herbaceous vegetation on mountain slopes, with shrublands and patchy forest in the valley bottoms (Hartmann 19H3).

Forests - Dense 5 to 10 m tall forests of Hippophae salicifolia. Salix spp., Hyricaria e^leg^ans, and ^ R.os_a webblana occur in patches on moist valley bottoms up to about 3500m. About ^0 percent of valley bottom land below 35UOm is covered with this forest, but it represents less than 1 percent of the total land area. Populus spp. are cultivated In widely scattered patches up to about 370Um, again only on moist valley bottoms. Open Juniperus macropoda woodland is occasionally present on slopes and valley bottoms between 3300 and 'iSOUm, and is best developed in the lower Khurnak drainge and vicinity. Big tula utills and wild Populus sp. also infrequently occur in moist sites along some valleys.

Shrublands - The mixed forest described above becomes gradually less than 5ra tall at elevations above 3500ra. It also grades into almost pure H_ig£Opha_e_salicJfolla_ and It. rhamnoides and extends up to about 4000m on the valley bottoms. In some small tributary valleys, open 5m tall stirublands of almost pure *S_ali*x spp. occur along the valley bottoms. Above 4000m, again on valley bottoms, Hippophae rhamnoides sometimes forms low (30cra) dense thickets and Hyricaria sguamosa occurs as isolated individuals. Scattered individuals of Rosa webbiana, Lonicera spp., Ephedr a gerandiana and Juniperus macropoda, occur on mountain slopes up to about 4000ru. Caragana sp. occurs in patches; on gently sloping uplands between 'i300m and 5000m. Overall, slirublands cover less than 5 percent of the total land area.

Meadows - Central Ladakh'e mountains are vegetated primarily with a

sparse cover of graminaceous and herbaceous plants, witii a ground cover generally less than 15 percent (Hartmann iyb3). Dominant species in these communities include Stachys j.j-jaej:*i.c*a , Fotcnti 1 l_a_ spp., Artemisa spp., Polygonum spp., and Agrostis spp. Other common species are Foa spp., Ra n un_culu_s_ sp., Corydal_is_ sp., Rheum sp., Nepata sp., and Leontopodium jacolianum. On valley bottoms, patches of sedge-grass meadows occur which are dominated by Carej< spp. and Kobresia sp.

Southern Ladakh

Forests - There is virtually no forest cover in the upper valleys of southern Ladakh, although some cultivated popular (Populu^s itajj-ca, _P. iiigra) and willow (Sa l ix spp.) are present along water courses in the lower portions of our survey area. Patches of birch (Betula utilis) forest apparently were present (probably up to 38UOm) in the past but currently the species Is almost extinct in the region.

Shrublands - Shrublands are present on the lower slopes and floors of the upper valleys (.above 3600m), but are nowhere extensive in cover. The most common shrubs are willows (Salix spp.), and form two distinct vegetation types. On northerly aspects, moist slopes and gullies, as well as valley bottom wetlands, a 1m tall ,->a_li_x_ spp. forms thickets, sometimes with a dense understory of sedges and grasses. Restricted to a several hectare area of valley washes In the vicinity of Rangdura Gompa (where they are protected) and a few other locations, widely spaced 2-3m tall Salj-j^ spp. shrubs, with virtually no understory, form the second type of willow shrubland. Scattered on hillsides up to about 4300m shrubs Rosa webbiana, Ephedra gerardina and LonIcer a spp. occasionally occur. Juniperus spp. shrubs appear to be very rare in this region. *I* ly ric a r i a spp. is sparsely distributed on the river washes and sometimes associated with the valley^A^bottom willow thickets.

Meadows - The upper valleys are dominated by large grassland and herbaceous meadows covering approximately 60 percent of the land area up to 500Um. The remaining area other than shrublands is sparse herbaceous vegetation on rock outcrops and scree slopes. Sedge-grass meadows dominated by Carex spp. and Kobresla sp. occur in patches on relatively moist slopes, especially on northerly aspects and on much of the valley floors. Grassland meadows, dominated by Agrostis canina, Agropyron repens , Ely cms nutans, and Poa sp. occur primarily on southerly slopes of 15-20 degrees and are well-developed on some uplands. Percentage cover in these meadows is typically around 3U-50 percent. Herbaceous meadows dominated by Artemisia sp. and lesser amounts of Anemont^ rupicola, Cicer microphylum and Astragallus zansharansis, and Ara i z a n t h u sp. occur in patches on relatively dry slopes of 30-40 degrees and cover is generally about 25-30 percent. Rocky outcrops and scree slopes support a sparse cover (<25X) of herbaceous (e g., Saxifraga spp.) and graroinoid (eg. Kobresia sp.) species.

Kulu-Manali and Govind Pashu Vihar

On the southern slopes of the Pir Panjal Range In Himachal Pradesh and the main Himalaya Range in Uttar Pradesh, the vegetation Is characterized by moist temperate coniferous forests, subalpine shrublands, and alpine meadows (Champion and Seth lyfaO, Gupta Meusel and Schubert 1971, Puri et al. iy»3).

Forests - Above 25UOm, moist temperate coniferous and broadleaved forests cover much of the elopes up to 3500m on southerly aspects and 3BOOm on northerly aspects. The coniferous forests include the deodar (Cedrus deodara) and blue pine (Pinus wal_l_i_chi ana) in the lower part of Cliis elevation range, with silver fir (Abies glnd^rpjj) and spruce (JPl_ce_a gmithiana) common in the middle level and the fir (Abies spectabills}) and yew (_Taxus_ tiaccata) more prevalent at higher elevations. Broadleaved forest species Include the evergreen oaks Quercus floribunda and (). semecarpifolia, deciduous maples (Acer spp.), walnut (jugj.ans regla), alder (Alnus nepalensis), horse chestnut (Aescuiuj^ indica), hazlenut (Corylus colurna), wild plum (Prunus padus), birch (Betuls utj. 1.Ji_s_), and sometimes Quercus semicarpi folia on southern aspects. Patches of the broad leaved species commonly occur In moist areas along stream sides and side-valley depressions. Understory species in the moist temperate forest Include Indigofera cp., Viburnum sp., Strobilanthus sp., Adlantlum sp., and Ski^mmia sp.

ShrubJLandjs - Near tlmberline Rhododendron campanula turn, a common understory species in the upper birch •• fir forest, sometimes forms dense shrub thickets. Around subalpine meadows Viburnum grandiflorum occasionally forms patches of shrubland. Rhododendron lepido t urn dominates dwarf shrublands especially along glacier moraines and other raised areas in the lower alpine areas. Junipejrus communis and J_. recurva form dense shrub patches on slopes between 4000m and 4300m, as does Gas slope fastigiata in limited areas.

He ad ows_ - Lush grassland meadows dominated by Phleum a Ipl num, Hierochloa sp., Bro_m_u_s sp., l^a^sp., _Carex^ spp. and KobresjU sp., are typical of southerly slopes and shelves In rock outcrops between 30UUm and 4UOOm. Moist subalpine and lower alpine meadows In the valley bottoms are dominated by herbaceous species such as Potentilla spp., Geranium sp., Ranunculus sp., Arenaria sp., Anemone sp. and Hypoxis aurea.

Wildlife presence _and habitat *use^*

Snow leopard (Fanthera unc^ia) shan, kogh, barfani chitwa

Regional surveys -Central Ladakh

Markha Region - Two snow leopard sightings, with a total of 30 hours of observation, were made In March. During the January surveys 32 km of tracks were followed; a total of 13y scrape markings and about 25 spray sites were counted. In February-March another 2b km of tracks were followed, 123 scrapes and about 15 spray sites located. Measurement data was obtained from a total of *ib scrape sites and 52 spray sites. One recent kill of a blue sheep was discovered and two probable old kills of blue sheep were found. Reliable reports of about 45 of domestic livestock killed by snow leopard were received during

our stay. Forty-seven snow leopard scats were collected.

Khurnak Region - Two hundred nnd eighty-four enow leopard scrapes and three very short sets of tracks were observed In the Khurnak area in June-July surveys. Measurement data was obtained from 5 scrapes and 2 spray sites. One probable snow leopard kill of an adult male blue sheep was found in this area and forty-seven snow leopard scats were collected.

Southern Ladakh

Upper Suru - Snow leopard tracks were found covering a distance of b km during the Nov.-Dec. surveys. Only ten scrape markings and no spray sites were found In this area. One possible kill of an adult male Ibex was discovered in the Itchoo nallali (A20Um) In December, and a snow leopard kill of 2 ibex In the main Suru valley near Parkachek (3700m) was reported to have occurred in January. Six snow leopard scats were collected in the upper Suru valley. One snow leopard skin was shown to us at the Rangdum monastery. No recent sign of snow leopard was found during the July surveys in the valley.

Southern Zanskar - Sixty snow leopard scrape markings and ly spray sites were found In the Lung Hag valley during June. Measurement data was obtained from 29 scrapes and 16 spray sites. Four sets of tracks covering very limited distances were found in this region and six snow leopard scats were collected.

Govlnd Pashu Vihar

About 1 km of leopard (snow leopard or common leopard) tracks were found In the upper Beech Koprl valley and above Sankri-Taluka in the main Supln valley. One old scrape site was found and one leopard scat collected.

Kulu-Manall region

About 't km of leopard (snow leopard or common leopard) tracks were followed in the Haropta nallah and the upper Parbati valley. No scrape or spray sites were located. One leopard scat was collected.

Bhaga-Jankar valleys in Lahul

No direct evidence of snow leopard was found in the 36 km of surveys here, although reports document its presence.

Evidence of snow leopard presence along 920 km of the main valley survey routes, separated by the major regions of survey, Is summarized in Table 7, Sign was most prevalent in Ladakh, especially in the central region. Acknowledging a high degree of variability in Ithe occurrence of enow leopard sign over the survey routes, the relatively high density shown for central Lgdakh appears to reflect a real difference in snow leopard abundance and suggests this area as the best surveyed for snow leopard to dace. Seasonal differences in sign frequency are related in part to the presence of snow in winter which tends to conceal old scrapes and enhance track visibility (see also

Table B) . Both snow leopard and common leopard are known to occur In the Govlnd Pashu Vihar and Kulu-Msnali regions. The leopard species responsible for tracks found in these regions could not be positively identified. Nevertheless, the limited number of typical snow leopard scrape markings found in these areas suggests a relatively low occurrence of this species.

Habitat -

based on the gross habitat characteristics estimated over 5 kilometer sections along the survey routes, the occurrence of snow leopard sign and its ungulate prey was associated with relatively steep and rugged terrain (Table ii). The variability associated with the presence and abundance of snow leopard sign was high, due both to terrain and seasonal influences (as mentioned above). For example, although snow leopard scrape abundance was clearly associated with the presence of valley-bottom cliffs (Figure 2), some survey sections with abundant cliffs of this type had few or no scrapes (due to ice or snow cover In winter; frequent livestock traffic or hJgh water in spring-summer) whereas others (e.g., with major stream confluences) had numerous scrapes. Still, the association of snow leopard sign with rugged terrain Is clear. More detailed information on snow leopard habitat use was derive^ from following their tracks.

Snow leopard track routes were characterized with regard to habitat at lUOm intervals for a total of 58 kilometers, all during December-March In Ladakh. Twenty-six separate sets of tracks were followed, twelve of single Individuals (27km), nine sets of two individuals (21 km), four sets of three individuals (9 km), and one set of four individuals (1 km). The tracks were found at elevations between 330Um and 4725m, with a mean elevation of 4040m (n=57b, SU=323). Nine kilometers of cracks were along ridgetops, 2U km on mountain slopes, and 29 km on valley bottoms.

Slope aspects were not used randomly ([1=578, X-square~44, p<.001), but the Indicated preference for westerly and avoidance of easterly aspects is a reflection of the east-west trending Markha Valley where most data was collected. The mean slope angle on mountain slope travel routes was 3b degrees (n=201, SD^ll), on ridge top routes 28 degrees (n=B8, SD=9), and on valley bottom routes 15 degrees (n=289, SD=11). Along mountain slopes and ridgetops, -snow leopard travel routes traversed broken terrain for 49 percent (n=289) of the distance, whereas along valley bottoms 78 percent (n-28^) of

Table 7. Frequency of snow leopard sign along major valleys In four survey regions.

Survey location	Month	Km. of survey	Frequency of snow leopard sign	
			km- travelled per track found	Scrapes per km.

Govind Pashu Vihar *	April	HO	4U	0.01
KulU-Manali	May	y5	48	none
Southern Ladakh	June-July	255	64	0.2
	Nov. -Dec.	*5	23	0.1
General Ladakh	July Jan. - March	130 2b5	44 a	2.6 1.1

* sign could be snow leopard or common Leopard.

Table 8. Average 5 k.rn sect-Ion habitat characteristics associated with the occurrence of snow leopard sign and ungulates.

Category	Snow leopard^ scrapes	Snow leopard tracks	Ungulates	Survey habitat
	n=673	n=45	n=14Zb	n=184
Elevation of valley bottom (m)	3800	3H5U	39UO	3750
Valley side slope angle (degrees)	43	41	3b	35
Percent of valley bottom with cliffs	M	48	29	27
Percent of valley slopes with cliffs	45	45	36	35
Valley width (m)	66	7b	Ibl	*225*
Percent snow cover on valley sides	20	5V	3U	28
Snow depth on valley bottom (cm)	*2*	7	5	"5

the travel route was over smooth terrain. However, fifty percent of «11 track locations were within 5 meter of sharp breaks in terrain such as cliffs and river terrace bluffs and 75 percent were within 30m. Habitat use by snow leopard, as compared to blue sheep and ibex, is presented in Table 9. Especially in terms of its travel route's close association with cliffs, the snow leopard is using habitat frequented by blue sheep and ibex (Figure 3).

The vegetation occuring along snow leopard travel routes is probably consequently related to a primary selection for the terrain characteristics outlined above. The most commonly traversed vegetation types were herbeaceous communities (e.g. Sjiachys sp. dominated slopes, and mixed herbeaceous types along ridgetops and in river gravels in the valley-bottoms). Vegetation percentage cover along travel routes averaged 11 percent (11=578, SD=14), which reflects the generally sparse vegecatlon cover in this region, especially during winter. A high percentage of snow cover along travel routes (snow depth was commonly only a few centimeters) was associated with the ease of following tracks in snow. Snow cover was 58 percent (n=28V, SD=38) along snow leopard ridge top and mountain slope travel routes, and 89 percent (n=2«y, SL)=22) on the valley bottom routes.

Marking sites -

Sixty-eight fresh snow leopard scrape markings were found along the ^y km of tracks, t>5 on valley bottom routes, three on mountain slopes, and none on ridgetops. Spray-marks (marking could not always be directly associated with the tracks being followed) were located at 2V sites, all along valley-bottom routes. Fresh scats were found at eight locations. The habitat associated with marking sites (scrapes, sprays, and scats) was characterized by close proximity to cliffs, gentle terrain, and low slope angle.

From the hundreds encountered, eighty snow leopard scrape markings were randomly selected for measurement of dimension and associated habitat characteristics. Sixty-four (8U/1) of the scrapes were found adjacent to cliffs, the remainder either near free boulders or slight breaks in terrain (e.g., stream bank, trailside). The mean distance from cliff, boulder or other break in terrain was 45cm (SD=48). Substrates in which scrapes were found included snow (24/i), cl ay *(237.)*, sand and sand-gravel (1UX), light-gravel (ly/i), gravel (^0%), and coarse gravel (5!i). Dimensions of the scrape marks were: total length (pit and pile) 3bcm (SD=7), length of pit 20cm (SLF4), width of pit 19cm (SD=5), depth of pit 5cm (SD=2), height of scraped-up pile 6cm (SI>=3), Twenty percent of the scrape piles had noticable urine deposits on them.

Table V. Comparative habitat use characteristics and population composition for snow leopard track locations, blue sheep and ibex visual observations.

Category	Snow Leopard	Blue sheep	Ibex
Mean elevation (m)	404U	42UO	43UU
Mean slope angle	24°	31°	31°
Mean distance from cliffs (m)	35	*72*	62

Mean group size		11	13
Composition		103oV: lUOo.0.: 39yr:97kid	yio*6":KJDjo.: 23yr:7Bkid

Seventy snow leopard spray sites were characterised, 53 occuring on rocky outcrops, 11 on free boulders, and 6 on trees. The spray mark was commonly located on the underside of a protruding outcrop or boulder. The mean height of the spray mark above ground level was yocm (SD-13) and mean distance out from Che cliff surface or boulder-ground contact was 56cm (n=30, SD=29). The angle of the surface sprayed, relative to a level ground surface, averaged Ib6 degrees (SD-36). Forty-four percent of the spray sites were judged to have only light use, (one or two marks visible), 44 percent with moderate use (3-5 markings visible), and 12 percent with heavy use (>5 markings). Odor was discerned at 27 percent of the spray marks light, *7″,* moderate odor).

Ungulates

Blue sheep (Psoudois nayaur)

In the Marklia region, approximately 150 blue sheep were observed during the January survey, and 470 during the February-March surveys In parts of the llemis National Park. The Jnmimi & Kashmir Department of Wildlife Protection (J&K. DWP) estimates a total population of 1500 In the park. In the adjacent Shang Wildlife Sanctuary, 230 blue sheep were observed where the J&K DWP estimate is 260. Blue sheep do not normally occur within the upper Suru valley survey area. However, one young male was observed at 42QOra on southerly slopes about 3 km northeast of Zulidok village. This area was within the range of an Ibex population, and about 2U km from the nearest known population of blue sheep (i.e. south of Fotu Ua). In southern Zanskar, ten blue sheep were seen on the northern side of the Kliurgiak Gnu within 10 km of its junction with the Tsarap Cliu. On the route between Zangla and the upper Mafkha valley (Zalung-Karpo La) 6U blue sheep were observed In late June and early July. Another 150 blue sheep were observed during July in 'ft resurvey of the upper Markha valley above Hankar, along with 230 individuals In a resurvey of the Shang valleys. In the upper valleys of Govind Pashu Vlhar 5U blue sheep were observed, and in the upper Parbati catchment (Kulu-Manali region) 90 blue sheep were obse rved.

Blue sheep population densities were 1.3 per sq km In the 190 sq km Shang'Wildlife Sanctuary and (using the J&K DWP (1V85) estimate of 1500) 1.2 per sq km In the Herais National Park (1200 sq km). In the sruali areas of suitable habitat surveyed in Uttar Pradesh arid Hiroachal Pradesh, blue sheep densities were close to one per sq km (calculated on the basis of alpine habitat). Mean group size of the 163 herds of blue sheep observed, was 11 (SD-11). During winter surveys, the population composition was 103 males:lOO females:39 yearlingsi'J? kids (n=3i*fa). In early summer surveys the ratio was 171 males : 100 females:48 yearlings:57 kids, probably reflecting the

isolation of females and new-born kids in small groups In concealed

locations at this time of year. The first new-born kids observed in central Ladakh were encountered in late June (28 June, however no classifications had been made since 1& June).

Blue sheep were found at elevations between 3350m and 4y50m with a mean elevation of 4200m (n=163, SD=315). Mean slope angle on which blue sheep groups were located was 31 degrees (SU=10). Blue sheep were found predominantly (61 percent) on smooth terrain, however 63 percent of all locations were within 50m of cliffs (»4% within 150m) (Figure 3). There was no preference for slope aspect by blue eheep in central Ladakh. However, in northern Uttar Pradesh and Himachal Pradesh, where in April and Hay snow lay deep on northerly aspects, there was a preference for south-facing slopes. Vegetation types In which blue sheep were found in Ladakh were predominantly the mixed herbaceous, grass, and Caregena types, whereas in Uttar Pradesh and Himachal Pradesh, grass, and sedge-grass types predominated. Characteristic of these vegetation types, percentage plant cover in blue sheep locations was 15 percent in Ladakh and 38 percent in U.P, and H.P. combined .

Ibex CCapra ibex) skin, tangrul, kail

Approximately 250 ibex were observed in the upper Suru Valley and another 225 along the Khurgiak - Lung Nag valley, both in southern Ladakh. Ibex do not generally occur within the Markha valley region, and no evidence of their presence was observed. However, during the summer previous to our surveys one member of the research team (P.K. Das) found an adult ibex horn on the high slopes near Lamika La (503Um), just west of Kunda La and 3U km east of the Zanskar River. In 198^ nine ibex were sighted by local wildlife officials within Hemis National Park a few^kilometers west of the Zanskar river up the Chlling nallah (J&K DUP 1985). In the upper Beas catchment 15 ibex were observed in Hampta nallali, 11 *in* J.iyntsukh nallah, and 2 in the Malana nallah. In Lahul, 15 ibex were seen enroute to Darcha, and another 5 in the Jankar valley on the way to Shingo La. Ibex are not present in the region of Govind Pashu Vlhar.

Ibex population density was approximately U.3 per sq km in both the upper Suru valley and along the main Lung Nag valley in southern Ladakh. Mean group size of *Ib* ibex herds observed, was 13 (n^yb, SD=10). Population composition from combined winter-spring surveys in southern Ladakh was 91 males: 1U(J females: 33 yearlings: 78 kids (n=312). The first ibex newborn kids were observed on 30 June (however, no classifications had been made since 21 June).

Ibex were found at elevations between 34UOm and WiiSm, with a mean elevation of 43UOm (n"124, SD-24U). Mean slope angle at which Ibex groups were located was 31 degrees (SD=y). Ibex were similar to blue sheep In that they were found predominantly (6S percent) on smooth terrain, although 65 percent of all locations were within 50m of cliffe (90 percent within 15Um) (Figure 3). Ibex use of slope aspect was non-random (x-square^{n}lb.7, p<.Ul); southerly aspects were preferred and northerly aspects avoided. They were found predominantly in grass

and Artemisia vegetation types, with an overall average plant cover of 38 percent (SD=21).

Ladakh urial (Ov 1 s orienta 1 is) shapu

Thirty-four Ladakh urial were observed in central Ladakh. One individual was seen up Shang nallah, *2i* in Mato nallah, 11 in the vicinity of Rumbok nallahs, and 1 near the mouth of Harkha valley. These were all in the vicinity of the Indus valley in central Ladakh and they occur nowhere else within the region of these snow leopard surveys.

Ladakh urial habitat is characterized by the wide alluvial fans, washes and scree slopes that form the sides of the Indus and large tributary valleys (see also Schaller 1977, Mallon 19S3). They are also found in the adjacent rugged mountainous terrain, and occasionally up in the smaller tributary valleys. Their habitat has been encroached upon by human activities over the centuries and is currently smaller than In the past and more restricted to the margins of the rugged mountains. The J&K Dept. of Wildlife frotection (no date) estimates a population of 270 Ladakh urial in the Hemls National Park and some 325 in other proposed wildlife sanctuaries Ladakh. Mallon (1983) estimates a total urial population of about 700 along the Indus and Nubra valleys a dejislty of about 0.7 per sq km in their range in Hemls National Park. Snow leopards appear to prefer the vicinity of rugged mountainous terrain and it f.s within this habitat that urial undoubtedly constitute a component of snow leopard diet.

Tibetan argali {Ovi s ammon) nyan

Seven Tibetan argali were observed in the upper Rumbok nallah near Kunda La on the western route into Markha valley In Central Ladakh. This is an isolated population, some 73 km from Che nearest argali populations to the northeast. Argali do not occur in the other areas surveyed.

Tibetan argali habitat Is the rolling mountainous margins of the Tibetan plateau (Schaller 1977). In Ladakh, they occur more typically on the less precipituous mountains of the northeastern border areas with Tibet. In the Harkha region, the small group of argali migrated

there BOtne 15-20 years ago and are currently protected within Hemls National Park.. This small group and other argalJ In Ladakh occur within enow leopard range. However, the degree Co which snow leopards utilize the marginal rolling mountains typical of argall habitat Is unknown (wolves are probably more common there). Tibetan argall probably constitute a prey resource of secondary importance for the snow leopard in Ladak.h.

Himalayan tahr (Hemitragus jemlahicus) kaarth, taheer

One Himalayan tahr was seen on the north slopes above the Beech Koprl river In Gnvind Pashu Vlhar. No other evidence of tahr was recorded during the surveys, but it Is reported to occur also along the southwestern border of Govind Pashu Vlhar, and on some of the outer high ridges of the upper Parbati and beas rivers.

The tahr's habitat is steep terrain associated with cliffs In relatively open (not densely vegetated) areas near timberline. This type of habitat represents the southern limit of snow leopard range along the Himalayas. As such, the tahr is probably are important prey item for snow leopards occurring on the south side of the Himalayas at these limits of snow leopard range. R. Jackson (pers. comm. } reports snow leopard kills of Himalayan tahr on the south slopes above the Langu River in northwestern! Nepal. An account of Himalayan tahr habitat use and food habits in central Nepal has been prepared by Green

Serow (C^apricornls sumatraensls) sarao

No serow were observed during the course of the surveys. Tracks were found In conifer and deciduous forests at about 260Um above SankrI village in Govind Pashu Vihar. Serow were reported to occur in the western part of Govind Pashu Vlhar and in some subalpine areas In the Hanall region.

The habitat of the serow is steep forest and brush covered slopes and ravines, usually associated with cliffs. Although it is occasionally found near tiraberline, it Is essentially a forest animal. For this reason, it is probably not a significant prey Item for the snow leopard, which is believed to remain In open subalpine areas or above timberline. However, if some of the leopard tracks we found in forested habitats in Govind Pashu Vlhar are snow leopard, then the serow is certainly a potential prey item.

Goral (Hemorhaedus goral) goral

Ten goral were observed in Govind Pashu Vlhar, and two up the ParbatI River (Hanali region). All sightings were made w elevation range of IdOUro to 2000m in forest openings in or near steep cliffs.

Goral occur in steep, brush or forest covered cliffy areas throughout the forested elevations of the Himalayas. However, especially on southern aspects, the upper limit of their range includes open grass covered cliffs near and above Cimberline. It is in this habitat that they probably constitute a prey Item of the snow leopard.

Husk deer (Hoschus chrysogastor) kasturl

three musk deer were observed between AOUOro and 4500m in the upper Supin Valley of Govind Pashu Vihar. Numerous musk deer tracks in snow were present in this same area, as well as in the upper Beech Kopri valley of Govind Pashu Vihar. Husk doer are reported to occur In the Manall region, however no tracks and only two piles of droppings were found In appropriate habitat during the surveys there.

Husk deer habitat is characterized by subalpine birch and birch-fir forests and associated alpine-subalplne meadows. They are secretive and generally crepuscular in their activity. Because of the high price available for the male musk pod, illegal hunting continues to place pressure on this species throughout the Himalaya. A detailed account of the musk deer and Its ecology in India's western Himalaya has been reported by Green

Sambar (Ceryus^ unicolor) jadow

Nine sambar were observed in Govind Pashu Vihar. These animals were all between 2500m and 2HOOm on the south side of the Supin valley in coniferous forest. A recently shed Sambar antler was found in coniferous forest at 2850m and fresh sarobar tracks were found just above snow line at 3U50m. In this area, the lowest recent sign was at about 21UOm and accumulation of winter pellet-groups indicated that these animals wintered at elevations around JJUOUm.

These observations represent an extention of Sambar range no higher elevations than that currently reported in the literature (e.g.j Prater 1960), The habitat of the sambar is typically In heavily forested zones, although they do use forest openings and meadows. (Their tracks were commonly found in subalpine meadows within our survey area above Sankri village). Sarabar presence In the subalpine zone, as indicated from our surveys, suggests its potential as a prey item of the snow leopard in some areas.

Wild boar (jus. Bcrofa) Suar

Three wild boar were observed in forested habitat at about 2500m In Govind Pashu Vihar. Numerous wild boar tracks were found in the forest on northerly facing slopes above Sankrl-Taluka In Govind Pashu Vihar. The tracks were at elevations between 200Urn and 29UOm, with the upper ones bel.ng at the current snowline. Wild boar sign was not found, nor were they reported to be present, in the other areas surveyed.

Wild boar habitat includes forest, scrub jungle, and the margin of forest/jungle openings and meadows. The wild boar encountered in our surveys represent the species at the upper elevational limits of its range in the Himalaya. its use of subalpine habitats in this area indicates that the wild boar is a potential prey Item for the snow leopard.

Large carnivores

Wolf (Canis lupus) changcu

Three individual wolves were seen in the Markha Valley for a total obervation time of about 1 hr. Local shepherds reported seeing wolves during early January In the Nlmaling area (4300 m) In the upper Markha Valley. Approximately *20* km of wolf tracks were found in the upper

Suru Valley and another 40 km of tracks in the Markha Valley region, and parts of the Khurnak drainage. Tracks were found between 3'tOO m and 50UO m, primarily along the major valleys and open passes. Thirty-four wolf scats were collected for analysis of food habits.

The wolves observed were all single animals, travelling near the bottom of the Markha Valley in the early morning hours. A prominent wolf marking site was located at the junction of the Nlmaling and l.angtang nallahs in the upper Markha Valley. Wolf tracks were relatively common in the upper Markha Valley especially in the Nlmaling nallah and uplands.

Dhole (Cuon alplnus)

The dhole is reported to occur in Ladakh and the Himalaya (Prater iyBU), but no conclusive evidence of its presence within the area of our surveys was found. There is undoubtedly confusion of this species with the wolf, and either the dhole is not present or local villagers do not distinguish between the two species.

Common leopard (Panthera pardus) chltwa, bggh

A common leopard was seen by locals near Oela village (2600m) during our survey in Govind Pashu Viliar. Leopard cracks were found between 2600m and 3000m in coniferous and deciduous forest of Che Supin valley above Sankri-Taluka, and ac 2700m and 3200-3500m in Che upper Been Kopri Valley of Govind Pashu Vihar. The identity of these tracks as common leopard or snow leopard is not clear. Similarly, leopard cracks found aC 3000-3400m in che upper Parbati valley, and 3600m in the HampCa nallah (Manali region) may be either species of leopard, although the reported scarcity of common leopards in this latter area suggests the probability that they were snow leopard tracks. The distribution and abundance of common leopard relative to finow leopard on the southern slopes of the Himalaya and Fir Panjal Ranges represents an Important area of inquiry with regard to conservation of Che snow leopard at Che southern edge of ICs range.

In Govind Pashu Vlhar, most of the shepherd's dogs had a meCal collar around its neck, the purpose of which was to decer attacks by the common leopard. In the Manali region the proportion of dogs with such collars appeared Co be smaller. In Ladakh dogs did not wear metal collars, indicating Chat snow leopards, as opposed to common leopards, do not commonly attack dogs.

Lynx (Fells lynx) Eee

The tracks of one lynx were found at MUOm north of Hankar village In the upper Harkha valley In Harch. The habitat was 2U - 30 souch facing slopes of sparse grass/herb vegecati.on In the vicinity of a hare colony. In January, shepherds reported that a lynx had killed one of their goats in Nimallng (4300m) in the upper Harkha valley. Ulthin the areas of our survey, .lynx was reported Co be found In the upper Harkha

and Shang catchments, and to occur rarely In other parts of the Markha region.

The areas where lynx sign was found, and where they are reported to occur coincide with regions of substantial hare populations. Throughout its circumpolar distribution, the lynx Is intimately associated with hares as Its primary prey, and its distribution in Ladakh probably conforms to this relationships. Although lynx are known to occasionally kill wild and domescic ungulates (Hurie 15*54 , and see above) they are competitors with the snow leopard primarily in smaller prey items such as the hare, marmot, and mouse hare.

Brown bear (Ursus jjrc^tos) denmo, lal bhalu

One brown bear was seen in the upper Halana valley and one was observed by tourists in the Hamta valley during our survey there

(both, Manali region), A female bear and two cubs were seen, along with abundant bear sign (tracks, diggings, and droppings) in the upper Suru valley. Bear sign (probably brown bear) in the upper valleys of Govind Pashu Vihar. The three brown bear scats were collected for food habits analysis.

The brown bear appears to be present in all the Himalayan crest arid eastern Pir Panjal areas surveyed. It is nowhere abundant, but its presence appears to be known to most all inhabitants in these areas. One hibernation cave was reported at an elevation of (1 3 5 0 0 [1]) in the upper Suru Valley.

black bear - (Selenarctos *thi*be^tami*s)* kalo bhalu

No black bears were seen during the surveys, but evidence in the form of tracks and diggings was found in the Supin valley (27UO m -300U m) of Govind Pashu Vihar, and the upper Parbati Valley *(27 W* m) in the Manali region. Black bears were reported to be common in the subalpine forests of both these survey areas. During our survey a black bear was reported to have killed a domestic goat above the village of Datmir (2500 m) in Govind Pashu Vihar. Black bears kill some domestic livestock, but are most feared for their propensity to attack and maul people working in the forests.

Other mammals

Fox (Vulpes vulpes) wahtse, lomri

Two foxes were seen in the upper Suru valley, and one each in Govind Pashu Vihar and the upper Parbati (Manali region). However, fox sign (tracks and droppings) was very common in each of the areas surveyed. Fox activity appeared to be nocturnal and crepuscular and the sightings were made during the morning hours (3) or at night (1) - In winter during vehicle-based moves into or between study areas in Ladakh, foxes were occasionally seen along roads at night under the vehicle lights.

Fox tracks were commonly found in the vicinity of snow leopard cracks, and they sometimes used snow leopard and wolf tracks in snow as a trail. In addition, foxes sometimes investigated snow leopard marking sites and droppings, and fox scats were occasionally found in snow leopard scrapes, near snow leopard scats, or in the depressions made by snow leopard tracks in snow.

Fox sign was found at all elevations surveyed, and was most common around valley bottoms and within 200 m up the adjacent slopes. Field inspection of fox scats indicate that their diet included

small rodents, birds, Ephedra sp. (stems), and Lonicera sp. (fruits).

Langur (Fresbytls enteljjjs) langur, bandar

Approximately 200 langvir were seen in coniferous and deciduous forests between 2300 and 2900 m in Govind Pashu Vihar. In Che Manali area about 45 langur were 'observed in spruce-fir forest of the upper Parbati Valley at 275U re, and 35 at about 27UU ra In the Hampta nallah. Langur droppings and evidence of feeding were common in the coniferous forest zone *of* Govind Pasliu Vihar, and occassionally in the Hanali area. Green (1982) observed a snow leopard hunting langur at 2700m in the Kedarnath Wildlife Sanctuary, Uttar Pradesli In March 1V79.

Otter (Ultra lutrji) chu strum

No sign of otter was found during the surveys in Ladakh, or during the spring surveys in Govind Pashu Vih.ir and the Manali region. However, they are reported to occur in the latter two areas year-round and in the Ladakh survey areas in summer.

Yellow throated Marten (Har_ces_ flavigula) gehtho

Two yellow throated marten were observed at 1850 m and 2550 m in the Beech Kopri and Supln Valleys of Govind 1'ashu Vihar. They were seen in forest openings along the valley bottom. Marten scats were occassionally found in the coniferous and deciduous forests of Govind fashu Vihar and in the Manali region, and are probably those of Che yellow throated marten in the area-

The yellow throated marten occurs in virtually all habitats within the temperate forest zone (below 2750 m) and lower forest zones in the Himalayan (Prater 1980). Its upper elevation limit is near the lower range of our surveys, and .its contact with the snow leopard IB probably limited.

Stone marten (jjarjen toina) kohar

Marten tracks and droppings, that can be reasonably assigned to the stone marten, were occasionally found throughout the areas of survey. The sign was found in all habitats, from about 35UCJm up to 45QU m in winter and 5000m in summer.

At the lower elevations of the areas surveyed on the southern side of the Himalayas, its range probably overlaps with that of the yellow throated marten (_H, flavigula).

Weasel (Hustela spp.) lakeymo

Two Himalayan weasels (Mustela sibiricaj were observed at 3750 m in the Rumbok valley of the Markha region. They were seen emerging from, and In the vicinity "of a rock wall near the village of Rumbok. One adult and four young were observed near Zulidok village in the

upper Suru valley (4000m). One adult was observed at 2000m near Jakar village in Govind Pashu Vihar. One pale weasel (H_. altcaia) was seen in the upper Kvirgiakh valley (43UUm) near Shingo La in south-eastern Zanskar.

Weasel tracks and droppings were occasionally found throughout the areas of our survey. Weasel sign was found up to 4500m in winter nnd 5000m in summer, and down to the lowest elevations surveyed. Droppings were most typically found on rocks along trails. However, this sign includes that of both above weasels, and probably the ermine (M. erminea), and the yellow bellied weasel (H. kathiah).

Marmot (Marmota spp.} pyah

Himalayan marmots *(ft.* bobak) were commonly observed from north of Darcha in Lahul, over Shingo La and along the Kurgiakh Chu and Tsarap Chu in Zanskar. They were also common in the higher parts of the Khurnak and Harkha Valleys that were surveyed. The long-tailed marmot CM. caudata) was common in the survey area of the upper Suru Valley.

Marmots occur in colonies on open slopes and level areas at elevations between 400Um and 5500m. Long-tailed marmots also occur at lower elevations in the Suru valley, outside our area of survey. Marmots remain underground in hibernation from late October-early November until May. During summer they are an important prey Item for the snow leopard, wolf, and probably also lynx.

Flying squirrel (Petaurista sp. and/or Hylopetes sp.)

Three flying squirrels were observed at night using torches, and several were heard calling in conifer-oak forests at 2700 m to iJyQO m in Govind Pashu Vihar and the Manali region. Flying squirrel droppings and evidence of feeding on oak leaves was found from 2100 m to 3000 m in both of these survey areas.

Woolly hare (Lepus oiostolus_) rJ.hyong

During winter, five hares were seen in the upper Shang Valley (3VOOm) below Chagdo village, about 20 in ttie Nimaling nallah (42:>0m), about 15 above Hankar village (^OOm), two near Rubering La (SOUOm), and four ^ear Kunda La (515Um), all in the Markha region. In summer, three hares were seen In the Ruberlng nallah of the Khurnak Valley, about 30 in the Long rung and NlmalJng catchment of upper Markha valley, and four in the Shang catchment. Numerous hare tracks and droppings were found in the Nimaling uplands (4bOOm), and tracks and droppings were occasionally found at elevations between 3yOOm and 5200m throughout the Markha region during winter. A. golden eagle was observed swooping down, grabbing, and killing a hare in the upper Shang catchment at about 4'tUOm on the route Co Gongmaru La in January.

Himalayan mouse hare, pika (Ockotona roylei) zehbra, chuah

Mouse hares were frequently observed within all Che areas of survey. The highest elevation at which they were found was at 5200m in central Ladakh, while the lowest was in blue pine-fir forest at

2600m in Govind Pashu Vihar. House hare tracks (especially on snow) and droppings (in rock crevices and caves) were common in rocky and boulder scree habitats throughout the survey areas. Mouse hare presence was evident in these alpine habitats on all aspects and slope angles as long the rock substrate allowed construction of burrows below ground. Our surveys encompassed the full altitudinal range of this mouse hare in the western Himalayas and It was common throughout the areas of survey.

Within the areas of our survey, the Himalayan mouse hare probably constitutes an important prey item of the fox, stone marten, lynx, wolf, and snow leopard. On the margins of the Tibetan plateau lands in the northwestern borderlands of Ladakh, other species of mouse hare (Ochotona spp.) occur in colonies on the steppelands.

Voles, mice, and shrews (Hurinae, Microtinae, Soricidae) pitsay

Voles were observed in the upper Suru Valley and the Harkha Valley of Ladakh (up to 40UU m) and their tracks and droppings were found in all survey areas. Mice were observed in the Harkha and Manali regions (310U m) and their tracks were evident In these and the Govind Pashu Vihar survey areas. They are reported to occur throughout the region (3600 m) and probably occur throughout the areas of survey. One shrew was observed at 400Um *in* Govind Pashu Vihar.

Human dimension

Upper Suru Valley - southern Ladakh

In the upper Suru Valley, an area of approximately 600 sq.kra., there are two villages and one small monastery, with a total human population of about 200. Livestock includes sheep, goats, yaks, yak-hybrids, and horses. The human settlements are on the valley floor at about 40U(Jm and, with cultivated land, occupy an area of about 33U hectares.

Grazing - During winter there le no grazing from about Dec. to April when deep snow covers the land. In summer, livestock from the villages just below our survey area are brought up into the lower reaches of the upper Suru. Government-run sheep breeding farms from the lower Suru Valley also bring their stock to the upper valley for summer grazing. In addition, several thousand sheep and goats are brought up the valley to its highest grazing areas by Bakrwal herders from the south side of the Himalayan crest. This Bakrwal migration began in this area only about 10-15 years ago, has increased over that period, and has developed some conflicts over land use with the local villagers.

Other resource use - The willow shrublands in the vicinity of villages are used for firewood collection, and for building materials. Large quantities of grass and herbs (e.g. Agrostis sp., Acogonum ep., CIcsum sp.) are collected in the autumn for winter livestock fodder. Art e me si a^ sp. is used for cooking fuel in summer grazing areas and at mountaineering base camps.

Wildlife - Few local villagers reported having seen a leopard in the area. Snow leopards kill livestock occasionally, but are not considered much of a menace in this regard compared with wolves and brown bears.

The local villagers, being Huddhist and living near a well respected small monastery, do not appear to hunt animals. The Bakrwal herders are reported to do some hunting in summer. The opening of the road from Kargil to Padum over the part 5 years has introduced some hunting by vehicle-based individuals and road workers. The animals most subject to hunting appear to be the ibex and brown bear.

Markha region - central Ladakh

Wi thin the proposed 120U sq.km. Hemls National Park, there is a total population of about AUU people. The valleys of the Rumbok and Markha rivers have nine villages, with 64 households and a total human population of 386. Livestock numbers include 2bUO sheep and goats, 8b horses, 165 donkeys, 52 yaks, 82 cows, and *b2* yak-cow hybrids. Agricultural land comprises a total of .42 sq.mi. Villages occupy sites on or adjacent to the valley floors and occur up to about 4Q(JUm.

Grazing - Local livestock is grazed on the bare or lightly snow covered hillsides up to A2UUm throughout the winter. Only locally owned livestock is grazed in the area in summer and this occurs up to about 520Uro.

Other resource use - Some livestock fodder is collected in the autumn for winter use, and this includes grasses, some Salix spp., Scopolia stramonifolia. Salix spp. and Populus^ sp. sre used for house framing and roof support, with the remainder of the house being made of clay bricks and mud. Hlppophae rhamnoides is used to make fences for directing livestock grazing. Scopolia stramonifolla is also collected for medicinal purposes. All shrubs and trees are used as firewood, and in the lower Markha valley there is some charcoal production from Hippophae salicifolia and jj alix spp. Co supply local metal workers in the lower Zanskar valley. Some firewood is exported to Leh. The Forest Department has developed n small willow and poplar plantation in the Rurabok drainage.

Wildlife - Nine of 38 persons interviewed reported that they had seen a snow leopard. The snow leopard is reported to be a common predator on livestock, although it is probably comparable to the wolf in the numbers of livestock killed. During ttie 12 months from March 1985 to March 1986 about 130 sheep and goats and about 10 yak and yak-hybrids were reported to have been killed by both snow leopards and wolves. Routine killing of livestock by snow leopard is generally accepted without much complaint because ttie domestic animal is usually retrieved from the leopard immediately, and the meat is utilized. However, when a snow leopard sometimes gets into a closed pen and kills 3U-4U sheep and goats, this tolerance runs thin and the leopard is occasionally killed. Lynx are also reported to kill livestock on rare occasions.

Currently, there appears to be very little hunting occurring with the Markha region. The Bhuddlst stipulation against killing animals, as well as increased Wildlife Department vigilance in the proposed National park (on both outsiders and locals) lias apparently brought about this effective protection of wildlife. However, animals that kill large numbers of livestock _are not tolerated; two snow leopards were reported to have been killed in central Zanskar during the winter

of

Govlnd ?ashu Vihar

The Govind Pashu Vihar Wildlife Reserve, that portion above and including the village of Sankri, encompasses a region of approximately 530 sq.km. Within this area there are 21 villages, with a total human population of 7UbQ. Livestock numbers include 10,100 goats, 24,700 sheep, and 5,500 cattle. The total area owned by villagers is 30,45y acres, with 6,830 acres of this being under cultivation. The villages are found on the valley slopes and occur up to about 2600m.

Grazing - During winter there is no livestock grazing above about 2700m, Apart from the locally owned livestock, sheep and goats from villages lower down the valley are brought up for summer gr addition the migration of Gujjar herders to the area from April to September brings a few thousand buffalo into the upper pastures. In 19H4, under pressure from the local inhabitants, the Gujjar herders were banned from entering the areas above Harkl Dun in the Supin valley.

Other resource use - The Uttar Pradesh Timber Corporation harvests substantial timber, mostly deodar cedar, from the lower portions of the area under consideratJon. During summer there has been selective felling of large conifer trees for house and other construction which takes place Lip to timberline near the summer grazing areas. Each household is entitled to a tree for its own use every three years, and more for large constructions, such as a house. There are also a large number of contract labourers who harvest medicinal plants from high subalpine and alpine zones - numerous holes dug in the earth attest to this activity. Local house construction is primarily wood, again mostly of deodar. The vicinity of villages is heavily used for gathering firewood and livestock fodder. Grasslands are commonly burned in winter to assure early leaf emergence for livestock grazing in spring. The Harki Dun area is a popular tourist trekking destination.

Wildlife - From 26 people questioned about wildlife, two had seen snow leopard, and only once in their lives. Snow leopard kills of livestock occur, but are not common. Few people claimed to have lost more than 10 goats/sheep at a time, when a snow leopard entered a livestock pen in summer pastures. Kills of livestock by common leopard are more common and are reported to have increased in recent times. There were two reports of common leopard attacks on dogs during our survey. Host dogs, especially those owned by herders, wear metal collars around their necks to deter common leopard attacks. Wild boars and especially black bears cause substantial crop destruction. Langur and rhesus jnonkeys cause some crop damage, but complaints by villagers were not great.

The total number of licensed guns exceeds 150, with probably a similar number of unlicensed firearms. There appears to be substantial hunting in the area, and every village apparently has at least one regular hunter. There is additional hunting and trapping by the contract labourers (mostly Nepalis) and the Gujjar herders. The most commonly hunted animals appear to be the musk deer (whose musk pod brings a good price) and the goral.

Kulu-Manall Region

Because several distinct sites were surveyed in this region, and no discrete management areas delirainated, no attempt was made to determine human and livestocks population sizes. Villages are present upto about 2450m, with cultivation up to 20Um higher. Recent

successes In government potato farraLng and ICE market distribution have brought about substantial conversion of pasture and forest Into potato

fields, especially at the upper levels of cultivation. In summer, the region is very popular for mountain climbers and trekkers.

Grazing - During winter there is no livestock grazing above about 2700m. In summer, livestock (mostly sheep and goats) from all the villages in the Kulu-Manali Valley are brought upto the higher elevations for grazing. In addition, Gujjar herders bring up large numbers of buffalos to subalplne and alpine pastures. However, the degree of this impact varies from one nallah to the next. In the Hampta nallah, east of Manali, tens of thousands of sheep and goats are brought through on their journeys to and from Lahoul. In contrast, the people of the upper Halana nallah refuse entry to all outside graziers, maintaining the upper grazing areas for their own livestock, which apparently includes about 11,UUO sheep and goats.

Other resource use - Substantial harvesting of timber, for construction, fruit packing crates, and firewood needs in the rapidly developing Kulu-Manali Valley, has taken place and continues In the more accessible forest tracts. Medicinal plants such as Dispara sp. are harvested for commercial sale. Various species such as Qxyria digyna are collected as food plants. Pasture lands are generally burned in the autumn to promote rapid growth In early spring.

Wildlife - From ten people interviewed regarding wildlife, one reported having seen a snow leopard and could describe it. Snow leopards art reported to occasionally kill livestock In the summer pastures, but this did not appear to be very common. Common leopards are also reported to kill livestock, although, again, it does not appear to be a very frequent occurrence. However, many shepherd dogs wear the metal collars used to deter leopard attacks. Brown bears occasionally kill livestock on the summer pastures, and black bears are reported to cause considerable crop damage. Langur and rhesus monkeys cause some crop damage.

Hunting appears to be fairly wildely practiced In the region. A relatively low presence of musk deer sign in their typical habitat here suggests that intensive hunting and trapping of this species has taken place. A brown bear was reported to have been shot in the Halana nallah a w«ek before our arrival there. Goral skins were found to be used as sitting mats and bags for carrying flour. Except at the higher elevations where snowcock and monal were found, other pheasants and grouse were not very apparent - again suggesting substantial hunting or trapping.

DISCUSSION

Kvldence of snow leopard presence was found in each of Che regions surveyed. However, the occurrence of snow leopard sightings and the substantially greater amount of sign found in central Ladakh indicates that this Is the best area for snow leopard in India that has been surveyed Co date. It *Is* consequently the area that has been selected for more Intensive Investigntlons of snow leopard ecology. Still, several factors remain to be considered in interpreting the data on snow leopard sign. The surveys were conducted in large part during winter, the season of snow leopard breeding when production of sign

(e.g., scrapes) appears to be greatest (Ahlborn and Jackson, in press). The relatively low snow depths in central Ladakh allow an ease of winter travel for predators such as the enow leopard that is not found in the deep snowfall zones near the Himalayan crest. It is thus possible that there is some seasonal movement of snow leopards to regions of low snowfall during winter, with consequent greater accumulations of sign in these drier areas.

Furthermore, the valley bottoms of our surveys in central Ladakh provided travel corridors and ideal marking sites (cliffs along dry river gravels) not consistently found in similar-sized valleys in the other regions that were investigated. Even so, alternate sites for snow leopard marking on the crest and southern side of the Himalaya (e.g., small tributary valleys, valley—side cliffs, ridges) did not have comparable amounts of sign relative to central Ladakh. Snow leopards undoubtedly do make some use of the heavy snowfall zones of the main Himalaya, but the period of this use is probably predominantly during summer when marking behaviour (e.g., the production of scrapes) is less prevalent. This would explain the lack of snow leopard interaction with locals in winter and the small amounts of sign (especially scrgpes) that we found In Uttar Pradesh and Himachal Pradesh. That snow leopards with ranges along the Himalayan crest zone may move to regions of low snowfall during winter is an important characteristic that requires further investigation. If the Himalayan crest regions do not provide prime year-round habitat, than we would expect snow leopard densities to be somewhat lower than in the drier trans-Himalayan region.

The large ungulate prey species of the snow leopard (most commonly blue sheep and ibex in the present study) are still widely distributed in the Himalayan and trans-Himalayan regions surveyed. However, population densities appear to have been diminished around sorae of the administrative centers and along road corridors (e.g., Kargil-Padum) in Ladakh. There is also a noticable increase in these species' wariness toward humans along road access routes and in western Ladakh and the southern side of the Himalaya where they are more commonly hunted. Better distribution and population data on these ungulate species is greatly needed In the Himalayan region. However because the present large scale survey could not provide accurate density estimates for the snow loepard prey, this should become an important aspect of continuing wildlife research in Che region. The smaller herbivore prey species such as hare, marmot, mouse hare and email rodents are unevenly distributed but locally abundant in suitable habitats in Ladakh, and probably provide important alternate prey for snow leopard, wolf, brown bear, and lynx. The interaction of these predators is another important aspect ttiat needs to be addressed In terras of both competition and impact on predation of domestic livestock.

With regard to studies of snow leopard ecology in central Ladakh, it appears that there is currently a sufficient population density in accessible areas of the Hemis National Park to warrant an intensive research effort on this endangered species. Such work would provide a very useful comparision with the data that has recently been gathered in western Nepal (Jackson and Alhborn, in press). The research should be designed to answer basic conservation questions relating to the maintenance of snow leopard and their prey populations in a manner compatible with the socio-economic development of the region.

Human interaction with wildlife

In central Ladakh the snow leopard Js tolerated as an occasional killer of livestock because in

most cases the villagers (who are Buddhist and averse to killing animals themselves) are able to retrieve the carcass and utilize the meat. In this regard, there is a positive interaction as far as the villager is concerned (how beneficial it is to the snow leopard depends on how often it is able to keep the kill for its own consumption). However, when a snow leopard gets Into *a* household livestock pen and kills JU or 40 sheep and goats at a time, such activity Is not tolerated and under these circumstances snow leopards are often killed. Such killing appears to be an important mortality factor for snow leopards in the region. In this regard, an important question that must be addressed is whether Che leopards that take livestock are in any way different (e.g. injured, old) from the general population. And conversely, how important is livestock predation for snow leopard populations as a whole in Ladakh?

Central and southern Ladakh appear to be areas where there Is substantial interaction between human resource use and the snow leopard. For example, although villagers contend that the wild ungulates do not deprive their domestic animals of food, there is undoubtedly some competition between blue sheep and domestic sheep and goats. The degree of this competition will determine the long term carrying capacity of the rangelands for wild ungulates and, hence, for snow leopards Chat subsist on wild prey. These are Important concerns I f , for example, efforts are to be made In developing pasture lands or increasing livestock populations in the region.

There Is little doubt that the traditional levels of natural resource uses In Ladakh are compatible with snow leopard survival; they have been coexisting for centuries. However, rapid changes have been occurring In the social structure, resource use and availability, and access In the region; the effects of which on wildlife need to be documented. In Che meantime, perhaps some immediate management programmes can be established to Insure better snow leopard survival under both traditional and modern conditions. Such programmes could include the provision of materials for securing household livestock pens against entry by snow leopards, and providing better protection from hunting (or a more even hunting distribution) for the ungulate species along road corridors. Uso, the Identification and establishment of areas for intensive conservation management (parks and reserves) should continue to develop as more information becomes available.

Conservation areas

In central Ladakh, the state of Jaranm and Kashmir is in the process of expanding Its system of National Parks and Wildlife Reserves (J&K Deptt. Wildlife Protection, no date). The Department of Wildlife Protection is currently considering extending the boundaries of the Hemis High Altitude National park to include the Shang Wildlife Reserve and areas to the south of Markha Valley in the Khurnak drainage. Based on results of the current surveys, such an extension to the park is highly recommended. The Khurnak Valley encompasses some prime snow leopard and blue sheep habitat that is relatively inaccessible and subject to low intensities of human use. It would provide an ideal core area for a~larger National Park, with the Markha Valley catchment to the north and part of the Tsarap Chu catchment to the south forming inhabltated buffers to this core. Detailed boundary recomraendations are being prepared for the Jammu and Kashmir government.

The upper Suru Valley in Kargil district (Ladakh) is proposed to be encompassed within the Rangdum Wildlife Reserve (J&K Deptt. Wildlife Protection, no date). With the recently completed Kargil -Padum road bisecting this proposed reserve, Increased grazing pressure by bakrwnl herders and government sheep breeding concerns, (and consequent conflicts with local herders), some immediate steps need to be taken in developing a conservation management plan for this area. This is especially so because of 1) the presence of snow leopard in the area, 2) a substantial population of ibex in the valley, and 3) the presence of the only population of brown bear on the north side of the Himalaya in this region.

The Govlnd Pashu Vihar Wildlife Sanctuary in northwestern Uttar Pradesh has been officially notified for many years. Recent increase In wildlife department personnel for this long-established sanctuary Indicate a needed Increase In management efforts there. The high degree of natural resource, exploitstlon (timber and medicinal plants)

and seasonal grazing within the boundaries does not appear to be compatible with its management as a wildlife reserve, especially because of the increased pressure it places on the permanent human inhabitants trying to maintain a subsistence living. This wildlife sanctuary has an extremely diverse array of large mammal fauna for the region, including a small population of sambar living in upper elevation coniferous forests as high as tlmberllne, and wildlife habtats that are still in relatively good condition. For this reason, Increased attention must be paid to the management of this area to insure the welfare of both the villagers and their surrounding wildlife resources.

The proposed Great Himalayan National Park on the southern slopes of the PIr Panjal Range in Htmachal Pradesh currently does not encompass portions of the upper Parbatl Valley within its boundaries. Including the upper coniferous forests and subalpine-alpine habitats of various pheasant species, musk deer, and blue sheep would enhance the diversity of this park, and provide protection for this unique trasition .-rea Into the Spltl region of Himachal Pradesh.

The small numbers of ibex found in the head waters of the Keas River (while recognizing that this is a southern limit to their distribution) suggests that better protection of this species is required In this area. In both Himachal Pradesh and Uttar Pradesh the question o£ the relative distribution of common leopard and snow leopard, especially in relation to the location of existing parks and reserves, needs to be addressed in greater detail than the present survey was able to provide. Areas with permanent snow leopard populations on the southern side~of the Himalaya need to be identified and appropriate measures taken to determine snow leopard habitat use and interaction with humans (especially during the winter period), and to provide for their conservation.

Recommendations for further research

As a result o£ the information gathered during the surveys, several areas of research requiring further investigation have become apparent. Without a doubt, the most Important aspect to build on is an understanding of the resident villager's and seasonal herders' attitude toward wildlife and natural resource use and the two-way effects of human interaction with wildlife. Associated with this concern, wildlife research recommended in the Ladakh region includes a) an intensive study of the ecology of snow leopard in central Ladakh, b} a species-epecific study of the brown bear in the upper Sum valley, d) a survey of lynx populations, e) statue and ecology study of Che argali in Hemie National Park, f) distributional range of ungulates in Ladakh, and g) status of antelope, argali, yak, and wild ass in northern Ladakh.

On the southern slopes of the Himalaya in northern Himachal Pradesh and Uttar Pradesh, several further areas of research were identified: a) determination of snow leopard vs. common leopard distribution and seasonal occurrence, b) effects *of.* high elevation timber harvest on wildlife, c) a species specific study of the subalpine sambar populations In Uttar Pradesh, and d) distribution

and status of mountain ungulates in the western Himalaya.

Current proposals for continuation of research in high altitude environments through the Wildlife Institute of India address some of these recommendations. However, other research organizations should also consider these Information needs (especially wildlife-man Interaction) in the development of conservation-oriented research projects in the Himalaya.

(Literature cited not included)