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The Status and Conservation of Forest Wildlife in Himachal Pradesh, Western Himalayas

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ABSTRACT

We report on wildlife and habitat surveys carried out by the Himachal Wildlife Project over two years in the upper Ravi, Beas and Sutlej catchments of Himachal Pradesh, Western Himalayas. Efforts were concentrated in the upper Beas area where natural forest ecosystems are most extensive.

The wildlife of temperate forest ecosystems in the Western Himalayas is threatened by destruction of habitat and hunting. Two species of pheasants occurring in the survey area are listed in the IUCN Red Data Book *(1979). We located small populations of both species and obtained information on their habitat requirements. The status of most large mammal species appears to be precarious, with the populations we encountered being small and fragmented. Species formerly common but now rare include Himalayan brown bear, Himalayan tahr, Himalayan ibex, and musk deer. The snow leopard has disappeared completely from the area.*

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The main causes of habitat destruction are domestic grazing, timber extraction, road construction, and extension of temperate agriculture. Adequate protection from illegal hunting is urgently required. We identified an area of relatively undisturbed natural forest in Inner Seraj, Kulu District, as the most promising place for the establishment of a National Park or Biosphere Reserve.

INTRODUCTION

The fauna of the Himalayan region constitutes a distinct assemblage sandwiched between the tropical forests of the Indian plains and the palaearctic steppe of the Tibetan plateau. The fauna of the alpine zone has much in common with that of adjacent Tibet, whilst many of the species typical of the subtropical foothills are also represented on the plains to the south. The intermediate temperate zone, a narrow ribbon of land 50–100 km wide and more than 2000 km long, contains the highest proportion of characteristically Himalayan species.

The temperate zone ecosystems of this area are small in extent and naturally fragmented both by the extreme topography and by human disturbance. During the past 150 years changes in agricultural practices, more intensive grazing by domestic animals and increased demand for timber resulting from increases in population have led to an accelerating loss of forest cover throughout the Himalayas (Cronin, 1979; Schaller, 1980). This reduction in forest area, combined with the fragmentary nature of the ecosystems, make the wildlife species of these Himalayan forests particularly vulnerable to local extinction (Diamond, 1974; Terborgh & Winter, 1980). International concern for the survival of some individual species inhabiting the temperate zone (e.g., cheer pheasant *Catreus wallichi* (Hardwicke) and western tragopan *Tragopan melanocephalus* (J. E. Grey); see IUCN, 1979) has already been expressed.

We report here on the status of probably the most vulnerable species, the pheasants and large mammals, of the upper Beas, Ravi, and Sutlej catchments in Himachal Pradesh, on their typical habitats and on prospects for their continued survival in the area. Our information is derived from surveys carried out during 1978–80 by participants in the Himachal Wildlife Project, a joint British–American–Indian programme of wildlife surveys (Gaston *et al.*, 1981*b*). We concentrated our attention on two areas proposed previously by the Himachal State Legislature as sites for

National Parks, and a major aim of the project was to evaluate the wildlife potential of these and other areas to make recommendations on conservation measures. Presently, Himachal Pradesh possesses neither a National Park nor any area managed specifically for wildlife.

STUDY AREA AND METHODS

Study area

Our surveys were concentrated in the upper Beas valley, above the dam at Pandoh (Fig. 1), but parties also visited the upper Ravi valley and a small area in the Sutlej valley. We could only visit a small part of the area in the time available and therefore selected survey sites recommended by Forest Department personnel as being likely to support appreciable wildlife populations. The locations of areas surveyed in the upper Beas region are shown in Fig. 2.

Climate

We distinguish three axes of climatic, and therefore ecological, change within the Western Himalayas:

(1) a vertical axis determined by the effect of altitude on temperature;
(2) a transverse axis determined by topography along which rain-shadow effects cause decreasing precipitation and increasingly extreme (continental) temperature fluctuations from SW to NE across the main ranges;
(3) a longitudinal axis determined by a geographical trend of decreasing monsoon precipitation (June–September) and increasing winter snowfall (December–April) from SW to NW along all the ranges. The third axis is important in determining major ecological trends over the entire length of the Himalayan chain, but it is less important than the other two axes in determining the ecology of localities within the Western Himalayas.

Within the temperate zone mean maximum temperatures range from 18 to 30 °C whilst winter minima range from −5 to 5 °C. Annual precipitation over most of the study area is between 1000–2000 mm (Negi, 1963; Basu, 1965). Localised temperature and rainfall effects

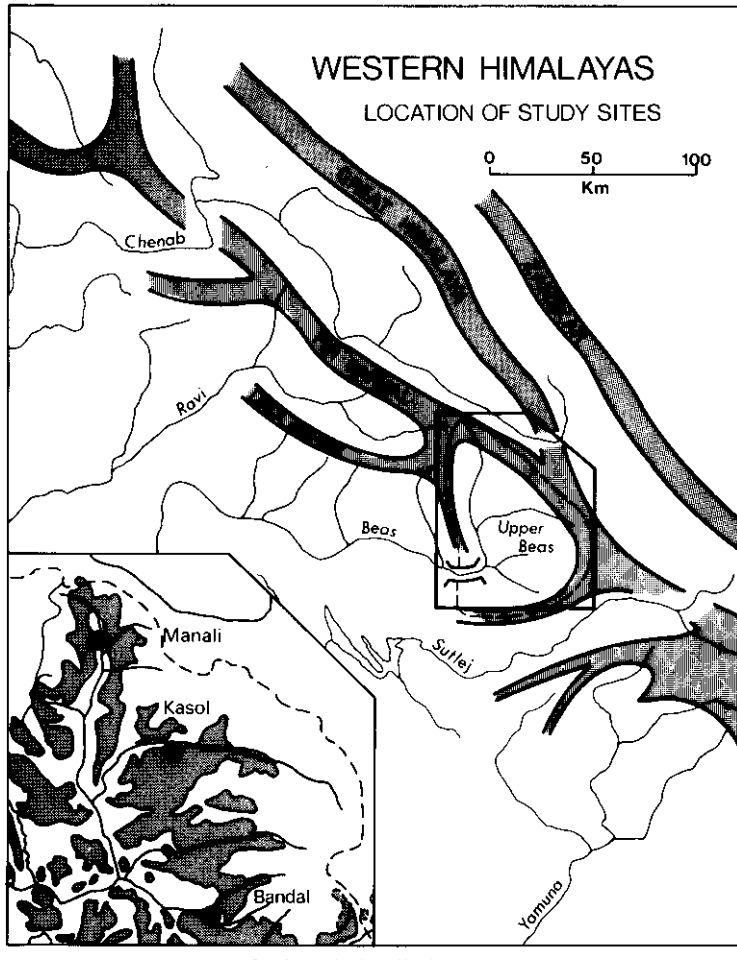

Fig. 1. Map of Himachal Wildlife Project survey area.

within the mountains probably cause considerable variations within this overall framework.

Natural vegetation

Himachal Pradesh is still comparatively well forested, with 39% of the land area designated as 'forest' in 1964 (Sagreiya, 1967). However, this figure also included areas covered by scrub, grassland and barren waste. Continuous forest cover extends over only 34% of the designated forest (Das Gupta, 1976; Bakshish Singh, 1979; Raina, 1979). Moreover, only

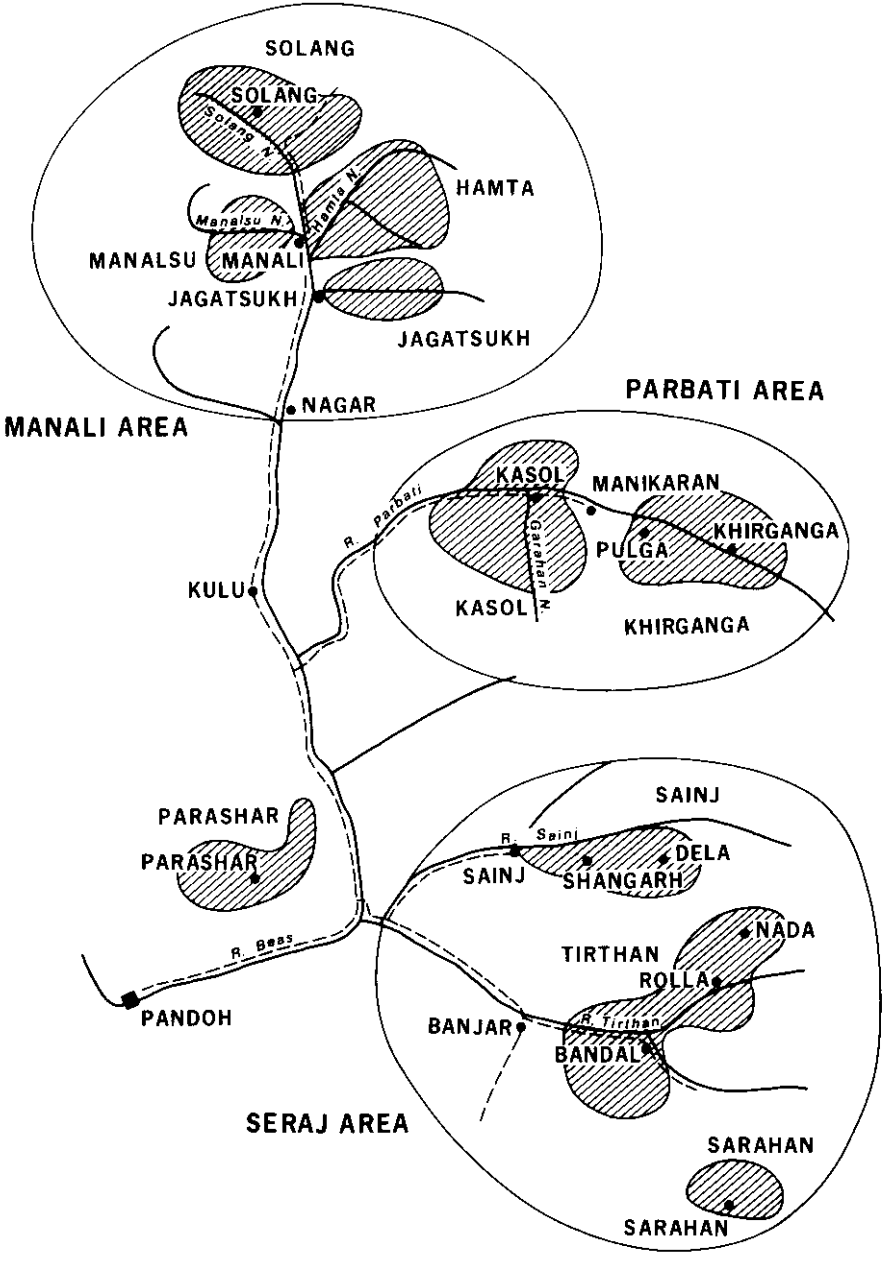

Fig. 2. The upper Beas area showing localities visited.

TABLE 1
Major Vegetation Types within the Temperate Forest Zone

Vegetation type	*Dominant species*	*Secondary species*	*Altitude (m)*
Low altitude oak/rhododendron	Ban oak *Quercus incana, Q. dilatata, Rhododendron arboreum*	Walnut *Juglans regia*	150–2 300
Low altitude coniferous	Deodhar *Cedrus deodara*, Blue pine *Pinus wallichiana*	Spruce *Picea smithiana, Rhododendron arboreum, Pyrus pashia, Picrasuma quassioides, Pieris ovalifolia*	1 600–2 500
High altitude oak	Kharsu oak *Quercus semicarpifolia*	Fir *Abies pindrow*, horsechestnut *Aesculus indica*, yew *Taxus baccata*	2 300–3 200
High altitude coniferous	Fir, spruce	Yew, horsechestnut	
Mixed deciduous	Horsechestnut, walnut, bird cherry *Prunus padus*, elm *Ulmus*, birch *B. alnoides*	Moru oak, kharsu oak, *Acer* spp.	1 800–3 000
Evergreen broad-leaved	*Machilus duthiei, Celtis australis*	Ban oak, *Rhododendron arboreum*	1 800–2 200
Scrub and grassland	*Indigofera, Rubus, Berberis*, grasses		1 500–3 000
Grazing meadows	Herb communities, including *Rumex* and other nitrophilous species		2 500–3 200

about 35% of designated forest is classified by the Himachal Pradesh Forest Department as protected or reserved (Das Gupta, 1976).

The temperate and subalpine forest zones collectively extend over an altitude range of 1500–3600 m in the study area. We divided temperate zone vegetation into eight types on the basis of associations that we distinguished in the field (Table 1). (For a more comprehensive classification of forest types in Himachal Pradesh see Champion & Seth, 1968.)

Lower altitude oak forest is more widespread in southern parts of the upper Beas than it is farther north, whilst evergreen broad-leaved forest is confined to a few tributary valleys of the Parbati near Kasol. The largest remaining areas of natural forest consist of low and high altitude conifers, but high altitude oak forest is also extensive in places. Mixed deciduous forest is widespread but patchy, usually being found on gentler slopes along valley bottoms.

The distribution of these forest types does not form an orderly altitude zonation but instead presents a complex mosaic related to altitude, slope, and aspect. Generally speaking, the cedar *Cedrus deodara* (Roxburgh) and kharsu oak *Quercus semicarpifolia* (Sm.) occur on south-facing slopes, whilst northerly aspects are dominated by silver fir *Abies pindrow* (Royle) and to a lesser extent by spruce *Picea smithiana* (Wallich). The distribution of scrub vegetation is related both to human activities (tree-cutting, livestock grazing) and natural physical effects (landslips, avalanches), whilst grassy meadows within the forest are found wherever the ground slopes relatively gently. These meadows are subjected to very heavy grazing in summer (May–October) and their extent is generally greater where domestic animals are numerous. We do not know how much the existence of these meadows is the result of human activities, but in some areas they have certainly been much enlarged by felling and burning. These meadows should be distinguished from true alpine grasslands which occur above the tree-line (roughly 3300 m) and which are also heavily grazed in most areas.

The upper Beas area contains much more natural forest than similar areas in the Ravi and Sutlej valleys. In addition, a higher proportion of the forests in the upper Beas have been designated as 'reserved', a category which excludes all grazing or felling and is subject to maximum protection by the Forest Department. Large areas of this forest still give more or less continuous cover, and hence provide large blocks of habitat for forest wildlife.

TABLE 2
Survey Time Spent in Different Altitude Zones in Different Months

Altitude (*m*)	*Time/month* (*hrs*)							
	Dec.–Jan.	*February*	*March*	*April*	*May*	*September*	*October*	*Totals*
4 300–4 600							2	2
4 300–4 000							8	8
4 000–3 700					4	1	16	21
3 700–3 400	2			3	18	34	15	70
3 400–3 100	29	2	19	31	39	18	21	111
3 100–2 800	64	8	44	57	39	17	34	197
2 800–2 500	23	27	44	73	59	16	8	272
2 500–2 200	30	93	59	27	50	38	6	215
2 200–1 900		74	31	70	57	32	9	350
1 900–1 600		9	2	44	15	32	14	210
1 600–1 300				20	7	10		48
1 300–1 000						4		4
Totals	148	213	199	325	288	202	133	1 508[a]

[a] This total includes 96 h spent in urban centres, such as Manali and Kulu, when notes were kept of raptors and passerines seen.

Data collection

Data were collected by direct observation, or by recording tracks, droppings, and other field-signs (see Appendix III, Gaston *et al.*, 1981*b*). Sightings constitute a much higher proportion of the data set for pheasants than for large mammals, which tend to be shy and silent.

Most field parties consisted of one to three people who covered areas on foot, usually following pre-existing trails to reduce noise. The following information was recorded for all encounters with pheasants and large mammals: date, time, locality, altitude, slope (estimated), aspect, forest type, and amount of snow cover. Where possible, the number, age, sex, and activity of animals was also noted. 'Forest type' comprised several variables estimated for the area within a 25 m radius of the encounter: commonest and next most common tree species, and percentage cover of the canopy, shrub, and ground vegetation layers. All data were coded numerically for subsequent computer analysis.

Each party kept a record of the time spent in the field in 300 m-wide altitude zones (Table 2). This information allowed us to make corrections so that the number of records of wildlife in different localities and different altitude zones at different times of year could be compared. This was necessary because it was impossible to survey all available habitat types with equal intensity or in proportion to their relative abundance (for instance, some south-facing slopes are sheer cliffs and some north-facing ones are impossible to traverse in early spring because of deep snow). In consequence, between-species comparisons of habitat requirements (preferences) are relative, not absolute. Comparisons between areas can be made on the basis of our data assuming that neither habitat differences between areas nor seasonal changes in behaviour significantly affected the detectability of the animals. Neither of these assumptions is likely to be met precisely, but we were not aware of major discontinuities in the field. We have introduced second-hand information on wildlife only where we were very confident of its reliability, and it is not included in any numerical analyses.

THE DISTRIBUTION AND ABUNDANCE OF WILDLIFE

Large mammals

Status

Some 17 species of large mammals occurred in the temperate forests we

TABLE 3
Records of Mammal Species in Different Survey Areas

Locality code:[a]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Survey time (party hrs):	428	248	129	257	53	42	26	18	9	[b]	[b]	14	35	[b]	[b]
Primates															
Rhesus	+	+	+	+	+		+		+			+		+	+
Langur	+	+	+	+	+	+	+		+		+	+		+	
Carnivores															
Jackal	+														
Wolf	+														
Fox	+	+	+	+		+						+			
Black bear	+		+	+		+	+		+			+	+		
Brown bear			+						+	+					
Weasel	+				+								+		
Marten	+	+	+	+	+	+							+	+	
Civet	+			+									+		
Jungle cat	+			+									+		
Leopard	+	+	+	+							+			+	+
Ungulates															
Musk deer	+	+		+		+									
Barking deer	+	+	+	+							+			+	+
Goral		+	+	+				+		+	+			+	+
Serow	+	+	+												
Tahr		+	+	+						+					
Ibex	+						+								
Rodents (large)															
Flying squirrel	+	+	+	+		+		+			+				
Porcupine	+	+	+	+							+			+	+
Lagomorphs															
Pika	+	+	+												

[a] Beas catchment: 1, Manali; 2, Tirthan; 3, Sainj; 4, Kasol & Garahan; 5, Pulga; 6, Shat; 7, Jagatsukh; 8, Parashar; 9, Chhot a Bangahal.
Ravi catchment: 10, Kugti; 11, Khajjiar.
Sutlej catchment: 12, Sarahan (Kulu); 13, Daranghati.
Elsewhere: 14, Simla Water Catchment Reserve; 15, Chail Sanctuary.
[b] Non-systematic surveys.

surveyed and a further 4 exclusively in the alpine zone above them (Table 3). A lack of direct sightings for virtually all of them, and especially for the nocturnal carnivores, precludes any assessment of actual population densities. We have therefore restricted ourselves to general statements about their apparent status, together with comparisons between survey sites based on relative frequencies of records.

We obtained 13 records of musk deer *Moschus moschiferus* Linn., and also found remains of deer that had been poached in Solang Nalla, at Jagatsukh, and at Nada Thach. This species appears to be rare in our study area, as it is throughout the Himalayas (Jackson, 1979*a*, *b*; Schaller, 1980; M. J. B. Green, pers. comm.). We saw Himalayan tahr *Hemitragus jemlahicus* (Ogilby) and goral *Nemorhaedus goral* (Hardwicke) or found their spoor and droppings in several places (Tables 3 and 4), but they were absent from the Manali area. This may have always been the case, according to local hunters.

The altitude of Manali is 1900 m and undisturbed forest higher up the Beas valley occurs only above about 2200 m. Consequently, wildlife in Solang, Hamta and Manalsu Nallas have no lower altitude refuge areas to retreat to during heavy snowfalls, in contrast to the more southerly valleys where forest extends down to 1800 m. This factor may be important in determining the distribution of tahr and goral.

Serow *Capricornis sumatraensis* (Bechstein) were probably present at Solang, where droppings were found and the species was reported by local people. Definite records were obtained in the Sainj and Tirthan valleys. We saw Himalayan ibex only in Hamta Nalla in the Manali areas. Groups seen there in October 1980 consisted of nine, six, and four animals of mixed sex and including kids. These are small groups compared with those of up to 26 animals seen by Schaller (1977, 1980) in protected areas in Pakistan. None of the ibex we saw had large horns, presumably because the population has been under considerable hunting pressure until recently. Small numbers were also reported by trekkers near Beas Kund at the head of Solang Nalla (A. A. Kazimi, pers. comm.) but we did not see them in that area.

The leopard *Panthera pardus* (Linn.) is widely distributed in our area, as is the Himalayan black bear *Selenarctos thibetanus* (Cuvier), which appears to be particularly common around Maṇali. Brown bear *Ursus arctos* Linn. occurs almost exclusively above the tree line in our study area (Winter-Blyth, 1951–52; Roberts, 1977; Schaller, 1977). A West German (ZDF) TV film crew obtained footage of this species (and ibex) on a visit

TABLE 4
Relative Frequency of Mammal Records/100 party hrs of Survey Time at Main Study Sites

Species	*No. of observations*[a]	*Study sites*		
		Manali	*Seraj*	*Parbati*
Primates				
Langur	68	2·1	6·9	8·9
Rhesus	38	0·4	7·3	0·7
Carnivores				
Fox	64	6·2	5·1	3·6
Marten	35	(5·8)[b]	1·2	0·4
Ungulates				
Goral	72	0·0	13·4	1·8
Tahr	32	0·0	6·5	2·8
Rodents				
Flying squirrel	66	10·4	4·1	1·1
Porcupine	21	0·8	3·8	1·4

[a] Within these main study sites only.
[b] Figure biased by the presence of a marten den close to camp.

to Hamta Nalla in the late 1970s. According to local hunters this species was formerly common and a popular big game quarry around Manali, but evidence from our surveys suggests it is now rare throughout the upper Beas. The only species known to have occurred in the area in the past, which appears to be extinct locally, is the snow leopard *Panthera uncia* (Schrebar) lat seen around Manali in 1965 (Harnam Singh, pers. comm.). The species still survives in Lahaul and Spiti to the north and in Kinnaur to the southeast (Forest Department Personnel, pers. comm.).

Primate densities are apparently highest in the Sainj and Tirthan valleys, although common langur *Presbytis entellus* (Dufresne) were also relatively common near Kasol in the Parbati valley.

Overall we obtained records for about the same number of large mammal species in each of our main study sites: 15 from Manali, 14 from Parbati and 13 from Seraj. However, an analysis of relative densities of eight species for which we obtained substantial numbers of records (Table 4) shows that Seraj has the highest figures for five of them, whilst Manali apparently holds the lowest densities for five and Parbati has intermediate figures for five.

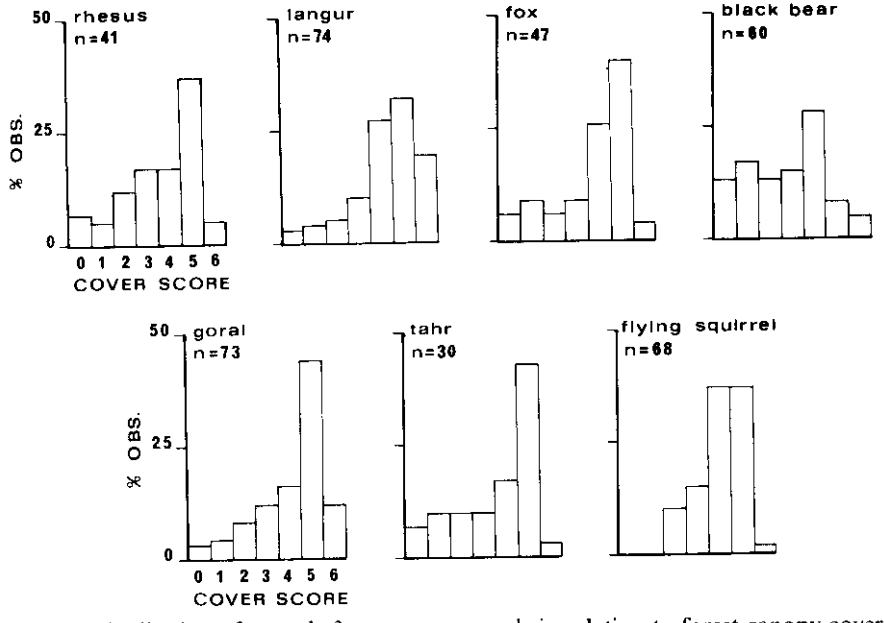

Fig. 3. Distribution of records for seven mammals in relation to forest canopy cover (0 = no canopy, 1 = <10%, 2 = 10–30%, 3 = 30–50%, 4 = 50–70%, 5 = 70–90%, 6 = >90%).

Ecology

Most of the large mammal species that we encountered live in forest all the year round. A preference for areas with extensive canopy cover was apparent for many of them and out of seven for which we have adequate data, only the black bear was frequently recorded in areas of less than 50% canopy closure (Fig. 3). Understorey cover also appeared to be important, with most species showing a preference for areas with dense understorey, particularly goral and common langur. Serow and musk deer have also been reported to prefer areas with heavy shrub and ground cover (e.g., Pythian-Adams, 1950; Schaller, 1977).

Most species showed some indication of seasonal altitude movements, probably in response to winter snowfall, and this applied particularly to common langur, red fox *Vulpes vulpes* (Linn.) and yellow-throated marten *Martes flavigula* (Boddaert) (Fig. 4). However, giant Indian flying squirrels *Petaurista petaurista* (Pallas) remained well above the snow line in winter, as did some foxes, martens, Himalayan tahr and goral. The two ungulates, however, avoided areas of heavy snowfall in winter and spring, occurring mostly on steep southward-facing slopes where the effects of

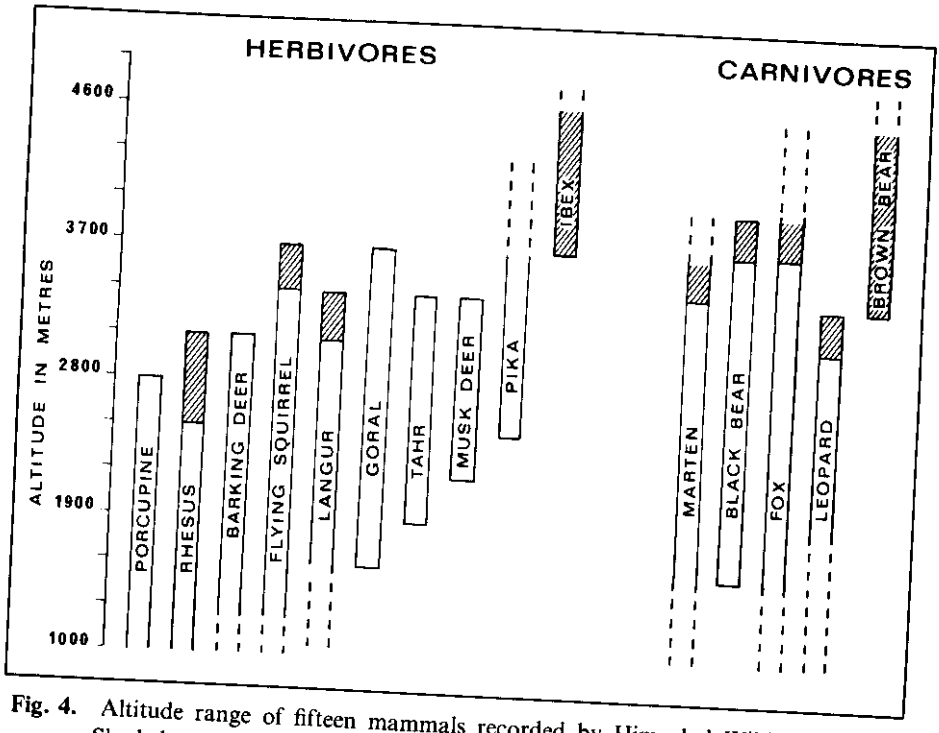

Fig. 4. Altitude range of fifteen mammals recorded by Himachal Wildlife Project. Shaded range covers altitudes only recorded during April–September.

gradient and insolation kept some areas relatively free of snow. All tahr populations located were associated with precipitous cliffs bordering on dense forest. Such habitat occurs in only a few places within our area, presumably limiting the potential tahr population.

Our information on altitude ranges and habitat differs from that reported previously for a few species. We found evidence of Himalayan black bears above the tree line on several occasions (see also Cronin, 1979), whereas Schaller (1977) and Roberts (1977) consider the species to be restricted to forest. Some expansion of black bear foraging range may have occurred in response to declining brown bear populations. Conversely, we encountered Himalayan pika *Ochotona roylei* (Ogilby) in *Quercus semicarpifolia* and *Abies pindrow* forest, as well as in the alpine zone, which is normally considered its typical habitat (Prater, 1971; Roberts, 1977). Tahr, which are wholly alpine in their distribution in Nepal (Schaller, 1973, 1977; Green, 1979), occurred almost exclusively in forest in our area. This could be related to competition from ibex above

the tree line, the latter being absent from the Himalayas east of the Sutlej (Singh, 1959).

Hunting

All hunting is now illegal in Himachal Pradesh, but this is likely to have very little effect on wildlife populations because even prior to the ban very few people bothered to obtain the permits required by the Forest Department. We found evidence of poaching in all the areas that we visited; at Solang we found traps and the remains of a musk deer; at Kasol the remains of a tahr that had been cooked; and in the Tirthan valley we found evidence of musk deer and goral hunting and many wire snares clearly set for ungulates. Herds of tahr seen were very small ($\bar{x} = 1{\cdot}7$, $N = 7$), suggesting that populations have been severely reduced by hunting pressure.

The value of musk is so high (8000 rupees/animal, M. J. B. Green, pers. comm.) that, despite the rarity of the musk deer and its relatively inaccessible habitat, there is a great incentive for poachers. Undoubtedly, many other ungulates are either caught in traps set for musk deer, or perhaps more commonly, killed to provide food for poachers trapping musk deer.

Both species of bear are shot as pests, black bears by orchard owners, and brown bears by nomadic graziers who consider the bears a menace to their flocks. Snow leopards were no doubt formerly destroyed for the same reason. Crop/flock protection licences for firearms are issued by district magistrates and therefore are not under the control of the Forest Department.

Pheasants

Status

Five species of pheasants occur in the temperate forests of the Western Himalayas and we recorded all of them within our survey area. We shall not give exact locations for records of the rarest species, the western tragopan, but the geographical distribution and relative abundance of the other four species (cheer, monal *Lophophorus impejanus* (Latham), koklas *Pucrasia macrolopha* (Lesson) and kaleej *Lophura leucomelana* (Latham)) is shown in Fig. 5. The relative abundance of the monal was probably exaggerated by the species' tendency to flush at long range giving a loud call which made the birds very conspicuous. Censuses of

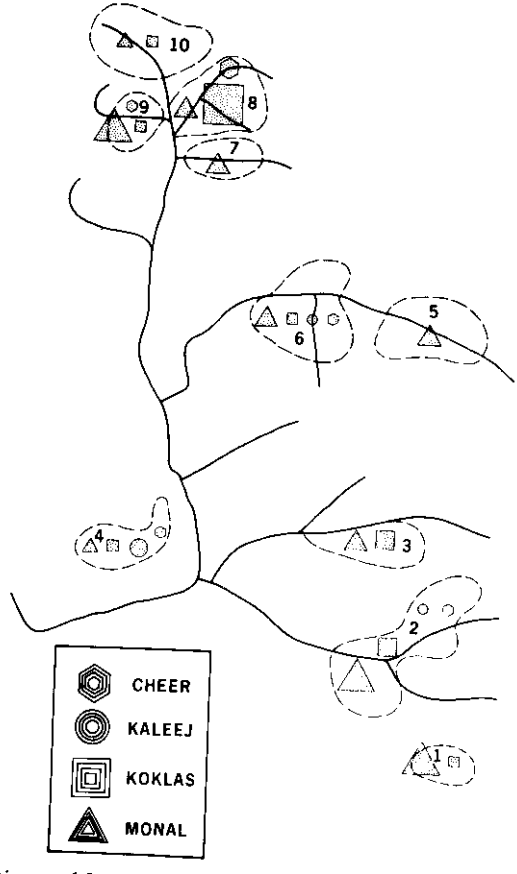

Fig. 5. Distribution and frequency of sightings for four species of pheasants in the upper Beas area. Symbols indicate numbers seen per 100 h in the field, in order of size <10, 10–20, 21–50, >50. 1. Sarahan; 2. Tirthan Rolla; 3. Sainj; 4. Parashar; 5. Khirganga; 6. Kasol; 7. Jagatsukh; 8. Hamta; 9. Manalsu; 10. Solang.

koklas on the basis of dawn crowing, a simple technique for this species (Howman & Howman, 1976; Gaston, 1980) probably gave a better measure of this species' abundance than encounters. On this basis the densest koklas populations occurred at 2300–2800 m in open *Pinus griffithii* (McClelland) forest (Kasol, Sarahan, Hamta valley) and at 3200 m in dense *Quercus semicarpifolia* forest at Nada Thach, in the Tirthan valley.

Our survey methods were not suitable, in most cases, for calculating actual population densities, but some idea of orders of magnitude can be

TABLE 5
Estimated Populations of Pheasants in the Upper Beas Area
(Beas Catchment above the Pandoh Dam)

	Observed range of density (*birds km*$^{-2}$)	*Estimated area of suitable habitat* (*km*^{2})	*Population range* (*birds*)
W. tragopan	2–5[a]	300	6000–1 500
Monal	2–16[b]	600	1 000–10 000
Cheer	5–10[b]	[50]	250–500
Koklas	4–20[b]	600	2 400–12 000
Kaleej	5–20[a]	60	300–1 200

[a] Based on sightings of individual birds; these are probably underestimates.
[b] Based on males counted calling during the breeding season $\times 2$. Sex ratios appeared fairly equal for monal and koklas.

obtained for populations within the upper Beas area on the basis of estimated forest area (Table 5). Judging from information available at present, the population of western tragopan in the upper Beas probably constitutes a large proportion of the world total of the species (Gaston, 1980). The population of cheer may also constitute a significant proportion of the world total, although we have estimated elsewhere that the total population of Himachal State is probably not less than 1000 pairs (Gaston *et al.*, 1981*a*).

Although numbers of monal appear healthy in some areas, densities are still much lower than those found throughout the species' range in the last century (Wilson, quoted in Hume & Marshall, 1879). Even as late as 1952/53 flocks of 20 or more were encountered in Solang and Hamta Nallas in September and February (I. Grimwood, pers. comm.). Clearly this species has declined sharply in the last 30 years throughout the Beas valley. The same applies to the western tragopan, of which Grimwood recalls seeing 'five or six in a day' in the upper Beas area, compared to our average of one or two sightings.

Ecology

The altitude distribution of all species except kaleej was broadly similar, extending from the lower part of the temperate zone to the subalpine forest (Fig. 6). Significant seasonal altitude movements were detected for monal and koklas, with monal wintering largely below 3100 m, but being most common above this level during the breeding season. Koklas spread

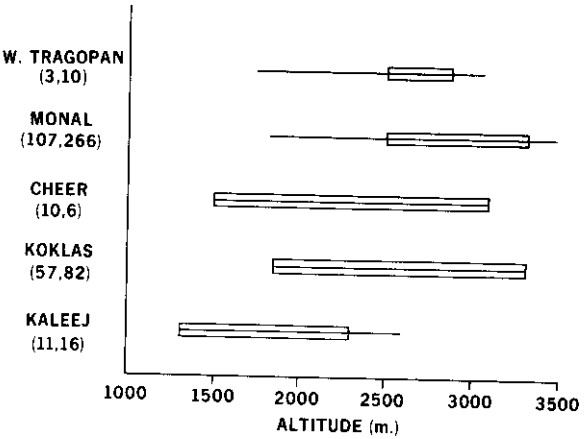

Fig. 6. Altitude distribution of pheasants in the Western Himalayas, including records from outside the upper Beas area. (Central line = non-breeding; bar = breeding season.)

out during the summer over their whole altitude range while in winter most of the population concentrated below 2800 m (Fig. 7). The species was entirely absent from the upper parts of Solang Nalla, despite apparently suitable forest between 2600–2200 m. The lack of any adjacent lower altitude refuge areas may be responsible for this; in winter the birds would have nowhere to go during heavy snowfalls.

The habitat occupied was determined partly by altitude distribution, but some preferences were discernible within a given altitude zone (Fig. 8). Western tragopan were found most commonly in higher altitude coniferous forest while monal apparently preferred higher altitude oaks. The apparent preference of kaleej for lower altitude oak forest was probably greater than our records indicate because this type of forest is much less extensive than lower altitude coniferous forest. The density of koklas was remarkably uniform in natural forest with 3–8 males being audible during the dawn chorus at practically every locality visited within the altitude range 1900–3400 m. Cheer were found most frequently on steep, grass-covered hillsides and, according to local people, often feed on cereal crops. In one hamlet near Bandal the residents even considered them a mild agricultural pest.

Hunting

Hunting for pheasants occurs regularly in areas adjacent to the main Beas valley and seems to be most popular in winter when they are driven downwards by snow. Birds are shot or killed in drop-traps sometimes

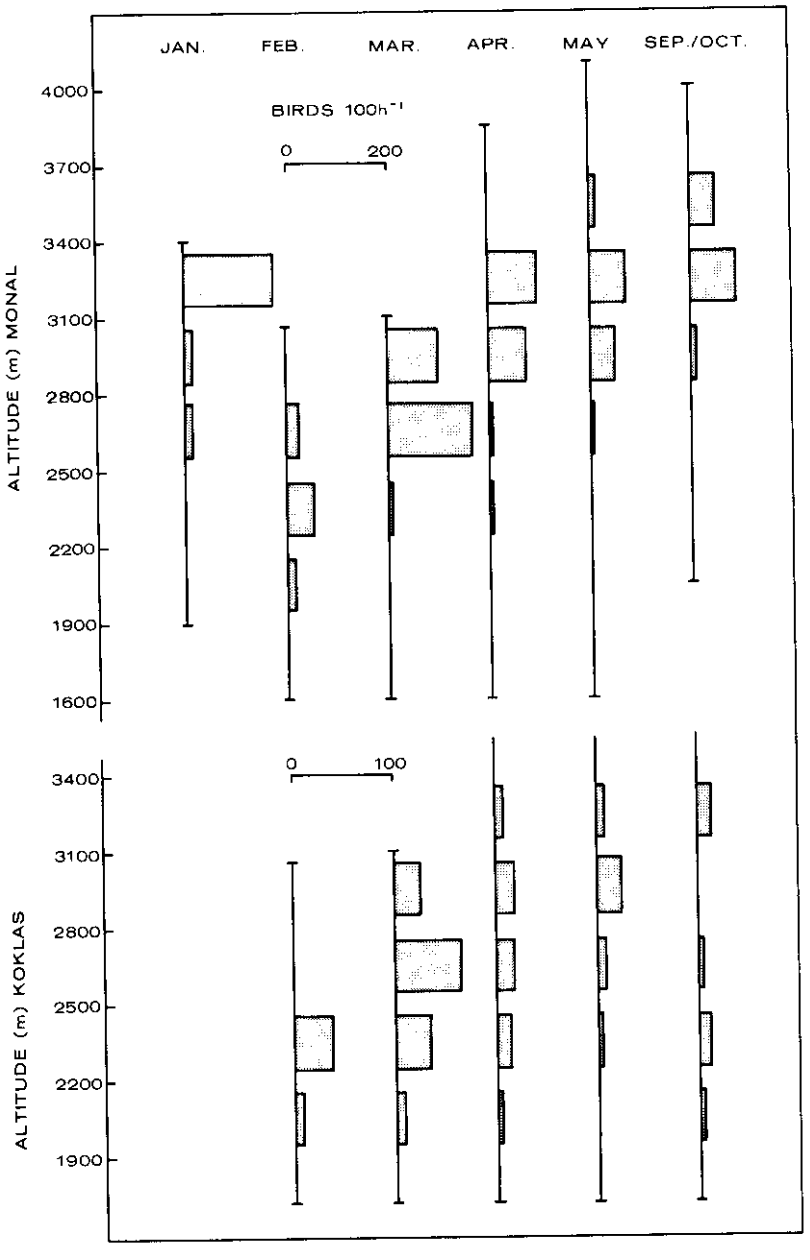

Fig. 7. Seasonal changes in the altitude distribution of monal and koklas in the Western Himalayas (data included, as for Fig. 6).

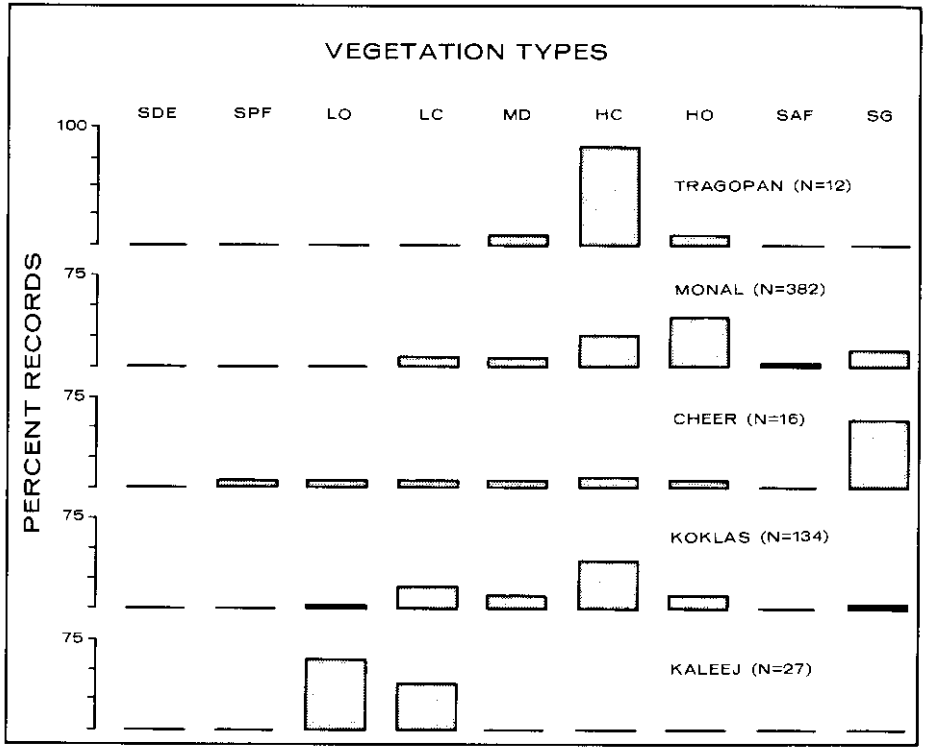

Fig. 8. Forest types in which pheasants were recorded in the Western Himalayas (data included, as for Fig. 6). LO = Lower oaks; LC = Lower conifers; MD = Mixed deciduous; HC = Higher conifers; HO = Higher oaks; SAF = Subalpine forest; SDE = Subtropical dry evergreen; SG = Shrubs or grasses dominant; SPF = Subtropical pine forest.

augmented by brushwood barricades. The main objects of the hunt are male monal because the crest feathers are popular hat decorations in the upper Beas and fetch 25–50 rupees, compared with only 15–20 rupees for the meat. Probably any type of pheasant is taken, however, and we saw both western tragopan and koklas feathers decorating apparel. The incidental kill of western tragopan in the monal hunts may have some effect on populations.

STATE OF NATURAL ECOSYSTEMS

The area surveyed is in no sense remote. Even the farthest reaches of the forest are at present no more than three days' walk from the nearest road,

and the human population is well distributed practically everywhere up to about 1600 m, with scattered communities as high as 2500 m. Population densities average about 100 people per km^2.

In view of the accessibility of the area, we were impressed with the amount of natural forest remaining in the upper Beas; the result of policies introduced by the Government of India early in this century to protect watershed forests for the management of water resources. The upper Beas provides a striking contrast, in this respect, with the Ravi and Sutlej valleys on either side, both of which support much less forest.

Detailed examination of the forest reveals a less satisfactory picture. In areas close to settlements, or the routes of migrant herds of domestic sheep and goats, the forest understorey is very sparse and there is little or no evidence of natural regeneration. A good example of the effect of grazing is provided near the village of Shuru, outside Manali, where blue pines have been planted. The plantation is protected by a wire fence which excludes domestic animals. The majority of planted trees have died, perhaps because of improper transplantation techniques, but they are more than compensated for by the luxuriant natural regeneration of pines taking place, presumably seeded from trees higher up the hillside. Outside the enclosure little regeneration is evident.

Areas where regeneration seems effectively halted include most of Solang Nalla, where few young trees are to be found below 3000 m; the south side of Hamta Nalla; and the extensive mixed deciduous forests on the south side of the Parbati valley above Manikaran. Grazing has also modified the understorey vegetation considerably, reducing the amount and diversity of shrubs and ground vegetation. Along grazing routes in particular, large areas of meadow consist almost entirely of dock *Rumex* spp. and other nitrophilous herbs. Understorey is best developed in areas subject to little or no grazing, such as the upper Sainj and Tirthan valleys which are not used by migrant herds because they do not provide egress to the east, and the Garahan Nalla area, much of which is too precipitous to encourage domestic grazing.

CONCLUSIONS

Comparisons of heavily and lightly grazed areas lead us to the conclusion that grazing by domestic animals is causing severe alteration of the natural forest flora. In most areas this reduces the suitability of the habitat for wildlife. Areas least affected are those which are not traversed

by the regular routes of migrant graziers, particularly the upper Sainj and Tirthan valleys.

Hunting is probably having an effect on wildlife populations throughout the area, large ungulates, snow leopards and brown bears being particularly affected. All ungulate populations encountered appeared to be well below natural equilibrium levels. The tahr, here close to the western edge of its world range (Schaller, 1977), gives particular cause for concern because the entire world population is concentrated in the Himalayas and divided into small, largely unprotected pockets. Ibex, on the eastern edge of their range, also appear to be surviving only precariously in the upper Beas. Their population in the area is known to have been much larger formerly (Burrard, 1925). Unless wild ungulate populations increase there is no prospect for a return of the snow leopard.

For pheasants the situation appears tolerable in areas away from the main Beas valley, but considerable declines have occurred in numbers of monal. Both of the *Red Data Book* species, cheer and western tragopan, are well distributed, though very sparse, and numbers of tragopans have certainly fallen in the last 30 years. Excessive hunting seems the most likely cause of these population changes. Only koklas appear to be maintaining their former status, at least where forest has not been cleared. For this species, as well as some mammals, it appears that access to refuge areas below 2500 m during winter is important in determining populations. This is one factor which makes Solang Nalla, proposed previously as a National Park area, less suitable than the Sainj and Tirthan valleys for forest wildlife.

Because most pheasants and large mammals seem to shift their ranges seasonally, it is important that any reserve or sanctuary designed to protect them covers a sufficient range of altitudes to encompass their entire annual requirements. In addition, species confined to forest habitats tend to be split into numerous isolated pockets, separated from other similar areas by high, barren ridges above and cultivated valley bottoms at lower altitudes. Natural recolonisation after local extinction is therefore much slower than might otherwise be the case. Reserves set up under these conditions need to contain as large an area of forest as possible through which mammals, in particular, can disperse freely.

Our conclusions regarding the best site for a National Park are that the Seraj area is superior to the Manali area in possessing larger areas of undisturbed forest, a greater natural diversity of wildlife, and less pressure from domestic grazing. The problem of environmental degradation caused by excessive grazing is one that clearly needs

attention throughout Himachal Pradesh. In choosing a site for a National Park, however, we feel that preservation of the more-or-less intact forest ecosystems of Inner Seraj is preferable to the rehabilitation which would be necessary in the Manali area.

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REFERENCES

Bakshish Singh (1979). Perspective of forest development in the Western Himalayan region. In *Man and forest*, ed. by K. M. Gupta and Desh Bandhu, 245–57. New Delhi, Today and Tomorrow's Printers and Publishers.

Basu, S. (1965). Weather and climate. In *The gazetteer of India*, **1**, *Country and people*, ed. by P. N. Chopra, 67–116. New Delhi, Government of India.

Burrard, G. (1925). *Big game hunting in the Himalayas and Tibet*. London, H. Jenkins.

Das Gupta, S. P. (1976). *Atlas of forest resources of India*. Calcutta, Government of India.

Champion, H. G. & Seth, S. K. (1968). *A revised survey of the forest types of India*. New Delhi, Government of India.

Cronin, E. W., Jr. (1979). *The Arun: a natural history of the world's deepest valley*. Boston, Houghton Mifflin.

Diamond, J. M. (1974). The island dilemma: lessons of modern biogeographic studies for the design of nature reserves. *Biol. Conserv.*, 7, 129–46.

Gaston, A. J. (1980). The Himalayas: Summary of current knowledge on the status of pheasants. In *Pheasants in Asia 1979*, ed. by C. Savage, 33–5. Exning, Suffolk, World Pheasant Association.

Gaston, A. J., Garson, P. J. & Hunter, M. L., Jr (1981*a*). Present distribution and status of pheasants in Himachal Pradesh, Western Himalayas. *J. World Pheasant Ass.*, **6**, 10–30.

Gaston, A. J., Hunter, M. L., Jr & Garson, P. J. (1981*b*). The wildlife of Himachal Pradesh, Western Himalayas. *University of Maine School of Forest Resources Technical Note*, No. 82.

Green, M. J. B. (1979). Tahr in a Nepal National Park. *Oryx*, **15**, 140–4.

Howman, K. & Howman, J. (1976). The World Pheasant Association in Pakistan. *J. World Pheasant Ass.*, **1**, 95–104.

Hume, A. O. & Marshall, C. H. T. (1879). *The game birds of India, Burma and Ceylon*. Calcutta.

IUCN (1979). *Red Data Book—Aves*. Morges, IUCN.

Jackson, R. (1979*a*). Snow leopards in Nepal. *Oryx*, **15**, 191–5.

Jackson, R. (1979*b*). Aboriginal hunting in West Nepal with reference to musk deer *Moschus moschiferus moschiferus* and snow leopard *Panthera uncia*. *Biol. Conserv.*, **16**, 63–72.

Negi, T. S. (1963). *Himachal Pradesh District Gazetteers—Chamba*. New Delhi, Government of India.

Prater, S. H. (1971). *The book of Indian animals*. Bombay, Bombay Natural History Society.

Pythian-Adams, E. G. (1950). Jungle memories, 7. Wild goats and sheep. *J. Bombay Nat. Hist. Soc.*, **49**, 418–26.

Raina, V. (1979). Forest and soil conservation in Himachal Pradesh: fifth five-year plan and its progress. In *Man and forest*, ed. by K. M. Gupta and Desh Bandhu, 258–69. New Delhi, Today and Tomorrow's Printers and Publishers.

Roberts, T. J. (1977). *The mammals of Pakistan*. London and Tonbridge, Ernest Benn.

Sagreiya, K. P. (1967). *Forests and forestry*. New Delhi, National Book Trust.

Schaller, G. B. (1973). Observations on Himalayan tahr (*Hemitragus jemlahicus*). *J. Bombay Nat. Hist. Soc.*, **70**, 1–24.

Schaller, G. B. (1977). *Mountain monarchs*. Chicago, Chicago University Press.

Schaller, G. B. (1980). *Stones of silence*. London, André Deutsch.

Singh, K. G. (1959). Eastern limit of the Himalayan ibex, *Capra ibex sibirica* Pallas. *J. Bombay Nat. Hist. Soc.*, **55**, 341–5.

Terborgh, J. & Winter, B. (1980). Some causes of extinction. In *Conservation biology*, ed. by M. E. Soulé and B. A. Wilcox, 119–33. Sunderland, Mass., Sinauer Associates.

Winter-Blyth, M. A. (1951–52). A naturalist in the northwest Himalaya. *J. Bombay Nat. Hist. Soc.*, **50**, 344–54; 559–72.