

## **HEMIS, A NATIONAL PARK FOR SNOW LEOPARD IN INDIA IS TRANS**

### **HIMALAYA**

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### **INTRODUCTION**

The recently established Hemis High Altitude National Park in India's northernmost district of Ladakh is potentially the best protected area for snow leopard (*Panthera uncia*) in India and represents an important component of efforts toward the conservation of this species in the Himalayan region. In 1981 the state of Jammu and Kashmir established, and in 1990 it expanded in size, the Hemis National Park which is located in the trans-Himalayan Zaskar Range south of Leh in central Ladakh. Hemis is the first national park to be established north of the main Himalaya Range in India and thus provides for the inclusion of a substantial tract of a previously unrepresented biogeographical zone in India's system of parks and reserves. The snow leopard is the most important large predator within the Eurasian fauna of the mountains of central Ladakh and the creation and expansion of the park has been described by *Jammu and Kashmir* as a major step in a statewide program for protection of this endangered species (Anon. 1986 a).

The results of recent cooperative international surveys designed to determine relative abundance of snow leopard and their prey in selected areas of northwest India concluded that the central Ladakh region, including Hemis National Park, was the best area for snow leopard that has been surveyed to date in India (Fox et al 1986, 1991). Subsequently, the Wildlife Institute of India has initiated an intensive study of snow leopard and their prey in a portion of the Hemis National Park (Chundawat et al 1990, Chundawat, this volume). From these studies it has become clear that the Hemis Park and its vicinity represent a prime area for continued research on and conservation of the snow leopard in India. The central government of India is expected to approve the initiation of a "Project Snow Leopard" to take place over the next five years. This conservation effort is modelled after the successful "Project Tiger" and will provide funds for management of national parks within snow leopard habitat in each of India's Himalayan states. It is clear that the Hemis National Park represents the best hope

for snow leopard conservation in Jammu and Kashmir (perhaps in India) and should constitute the primary recipient of funds from Project Snow Leopard in this state.

## PARK STATUS

Hemis National Park was first officially gazetted by the state of Jammu and Kashmir in 1981. Following an international symposium on snow leopard held in Kashmir in 1986 the Jammu and Kashmir Department of Wildlife Protection issued a report which proposed a large expansion of the size of the park as a cornerstone of its "Snow Leopard Recovery Programme" (Anon. 1986 a). The expanded park, with some changes from that proposed in 1986, was so gazetted in mid-1990 (A.R. Wani, pers. comm.). The current notifications of park boundaries and proposed core area reflect almost identical recommendations by both Mallon and Bacha (1989) and the present authors, and are shown in Figure 1.

There has been some confusion in published accounts regarding the size of the Hemis National Park. Central government reports and private publications (Israel and Sinclair 1987, Rodgers and Panwar 1988) repeat a state government (Anon. no date, Anon. 1986 a) figure of 600 km<sup>2</sup> as the size of the park designated in 1981, whereas measurement of the park's area, based on boundary maps provided by Department of Wildlife Protection publications and using USAMS 1:250,000 maps as sources, gives an area of approximately 1,200 km<sup>2</sup> for the originally designated park. The expanded park as described by the Department of Wildlife Protection (Anon. 1986 a) is not the 3,350 km<sup>2</sup> as stated in their report, but rather an approximately 4,400 km<sup>2</sup> area. The total area of the newly expanded park as outlined in Figure 1 is approximately 4,800 km<sup>2</sup>, with the core area being about 1,400 km<sup>2</sup>. These revisions should be recognized in subsequent evaluations of the park's conservation value and management considerations.

## PARK LOCATION AND DESCRIPTION

Hemis National Park is located (76° 50' - 77° 45'E, 33° 15' - 34° 20'N) in the trans-Himalayan Zaskar mountains directly across the Indus valley to the south of the main town of Ladakh, Leh (Figure 1). Park elevations range from 3,300 m at the confluence of the Indus and Zaskar rivers in the northwest to the 6,400 m Kang Yisay massif in the northeast. The Zaskar river cuts through the trans-Himalayan ranges of the park in a spectacularly steep, rugged, and uninhabited gorge. This canyon is impassable during summer due to the raging meltwaters from the main Himalaya to the south, but the frozen river becomes a lightly used travel corridor between Zaskar and the Indus valley during the months of January and February. The upper valleys in the eastern portion of the park comprise more open rolling country in transition to the high plains of the Tibetan borderlands.

The central Ladakh region of Hemis Park is characterized by a very dry climate, with cool summers and cold winters. Temperatures in winter commonly fall below -20 C and although summer

temperatures can reach 300 C at the lower elevations, snowfall can occur at any time of year. Annual precipitation in Leh at 3,500 m in the Indus valley is about 10 cm, but rainfall and snow increase with altitude. The vegetation in Hemis National Park is predominantly alpine and steppe (Hartmann 1987) with various tree and shrub communities present in the valley bottoms. The moister upper mountain slopes support limited areas of alpine vegetation, characterized by genera such as *Anemone*, *Gentiana*, *Thalictrum*, *Lloydia*, *Veronica*, *Delphinium*, *Carex* and *Kobresia*. The remaining mountain slopes and open hillsides, comprising the major portion of the park, support primarily steppe vegetation dominated by *Caragana*, *Artemisia*, *Stachys*, and *Ephedra* (Kachroo et al. 1977, Hartmann 1987). Shrubland (*Hippophae*, *Salix*, *Myricaria*) and some trees (*Populus*, *Betula*) are present along the lower river courses (Figure 2).

Although the vegetation is sparse it supports a diverse large mammal fauna amid the varied mountain and riverine habitats. Fox et al. (1986) estimated that 5-10 snow leopards commonly used areas within the original park (Figure 3). However, more recent information indicates that the actual number may be 2 to 3 times greater (R. S. Chundawat, unpubl. data). Perhaps 50-75 snow leopards (*Panthera uncia*), 25-50 wolves (*Canis lupus*) and wild dogs (*Coon alpinus*), and a few lynx (*Lynx lynx*) occur within the expanded park.

The original park supports approximately 1,500 blue sheep (*Pseudois nayaur*) (Anon. 1985, Fox et al. 1986), and the expanded boundaries may triple this number. Nearly 300 of the endangered Ladakh urial (*Ovis vighel*) occur within the park along the mountains bordering the main Indus valley and its confluence with the Zaskar river. A small population (11 in 1990) of the endangered Tibetan argali (*Ovis ammon hodgsoni*) are present in a minor valley in the northwest portion of the park, and some possibly occur in the upper Khurnak drainage within the expanded boundaries. Some 20 ibex (*Capra ibex sibirica*) were counted in 1984 on the west side of the Zaskar river in the original park (Anon. 1986 a) and significantly more occur along the Zaskar gorge within the expanded boundaries. A few kiang, or Tibetan wild ass, (*Equus hemionus /dang*) have been reported in eastern areas of the expanded park (Osborne et al. 1983, Nurbu, unpubl. data).

Other common smaller mammals include the fox (*Vulpes vulpes*), marten (*Martes ssp.*), otter (*Lutra lutra*), Himalayan weasel (*Mustela sibirica*), hare (*Lepus oiostolus*), Himalayan marmot (*Marmota bobak*), and the mouse hare or pika (*Ochotona roylei*). Some of the larger birds include the golden eagle (*Aquila chrysaetos*), lammergeyer (*Gypaetus barbarus*), griffon vulture (*Gypsfulvus*), Himalayan and Tibetan snowcocks (*Tetraogallus himalayensis* and *T. tibetanus*), and the chukor (*Alectoris chukar*).

Snow leopards are characteristically found in the more steep and rugged mountainous regions of the park, and although wolves and wild dogs are more common in relatively open country there is considerable overlap among all three species. Snow leopard prey species include all the wild ungulates, the marmot, hare, mousehare, snowcock, and chukor. From an analysis of snow leopard scats it is apparent that the major prey item for snow leopard in the park is blue sheep, followed by domestic livestock, marmots and a variety of other species (R.S. Chundawat and J.L. Fox, unpubl. data).

The most isolated portion of the zaskar canyon, the tributary Khurnak river gorge, and several smaller zaskar tributaries have been proposed as a core area for the newly expanded park (Figure 1). This area encompasses prime and currently relatively undisturbed habitat for snow leopard and their major prey in the region, the blue sheep and ibex. As an area of strict protection subject to severe restrictions on human use, this region would provide the key to the long-term sustainability of a viable population of snow leopard in central Ladakh. Other areas of the park either include or are adjacent to human habitations, substantial livestock, and localized tourism, and will be managed as different types of buffer areas to the park core. It should be stressed that the core area is so rugged and isolated that it is very little used by people now, and efforts to preserve its true wilderness qualities would have a negligible effect on current land use practices and need not hinder normal development in other regions of the park.

#### HUMAN LAND USE Fanning and animal husbandry

Traditional land use in the park has been based on a combination of agriculture and

livestock husbandry. Most farming is centered around the permanent villages, whereas a portion of most families make summer migrations with livestock to mountain pastures for milk product, meat, and wool production as well as accumulation (or collection) of dung for crop fertilizer and cooking fuel. The current park boundaries include 23 permanent settlements and a human population of about 1,600 (Mallon and Bacha 1989), located primarily in the northern portion of the park and, to a lesser extent, along its southern extreme. Less than 200 hectares are intensively used as village sites and irrigated cropland along valley bottoms where primarily barley, wheat, and legumes are cultivated. Within the original 1,200 km park there are approximately 2,600 sheep and goats, 220 yak and yak-cow hybrids, 165 donkeys, and 85 horses kept permanently within the area (Anon., no date, Fox et al. 1986), although more are brought in from villages outside the park during summer. The expanded park includes substantially more livestock from nomadic herders in the upper Khurnak valley and from additional villages in both the northern and southern portions of the park.

Villages are set along the bottoms of the valleys where both irrigation water and nearly level land are available. The highest year-round villages are situated at about 4,000 m, the highest cultivation at 4,300 m, and the highest summer grazing settlements are at about 4,750 m in the upper valleys. The headwaters of the various valleys constitute traditional summer grazing grounds for villages within and adjacent to the park and are divided into regions where specific families have primary rights to the grazing and fire fuel resources. All but the steepest and most rugged terrain is used for livestock grazing. Exotic breeds of sheep, goats, and cattle are being introduced to Ladakh by the Kashmir government to increase textile fiber and milk production. Although these have not been

introduced on a large scale to areas within the park as yet, they are in adjacent areas and will certainly soon become a part of park's livestock. Consequences of these actions on the conservation of wild ungulates (snow leopard prey), which as grazers compete with the domestic ungulates, has not been adequately assessed, and will require the attention of national park authorities.

#### Tourism and development in the Park

Ladakh was opened to tourism in 1974, and from the few hundred people that arrived that year, the number has risen to over 15,000 in 1988. Most tourists come to Ladakh to visit the towns, villages, and monasteries along the main roads. However, an increasing number come to trek in the mountains, either individually or in organized groups. Areas within Hemis National Park, especially in the northern portion, are among the most popular trekking routes in Ladakh.

Because of their relatively restricted movements and activities, the presence of tourists, per se, will probably not greatly affect the status of snow leopard and their prey in the park. Visitors remain for the most part on established trails, which are restricted to the valley bottoms and major passes. However, the effect on tourism on local economics may indirectly influence wildlife conservation. The northern portion of Hemis Park will probably continue to develop as a tourist destination and changes in local land use and economy paralleling that in other high Himalayan parks such as around Mt. Everest (Bjoenness 1982, Jefferies 1982) are likely to follow. This would mean a greater reliance on milk-producing livestock with consequent increased grazing near villages (Jefferies 1982), with a possible decrease in efforts spent herding livestock in remote areas. The introduction of exotic livestock (including hybrids with local varieties) introduces animals less able to utilize the sparse vegetation present in the rugged mountains and may also serve to lessen grazing intensity by domestic animals in remote areas. Both changing economies and the introduction of exotic livestock could then act to increase the habitat quality for wild ungulates in the mountain regions of Ladakh. Still, possible increases in livestock numbers and more intensive grazing of the lower elevation wild ungulate wintering areas could act to offset or reverse such a trend. Thus, the effects of changing pastoral patterns need to be closely watched outside and regulated within the national park.

Tourist trekking, as in Sagarmatha National Park (Bjoenness 1982, Jefferies 1982), will also serve to increase demands for transport services (horses), food sources, and firewood sources during travel in the remote valleys of the park. The grazing of horses and the use of firewood by park visitors need to be strictly regulated throughout the park and especially in its core area.

#### Human - wildlife interaction

Some portions of the Hemis Park, in particular the Rumbak and Shang valleys adjacent to the Indus valley, have in the past been popular hunting locations for British and Indian army personnel or sportsmen (Figure 4). Ward (1924), for example, includes an illustration of wild

sheep hunted in the "Rambak" valley of Ladakh. The Shang valley, now a part of the expanded Remis Park, was originally conceived by Jammu and Kashmir as a game reserve, primarily for blue sheep.

Traditionally, however, within the Buddhist areas of central Ladakh hunting has not been prevalent, and this in part accounts for the continued good wildlife populations within relatively close proximity to the Indus valley near Leh. This is in contrast to the widespread decimation of wildlife populations in accessible areas along roads and near military establishments during the past 40 years (Fox et al., in press.). The Remis Monastery is one of the most famous and powerful in Ladakh. It has a strong influence on society in many villages in the northern portion of the park and has (along with other monasteries) been instrumental in maintaining the sanctity of wildlife in the area. Some hunting has traditionally taken place over the years, including limited trapping for chukor and snowcock and various methods to kill large predators, especially when they take livestock. Still, there is little doubt that the relatively abundant wildlife found even in areas intensively used by the Buddhist villagers is a reflection of their tolerance of, and reluctance to kill wild animals.

Local livestock owners in central Ladakh are of the opinion that the wild sheep present in the mountains do not compete for food with their domestic animals. Such a view, even if not completely accurate, also fosters tolerance of the wild sheep which can often be found in close proximity to many of the villages. With regard to predators on livestock, snow leopards,

wolves, and wild dogs are usually killed on the rare occasions when they are caught while taking livestock, especially when they get into enclosed pens and kill many animals at once. Many villages also have large stone pit traps for luring wolves and other predators that have become troublesome livestock killers. It is clear, however, that the occasional loss of livestock to predators is tolerated as normal, and even benign when, for example, some livestock can be quickly retrieved (and salvaged as food) from the predator which has performed something of a service to the Buddhist villager by killing the animal (Fox and Chundawat 1988).

## PARK MANAGEMENT

Hemis National Park encompasses representative trans-Himalayan habitats dominated by relatively rugged terrain, and includes some of the best areas for snow leopard and those least heavily used by people in the region of central Ladakh. In terms of providing protection for the snow leopard, the primary management requirements for the park will be to:

- 1) prevent excessive killing of snow leopard (the removal of problem animals may be necessary), 2) minimize predator access to livestock,
- 3) create a practical policy for documenting and compensating predator-related damage in the park,
- 4) monitor prey population size,
- 5) determine an acceptable limit to livestock numbers to prevent excessive competition with and possible disease transmission to wild ungulates (snow leopard prey),
- 6) restrict and monitor human use in the core area.

Other, equally important management concerns associated with conservation in the Park include:

- 1) participating with village councils in selecting development alternatives that are in keeping with park goals,
- 2) limiting the use of native vegetation for fuelwood (especially for visitors),
- 3) the monitoring and regulation of tourist access to the park,
- 4) conservation education for park and neighboring residents and for visitors.

These are all especially important concerns because the rapidly developing town of Leh will be making increasing demands on the resources of nearby areas such as those included in the National Park. A management strategy designed now to anticipate both the adjacent urban demands and the desires of those living within the Park will be crucial to the planned economic development of the inhabited areas in conjunction with the conservation of wildlife and native habitats.

Concerning development actions, we can consider the ongoing construction and plans for roads within the park. There is currently only one road (under construction) in the park which goes up the Zaskar river gorge for about 5 km. The state has long-term plans to continue **this road**

all the way up the gorge to Padum in Zaskar, a development that will compromise the value of the park's proposed core area, and if completed will require substantial management of human activities along its route. The Department of Wildlife Protection is recommending against construction of this proposed road through the Zaskar gorge, but other interests may prevail in allowing its completion. Roads are also proposed to villages within the park including Rumbak, Shang, and Markha, all being developments that may significantly alter the conservation and tourism values of the northern portion of the park. The completion of such roads will, for example, probably greatly increase demands for trekking tourism in the more remote areas of the Park, including the core area. Furthermore, a decision to complete the road through the Zaskar gorge will require concerted efforts on the part of the Department of Wildlife Protection to maintain the integrity of the unique relict juniper (*Juniperus*) stands, valley-bottom woodlands, and undisturbed wildlife populations in this pristine area.

With regard to efforts aimed at minimizing predator access to livestock, for example, the Department of Wildlife Protection in 1986 began a pilot project to provide materials for the construction of metal barriers to the windows of livestock pens to prevent the entrance of snow leopards (Mallon and Nurbu 1988). Such efforts need to be extended to the entire park and its surrounding areas.

Although official designation of Hemis National Park first took place in 1981 (Anon., no date), during 1984 the villagers of the Rumbak and Markha valleys apparently became aware that the inclusion of their villages within the boundaries of a national park might have dire consequences associated with their ability to continue normal activities or even remain living in the park. A contingent of villagers proceeded to lodge a protest against the park with the Leh District Wildlife Range Officer and the District Forest Officer. They were assured that no actions would be taken against their traditional land use rights, and that there was no intention of removing them from the park area. This incident, however, highlights the very fundamental need to, from early in the management process, involve both the park residents and others with traditional land use rights in the area. This has been demonstrated in other Himalayan mountain parks, such as Sagarmatha or Mt. Everest (Jefferies 1982), and must become the keystone of a successful management policy for the Hemis Park.

The management situation especially in the northern portion of the park has become somewhat complicated by the number of organizations that claim different degrees of administrative jurisdiction in the region. Along with the national park designation, the area (without reference to its national park status) is publicized by the *Jammu* and Kashmir Tourism Department (and private tour groups) as a primary trekking destination, several roads are planned by the Department of Public Works, and it has become a prime area of development activity for the international Save the Children Foundation. Communication among these various organizations, including the Department of Wildlife Protection, and between the Department of Wildlife Protection and those villagers affected by Park management all need improvement to best organize a coordinated approach to development and conservation within the national park.

Lastly, we need to consider briefly the rather unclear legal status of the protected area designations that are being applied and discussed in regard to the Hemis reserve. The use here and in various reports (e.g., Anon. 1986, Mallon and Bacha 1989) of the terms "national park" with an internal "core" area presupposes that land use activities consistent with the legal definitions of these conservation categories are appropriate and desirable. Legally, a national park in India is defined in terms of an area without human habitation and with very limited human use. In practical terms this is seldom the case, but the implication is that sometime in the future the goal of true national park land use status will be achieved. In the case of Hemis, for example, the core area can probably be viewed in terms of legal national park status, whereas the remaining 70% of the area now called the national park is permanently inhabited and supports limited agriculture and substantial livestock grazing. As there is every desire to have these activities continue, the designation of this area as a national park may be legally inappropriate.

Because there is a problem with many currently designated national parks in India, some national consensus will have to be arrived at regarding protected area definition and goals. A conservation designation currently being suggested for wide application in India is that of the Biosphere Reserve, which incorporates the concept of a core area of strict protection surrounded by buffer areas with less restriction on human use, but again there is some confusion regarding the legal basis for such designations in India (Rodgers 1989). Hemis has been suggested for consideration as a Biosphere Reserve (Mallon and Bacha 1989, Rodgers 1989), and is certainly appropriate in terms of its size, biological diversity, and representative trans-Himalayan ecosystem. Regardless of the final legal decisions, however, an appropriate conservation status for the protected area outlined in Figure 1 would be one which allows continuation (and appropriate development) of current land use practices throughout the areas surrounding the "core" region, with strict protection of nature (i.e., severe restrictions on human use) within the uninhabited "core" area. In the mean time, much work needs to be done in the way of determining and documenting current land ownership, grazing rights, and appropriate development alternatives within the currently designated park.

## CONCLUSIONS

With a probable population of 50-75 snow leopards, Hemis National Park represents one of the primary protected areas in the Himalayan region dedicated to the preservation of this species. It is also currently one of the largest protected areas in the Himalayan region. Still, this number of snow leopards does not represent a viable population in the long run, and additional contiguous populations are essential to both genetic interchange and the population's ability to survive local catastrophes. Therefore, the long-term preservation of snow leopard in the Himalayan region, and elsewhere, will require both a system of national parks and reserves (islands of secure habitat) and some protection in areas outside of reserves, especially where these areas form geographical links between reserves. The state of Jammu and Kashmir's "Snow Leopard Recovery Programme", which in addition to the Hemis Park includes two additional protected areas in the main Himalaya (established) and the Karakoram mountains (proposed)

(Anon. 1986 b,c), is an important conceptual start in such a coordinated program for preserving the snow leopard. Additional thought must, however, be given both to the means of protection applied within the reserves and to adequate protection in intervening areas between these fully protected zones. For example, the measures taken to prevent snow leopard access to livestock pens is one action that, if successful in decreasing human – snow leopard conflict, could be extended to all areas of good snow leopard habitat. Conservation education programs in schools and interpretive programs associated with the national parks and reserves are also essential aspects of a coordinated effort to insure our ability to sustain wildlife and their habitats within and outside the protected areas. As the next logical step in such a coordinated system of reserves, state and national agencies responsible for wildlife and endangered species conservation need to consider the international aspects of snow leopard conservation. The range of the snow leopard encompasses many international borders so that the placement and management of protected areas in one country can significantly affect the conservation value and effectiveness of reserves in neighboring countries. It would be most beneficial, then, if international cooperation were to become an integral component of efforts to preserve the snow leopard in its native habitat.

Because many of the international borders within snow leopard range are still in dispute, the opportunity to cooperate on conservation of shared populations of endangered species may also serve to help lessen international tensions. The location and establishment of the proposed Karakoram sanctuary, for example, could be coordinated with nearby protected areas in Pakistan, and may be an appropriate initiative in this regard.

The state of Jammu and Kashmir acknowledges that the establishment of Hemis National Park is the most important step in its "Snow Leopard Recovery Programme" because it is clear that the success of conservation efforts in this park will be a measure of the practicality and

effectiveness of such efforts throughout the region. The area of the park is remote from state administrative facilities and will require special efforts to foster the training of qualified local park officers and establish management, education, and interpretive programs appropriate to the unique aspects of the area and its people. Contributions from the central government's "Project Snow Leopard" can be instrumental to the park's development, and combined with the efforts of the state of Jammu and Kashmir the Hemis Park has the potential to become a model for the conservation of snow leopard in its native range.

## REFERENCES

*ANONYMOUS: Status survey report of notified and proposed National Parks, Sanctuaries, and Reserves in Ladakh region. Dept. of Wildlife Protection, Jammu and Kashmir Government Srinagar. 37 pp., no date*

ANONYMOUS: Ecological cum management plan for Hemis High Altitude National Park - Leh (Ladakh), Jammu and Kashmir State 1985-1990. Dept. of Wildlife Protection, Jammu and Kashmir Government, Srinagar. 27 pp., 1985

ANONYMOUS: Snow leopard recovery programme for Hemis High Altitude National Park, Jammu and Kashmir State 1986-1987 to 1989-1990. Dept. of Wildlife Protection, Jammu and Kashmir Government, Srinagar. 54 pp., 1986 a

ANONYMOUS: Snow leopard recovery programme for Kisthwar High Altitude National Park, Jammu and Kashmir State 1986-1987 to 1989-1990. Dept. of Wildlife Protection, Jammu and Kashmir Government, Srinagar. 52 pp., 1986 b

ANONYMOUS: Snow leopard recovery programme for Karakoram (Nubra-Shayok) Sanctuary, Jammu and Kashmir State 1986-1987 to 1989-1990. Dept. of Wildlife Protection, Jammu and Kashmir Government, Srinagar. 36 pp., 1986 c

BJOENNESS, I.-M.: Ecological conflicts and economy dependency on tourist trekking in Sagarmatha (Mt. Everest) National Park, Nepal. An alternative approach to park planning. *Norsk Geogr.* 34: 120-138, 1980

CHUNDAWAT, R.S., H.S. PANWAR, AND G.S. RAW AT: The ecological studies of snow leopard and its associated prey species in Hemis High Altitude National Park, Ladakh. Tech. Rep. No. RR-1, 1990. Wildlife Inst. of India, Dehra Dun

CHUNDAWAT, R.S.: Habitat selection by a snow leopard in Hemis National Park, India. *Int. Ped. Book of Snow leopards* 6:85-92, 1990

FOX, J.L., S.P. SINHA, R.S. CHUNDAWAT, AND P.K. DAS: Survey of snow leopard and associated species in the Himalaya of northwestern India. 51 pp., 1986. Project Completion Report, Wildlife Inst. of India, Debra Dun.

FOX, J.L. AND R.S. CHUNDAWAT: Observations of snow leopard stalking, killing, and feeding. *Mammalia* 52: 137-140, 1988

FOX, J.L., S.P. SINHA, R.S. CHUNDAWAT AND P.K. DAS: Status of the snow leopard *Panthera uncia* in northwest India. *BioI. Conserv.* 55:283-298, 1991

FOX, J.L., C. NURBU AND R.S. CHUNDAWAT: The mountain ungulates of Ladakh, India. *BioI. Conserv.* (in press.)

GANHAR, J.N.: The wildlife of Ladakh. Haramukh Publ., Srinagar, Kashmir. 91 pp., 1979

HARTMANN, H.: Neue und wenig bekannte Blütenpflanzen aus Ladakh mit einem Nachtrag zur Flora

- HARTMANN, H.: *Pflanzengesellschaften trockener Standorte aus der subalpinen und alpinen Stufe im sudlichen und ostlichen Ladakh. Candollea* 42: 277-326, 1987
- ISRAEL, S. AND T. SINCLAIR: *Indian wildlife. APA Prod., Hong Kong.* 363 pp., 1987
- JEFFERIES, B.E.: *Sagamuha National Park: the impact of tourism in the Himalayas. Ambio* 11: 274-281, 1982
- KACHROO, P., B.L. SAPRU AND U. DHAR: *Flora of Ladakh, an ecological and taxonomical appraisal.* 172 pp. Bisen Singh & Mahendra Pal Singh Publ., New Delhi, 1977
- MALLON, D.: *The snow leopard in Ladakh. Int. Ped. Book of Snow leopards* 4: 23-37, 1984
- MALLON, D. AND C. NURBU: *A conservation program for the snow leopard in Kashmir. Proc. Fifth Int. Snow Leopard Symposium, Srinagar, India, Oct. 1986 (ed. H. Freeman), pp. 207-214, 1988*
- MALLON, D. AND M.S. BACHA: *Ecology and management of the Hemis National Park. Unpubl. report to Dept. of Wildlife Protection, Jammu and Kashmir Government, Srinagar, 1989*
- OSBORNE, B.C., D.P. MALLON AND S.J.R. FRASER: *Ladakh, threatened stronghold of rare Himalayan mammals. Oryx* 17: 182-189, 1983
- POLUNIN, O. AND A. STANTON: *Flowers of the Himalaya. Oxford Univ. Press, New Delhi.* 580 pp., 1985
- RODGERS, W.A.: *Biosphere reserves in the Indian Himalayas. Wildlife Inst. of India, Dehra Dun, 1989. (unpubl. report)*
- RODGERS, W.A. AND H.S. PANWAR: *Planning a wildlife protected area network in India. Vols. I & II. Wildlife Inst. of India, Dehra Dun, 1988*
- SCHALLER, G.B.: *Mountain monarchs. Univ. Chicago Press, Chicago.* 425 pp., 1977
- WARD, A. E.: *The mammals and birds of Kashmir and the adjacent hill provinces. J. Bombay Nat. Hist. Soc.* 29: 879-887, 1924