THE SNOW LEOPARD IN LADAKH

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1. INTRODUCTION

The snow leopard, Panthera uncia, is notoriously difficult to study in the wild. Its natural environment is usually remote and difficult of access; its population density is very low and its territory large; it is mainly nocturnal in its habits and shy and elusive in its nature. This formidable combination of difficulties has so far greatly restricted our knowledge of the snow leopard, knowledge that is vital for its conservation. In most of its range the snow leopard is under threat from hunting, from the hunting of its prey animals and from the expansion of the human population and their livestock, which restricts wildlife to an everdecreasing area.

The present study of the snow leopard was undertaken as part of a wider survey of the ecology and wildlife of Ladakh, northern India, an area which has so far seen little ecological research, largely because it was closed to outsiders until 1974.

The aims of my study were: (1) To establish how widely snow leopards are distributed in Ladakh. (2) To attempt to estimate the size of the snow leopard population in Ladakh. (3) To establish whether any measurable decline has taken place in this population, and to suggest reasons for such a decline, if any. (4) To assess the populations of the major prey species, and their conservation prospects. (5) To establish the extent of the role of the snow leopard as a predator on domestic stock. (6) To collect information on the ecology of the snow leopard in Ladakh. (7) To assess the prospects for survival of the snow leopard in Ladakh. (8) To work out a conservation programme in conjunction with the local Forest Department.

2. STUDY AREA AND METHODS

A brief reconnaissance visit was made to Ladakh in 1976, and work began in 1980 on a survey of the ecology and the mammals of the area; it is hoped to report in full on this at a later date. Survey work was carried out on five expeditions which took place between July 1980 and April 1984, and covered a total of 17 months spent in Ladakh. Four expeditions took place in winter; this season was chosen despite the disadvantage of severe weather conditions, because animals are easier to find at this time, as they occupy lower elevations; the snow cover provides more information in the form of tracks, and almost all attacks on livestock by snow leopard take place at this season.

Information on the snow leopard was collected on every visit; the two most recent visits, in the winters of 1982-83 had as their primary objective the study of the snow leopard. Information was obtained from printed accounts by hunters and other visitors; from the personnel of the state Forest Department; from a large number of local informants from all parts of Ladakh, and from the evidence of of snow leopard sign - tracks, scrapes and droppings.

Data on the prey and possible prey species was collected using the same methods, with the addition of personal observations of the animals themselves.

The Nubra valley, the eastern plateau of Ladakh and the Indus valley below Khalse are considered sensitive border areas and are closed to foreigners; for these areas I had to rely on printed sources and local informants. Fieldwork was carried out in the rest of Ladakh. Foot surveys covering approximately 3100 km were completed, and additional visits using road transport were made to various villages and sidevalleys along the Indus valley. As much time as possible was spent in remote areas, with little or no human disturbance.

3. LADAKH: DESCRIPTION

Ladakh lies in the north-east of the Indian state of Jammu & Kashmir, on the northern side of the main Himalayan range. and thus in its rain-shadow. It covers an area of95,876 km2, of which 37,555 km2 have been under

Chinese administration since 1962. The human population was 105,291 persons in 1971, making it the most sparsely populated area of India (there is in addition a large military presence).

The entire area is mountainous; the lowest point is circa 2700 m, while the highest summits exceed 7000 m. Most of the land is over 3000 m high, and over 4000 m in the east (Pictures 1--4).

The climate is continental; precipitation decreases to the north and east, once across the main ridge of the Himalaya. The average annual precipitation is 306 mm at Kargil and 115 mm at Leh. Winters are long and cold; mean temperatures for January (the coldest month) are -33 °c at Dras; -20 °c at Kargil, and _19 °c at Leh. The aridity has a limiting effect on agriculture, and settlements, which have an oasislike character, are mainly restricted to the major river valleys . the Indus, Zanskar, Nubra and Suru. Each of these valleys and its surroundings forms a small sub-region. They are separated from each other by areas of high mountains, often precipitious and cut by huge gorges. In the east of Ladakh, the high plains of Rupshu form the edge of the Tibetan plateau.

The Transhimalayan, as opposed to purely Himalayan character of the country has had a marked effect on the vegetation. There are no closed forests and trees are limited to a few junipers (Juniperus), and thick scrub in some valleys. The plants in general consist of alpine, steppe and semidesert communities.

4. OTHER WORK ON SNOW LEOPARD IN LADAKH

The snow leopard is known as "shan" in Ladakhi (a dialect of Tibetan), and this name is used in Ladakh as well as in Lahul, Spiti and possibly in parts of western Tibet. In other parts of Tibet it is usually known as "kang -zig" (Ii terall y: ice-leopard).

Earliest evidence of this species in Ladakh is provided by rock carvings which show stylised snow leopards along with depictions of other animals (Picture 5 & front cover). The earliest written mention of the snow leopard in Ladakh was by Moorcroft (1837) who obtained a skin in Leh. Several later works of the fauna of India, e.g. Blanford (1888), Prater (1965), make general references to snow leopard, without providing any specific information on Ladakh. From about 1860

onwards Ladakh was visited by small numbers of sportsmen and naturalists, several of whom left written accounts of their visits containing information on prey animals and sometimes on the snow leopard itself.

Dunmore (1893) reported a sighting of a snow leopard by his shikari; Meinertzhagen (1927) saw two together in the Changchenmo valley of the eastern plateau; Stockley (1928) also reported seeing one. Osmaston (1925) said that snow leopard appeared to be very scarce, but van der Byl (1915), Ward (1923, 1926), and Burrard (1925) all said that snow leopard were more numerous than generally supposed, and were seen very rarely only on account of their natural habits. Burrard in fact said that they were abundant in the Zanskar range (which runs across Ladakh), though this seems to be an overstatement.

Three more recent works by local writers make a brief, general reference to snow leopards in Ladakh (Gergan 1962, Ganhar 1979, Paldan 1982). Some fieldwork was done by Nath (1982) and some preliminary results of the present survey, including a short account of the snow leopard and some of its prey appeared in Osborne, Mallon & Fraser (1983).

5. **RESULTS: SIGN**

1 relied heavily on snow leopard sign (tracks, scrapes, and droppings) for information as I was not fortunate enough to see a snow leopard, though one walked past the cave in which I was sleeping one night, and on other occasions fresh tracks showed that I had missed one by a matter of hours.

Snow leopard sign was found throughout the study area, but the frequency of occurrence varied from place to place. In a 100 km stretch along the Indus, 12 out of 14 side-valleys contained snow leopard sign and 2 did not; in one stretch of 65 km of apparently uniform habitat, **11** sets of tracks were found in 40 km, but none in the next 25 km.

Taken together, the various kinds of sign show the regular trails used by the snow leopard. These trails are found in a variety of situations: they may follow paths already made by man or his domestic animals; paths used by other species of wildlife, such as ibex and bharal; they may follow ridges (as reported by Stockley 1928, Schaller 1977); they may run across scree slopes, cliffs, river terraces and along valley floors. In the more open mountain

Picture 3. Snow leopard habitat from Ladakh (ca. 4000 m). This habitat is also typical for ibex. Photo: David Mallon

areas, trails are found both in valleys and along ridges, but the greatest concentrations of sign occur in the beds of the deep gorges which cut across part of the central mountains. I spent a lot of time in such places as they are uninhabited and free from human disturbance. In these areas, the mountains consist of steep cliffs and rocky peaks whose ridges even snow leopard would have difficulty in following, and the gorges no doubt represent the easiest route between the various side-valleys and their prey populations. These valley trails (including those in easier terrain) are used at all seasons, though tracks are more apparent in midwinter, on the ice of the frozen rivers. Along the banks, if there is no covering of snow, such trails do not show continuous snow leopard tracks, however, individual tracks in patches of dust or sand, scrapes and droppings can be pieced together to show the line followed (Pictures 6-8). One such trail which I followed for 7 --8 km emerged from a side-valley, followed a river terrace for a short distance, descended steeply to the river's edge and continued along a sandbank, over rocks, across a cliff, back to more sand, up onto another river terrace and up a steep cliff where I was unable to follow.

Tracks were found in the winter snow (when they are most visible), in sand along river banks or in caves, in dust and earth along trails, and in mud. There is no possibility of confusion with the tracks of the common leopard Panthera pardus which does not occur in Ladakh. The track of the lynx Felis lynx is similar in appearance to that of the snow leopard, but is markedly smaller. The lynx is even rarer in Ladakh than the snow leopard, and all the small cat tracks which I found were in conjunction with adult snow leopard-sized tracks, and were made at the same time; this was assumed to represen t an adult snow leopard with one or more young animals. No other small tracks were found.

As an aid to estimating the numbers of snow leopard in one area, I investigated the possibility of identifying individual snow leopards by distinctive paw prints, as has been done with Panthera tigris on Project Tiger, but this technique turned out to be ineffective owing to variations in track size and shape due to the differing snow conditions within a short distance, and distortion caused by melting in the strong sun.

A series of continuous tracks was followed for a total of about 75 km; many more short sections and individual prints were found. The longest sections of track followed were 10 km, 11 km, and 14 kill. These long sections all followed valley bottoms, mostly of the frozen. surface of the river, and occasionally on the bank. All made detours from the centre to make scrapes at, or investigate overhangs and the bases of cliffs, other snow leopard tracks or objects of interest such as an ibex skull.

Once a female with one young animal had met a large male coming from the opposite direction; there was an area of jumbled tracks were some kind of interaction had taken place and then they continued on their separate ways. One snow leopard, crossing the tracks of a second which had passed in the opposite direc. tion a day or so previously, squatted on these tracks, leaving a clear impression, and also urinated on them (Picture 7). Another set of tracks showed that one snow leopard had ascended a valley on the frozen stream, then left the ice to continue along a thin track on the bank for 1 km, then turned sharply back

to the river and crossed to the opposite bank at a point where a second set of snow leopard tracks had descended and passed under a low, overhanging cliff. **In** another valley, a snow leopard had gone up and then down again, leaving one set of tracks superimposed on the other. A female and one young ascended a valley to a pass of about **4100** m, walked around the pass, descended a ridge, passed a small village, followed a path across a long scree slope to an area of cliffs on the edge of a second village, and apparently hid there, before killing and eating a sheep.

Scrapes may be made in sand, gravel, stones or snow; they remain for some time and are a good indication of the presence of snow leopard in the area. Careful noting of the position of these, and the subsequent appearance of new scrapes provide some indication of the relative frequency of visits by snow leopard along a trail or valley. The scrapes usually measure 18-25 em in length (most are around 20 em), but may be longer: one 31 em long, and one of 50 em were found.

Scrapes occurred in locations throughout the study area. They may be made in the middle of a path (usually at a prominent place, such as a knoll, steep slope, etc.), but occur more often at the foot of a cliff or under an overhanging rock (Picture 8). This is perhaps because in such places the scrapes are more sheltered from snowfall and so remain visible for a longer period of time. It is notable how the snow leopard tracks regularly diverge from an obvious route to investigate such overhangs and cliffs.

In the winter 1983-84, 163 scrapes were found; 133 of these (81,6 %) were located at the base of the cliff or an overhang, and 30 (18,4 %) were in the open. Scrapes may occur singly or several together; sometimes there are two adjacent scrapes. I found, inter alia, 7 scrapes in 5 m, 6 in 8 m, 4 in 1 m and 12 in 20 m. It was apparent that many of these had been made at different times, but it is not clear whether in each case it represented repeated visits by the same snow leopard, or by more than one, perhaps at a point where two or more territories overlap. One animal whose tracks I followed for 10 km had scraped three times in that distance. Urine and droppings may be deposited in or near the scrapes; droppings were present at 33 out of 163 scrapes. Sometimes, droppings of several different ages are deposited together. The droppings consist mainly of hair, bone fragments and vegetable matter. **In** one dropping I found the hoof of a young bharal Pseudo is nayaur.

6. DISTRIBUTION AND NUMBERS

From all sources (printed accounts, local informants and sign) it is clear that snow leopard occur throughout Ladakh, but their population density varies from place to place. As noted above, tracks and scrapes were numerous in some parts of the study area, while in others they were sparse or absent altogether. Records of attacks on village livestock show that most villages suffer an attack once every 2-3 years; some have extremely few attacks, while others expect to be raided every winter.

Calculating the size of the snow leopard population in a given area is both the most difficult aspect of field studies on this species, and also the most important for its conservation, since accurate data on territory size would allow the creation of reserves of a size that was known to be viable. As well as estimating the territory size, we also need to know the numbers of transient or free-ranging individuals moving throughout or around the area. The size of the snow leopard's territory is to some extent dependent on the numbers of prey animals available, and variations in the prey populations may account for the apparent variations in the density of the snow leopard population.

During the winter 1983-84, at least 3 adult snow leopards plus 2 cubs were present in an area of about 350 km2 of a newly designated national park, though it is not clear how far outside this area they ranged in addition. Four of these animals, including the two cubs, were killed in the course of the winter. In other areas: 2-3 adults and 2 cubs were present in 650 km2; evidence of 6 was found in 900 km2 of the central mountains, and 2-3 in 200 km2 . I have concluded that a rough figure of one snow leopard to 150 km2 is a realistic estimate in favourable areas of Ladakh. Extrapolated to the whole of Ladakh (58,321 km2 under Indian control) this would give a total of nearly 400 snow leopards, which is too high; (compare to the estimates of fewer than 250 in Pakistan, Schaller 1977), 150-300 in Nepal (Jackson 1979) and 300-1000 in the USSR (Braden 1982). Taking into account the less favourable areas of Ladakh, I would estimate that the snow leopard population there is not less than 100 and may be as high as 200, though this last figure seems rather high. It is hoped to continue work on the territory and population of the snow leopard in winter 1984-85.

There are no previous population studies available for comparison, so it is difficult to quantify any decline that may have taken place. I can certainly state that, with the exception of the Sum valley area, the evidence I have collected shows no sign of any decrease in the Ladakh snow leopard population over the last four years. Furthermore, the concensus of opinion among the Forest Department personnel and my other local informants was that there had been no significant change in the snow leopard population for many years. Everyone described the snow leopard as uncommon, and said that this had always been its status. Nowhere was I told that snow leopard used to occur in an area but no longer did so, though Nath reported one such statement from Zanskar (1982), and Ganhar said that the snow leopard had declined in Ladakh along with its prey animals (1979). The exception to all this is the Sum valley-Kargil area, where hunting pressure is greater than in other parts of Ladakh, and it seems that here both prey and snow leopard have suffered a decline. For the rest of Ladakh it appears that the snow leopard population has not undergone a marked reduction, though in such an arid, unproductive area it has never been very common either.

7. HABITAT AND BEHAVIOUR

The snow leopard in Ladakh is a year-round, high-altitude animal; in only very few places can it descend below 3000 m and in practice there are only a few records below 3200 m; at the upper limit, there are records up to 5400 m and no doubt it ranges higher when necessary, limi ted only by the presence or absence of prey animals In winter it spends more time at lower altitudes and most attacks on domestic animals take place then.

Its habitat consists of alpine and sub-alpine steppe and semidesert. The snow leopard is mainly active at night, but local people report several sightings during the day. Everyone I spoke to agreed that the snow leopard was shy and hard to see. However, it is remarkable that many reports of domestic animal kills refer to the snow leopard being almost indifferent to human presence and reluctant to leave a kill until driven away by several people shouting and throwing stones. Often the snow leopard then just walks slowly away.

Picture 5. Rock-carvings from Ladakh, showing two large and some smaller snow leopards.
Photo: David Mallon

According to local informants, the mating season for snow leopard in Ladakh is late March-April; shepherds say that they sometimes hear snow leopard calling at night at this time. The young are born in June or July. On rare occasions the cave in which the cubs are being reared has been located by villagers; unfortunately this did not happen during any of my visits to Ladakh. By late summer the cubs are hunting with their mother. In early September 1980, a female with two cubs raided a government sheep breeding station in the Indus valley; the adult animal was driven off, one cub was killed and the other captured and kept in the Forest Department compound for eight months, when it died. Such attacks by a female and cubs have been reported through the winter months, up to mid-March. Schaller (1977) gave similar dates for the breeding season of the snow leopard and Bailey (1911) reported finding cubs one week old in the first week in June, near Gyantse in southern Tibet
(29°N, 90OE). These dates for the breeding season of the snow leopard are probably similar in the whole Tibetan and Himalayan region.

8. **PREY**

Snow leopard are known to prey on a variety of wild and domestic animals. Wild species which occur in Ladakh and on which snow leopard are known to prey include: urial Ovis orientalis, bharal Pseudois nayaur, Siberian ibex Capra i. sibirica, marmots Marmota bobak and M. caudata, hares Lepus oiostolus and L. capensis, pikas Ochotona spp., snowcock Tetraogallus spp., and partridge Alectoris chukar (Dang 1967, Dash et al. 1977, Nath
1982, Schaller 1977).

In the eastern plateau there are several more ungulate species which could form prey: wild ass Equus hemionus kiang and argali Ovis ammon (on both of which snow leopard are known to prey in Mongolia); Tibetan antelope Pantholops hodgsoni, Tibetan gazelle Procapra picticaudata, and wild yak Bos mutus. The latter three are very rare within their limited distribution in Ladakh.

Other species in Ladakh which could conceivably form prey animals are the smaller carnivores (dhole Cuon alpinus, red fox Vulpes vulpes, Pallas cat Felis manul, lynx Felis lynx, stone marten Martes foina, small mustelids Mustela spp., the young of the brown bear Ursus arctos) as well as several small rodents and lizards. With the exception of the young bear (recorded as prey in the Tien Shan by

Shaposhnikov 1956), I am not aware of any records of snow leopard predation on other camivores; in any case the rarity of these animals in Ladakh, and the small size of the rodents means that they are unlikely to be a major constituent of the snow leopard's diet.

Many of the snow leopard droppings I found contained vegetable matter, including fragments of Salix and Myricaria twigs. At one cliff base with 12 scrapes and several droppings, 1 found the remains of a raven Corvus corax and on another occasion, on a snow leopard track were the remains of an Alpine chough Pyrrhocorax graculus. There were no signs of another predator in either case, but it was not possible to prove with certainty that a snow leopard had been responsible.

The domestic prey include horses, donkeys, sheep, goats, cows, bulls, dzo (a cattle-yak hybrid), yaks and dogs. Attacks on livestock are considered in more detail below.

Of the wild prey animals listed above, urial Ovis orientalis have a limited distribution in low hills along the Indus valley and in recent years have suffered from hunting pressure (Mallon 1983). Hares are not found in all parts of Ladakh and marmots are in hibernation for
6 . 7 months of the year. The main prey species of the snow leopard in Ladakh are bharal and
ibex; together their distribution covers the whole of Ladakh. Generally speaking, bharal are found in the east of Ladakh and ibex in the west, but there is some overlap in places. Both species are quite common in Ladakh and their numbers run into thousands.

9. A **TT ACKS ON LIVESTOCK**

All kinds of domestic animals are liable to be attacked by snow leopards but sheep and goats are the most frequent victims. Adult yaks should be too large to be killed by a snow leopard, but a female was killed last winter. A male yak was injured in an attack at Alchi in the Indus valley in summer 1983; deep claw marks on its back and neck showed that it had been attacked and had successfully defended itself. Yaks are normally left out to graze for days at a time on the high pastures.

Through these attacks the snow leopard is known to everyone in Ladakh and is regarded as an enemy by livestock owners. It is, however, seen as less of an enemy than the wolf *which* is more numerous and a more regular, year-round predator on domestic animals. Several villages have a circular, stone pit wolf trap, known as a shangdong, in which snow leopard may occasionally be caught.

Attacks by snow leopard may take place during the day on animals out grazing (at summer pastures or near villages) or in the rooms adjoining houses, in which the animals are kept at night. Most villages lie between 3000--3700 m and summer pastures 4000-4500 m. Attacks in the open usually involve single prey, but if the snow leopard gains entrance to the inner sheep and goat rooms, (usually through a ventilation hole), many animals may be killed, presumably as a result of the ensuing panic. I can confirm the report by Nath (1982) concerning the belief of the villagers; every Ladakhi I spoke to is convinced that in these cases, snow leopard simply suck the blood of their victims; they then become "blood-drunk", have difficulty in moving and can be killed easily. Rarely, the snow leopard caught in one of these rooms may be shot, if a gun is available, but usually it is killed with sticks and stones. However, not all snow leopards caught in such situations are killed; often they are chased away with shouts and stones.' **In** view of the snow leo
pard's customary elusiveness, it is remarkable how many people spoke of occasions when one had been very reluctant to leave a kill, and were only driven off with difficulty, or of snow leopard, faced with a group of villagers, that just walked slowly away.

Although the snow leopard often escapes following an attack on livestock, some are killed every winter, and this represents an important cause of mortality in the snow leopard population. It is illegal to kill snow leopards but those which attack livestock have always been killed, and always will be, regardless of the penalties involved.

A sheep or goat can be worth up to US $ 30, however, there is a very small market for domestic animals which means that the value of animals killed is largely notional. The death
of one or two sheep or goats is not likely to be considered a heavy loss, but if all, or most of a family's animals are killed in a single night, it can cause very real hardship. The loss of a horse or a dzo which are much more valuable would also cause hardship to a family. I heard of a few cases where 10-15 sheep or goats had been killed, and one case involving 34. Burton

(1926) reported a case in Spiti where 21 were killed under similar circumstances.

The role of the snow leopard as a predator on domestic animals varies from place to place. Most villages report occasional attacks by snow leopard, perhaps once every 2-3 years; others suffer extremely few or no attacks while others except to be raided every winter. People seem to accept such losses as inevitable, and take few precautions. They often take their sheep and
goats out grazing without a dog to warn of wolves or snow leopards in the vicinity, and the ventilation holes in the night pens are often unnecessarily large, which enables the snow leopards to gain access to the animals inside.

During the winter 1983-84, there were 20 attacks by snow leopard on 15 out of 40 villages in the central Indus valley area, rather more than usual. One village had four attacks, two other villages 8 km apart were each attacked twice. These multiple attacks all concerned attacks by a female with two young.
The total of 20 attacks resulted in the death of one female yak and at least 95 sheep and goats (including 34 in one room). At least five snow leopards were killed as a result of these attacks,
including one female and her two cubs. The final total could be higher, as people were sometimes reluctant to admit killing snow leopards which they know is illegal, even though the Forest Department would be very unlikely to prosecute someone who was protecting his own animals.

The importance of domestic animals as an item of prey for the snow leopard varies depending on the area. In much of Ladakh, settlements are absent and so livestock is not available as a prey. In a few places it may be an important part of the diet for 3-4 winter months but overall it cannot be considered as more than a subsidiary part of the snow leopard's diet.

10. **MORTALITY**

The snow leopard in Ladakh has no natural enemies except the harsh climate. Blomqvist (1978) said that pre- and postnatal mortality among cubs must be very high; this may well be especially true in conditions such as those in Ladakh. Snow leopard are killed by villagers following attacks on livestock and this is an important cause of mortality. Some, probably very few, are shot by hunters and very occasionally one may be caught in a wolf trap. Snow leopard may be killed in avalanches in

the spring; one informant found a female and two cubs dead in an avalanche in a Zanskar valley in March 1983. They may also be killed in falls while hunting; Nath (1982) reported one example, and I was told of a similar incident. In this, a snow leopard jumped at an ibex and missed, falling over one hundred metres to its death; However the details of this story were vague and I was unable to check its veracity.

11. HUNTING AND CONSERVATION

Several aspects of the social conditions in Ladakh have had important consequences for its wildlife. As well as the low density of the human population, the annual rate of increase has always been very low, due to polyandry, a high proportion of monastic celibacy and high infant mortality. Inevitably, changes have taken place following increased contact with the outside world. The birthrate has increased over the last 20 years but this has not led to a big change in the rural population as many people have been attracted by jobs in the towns; also, the terrain and the shortage of surface water restrict the expansion of farmland.

The predominant religion is Tibetan Buddhism which forbids the taking of life, with the result that hunters have always been few, and do not enjoy high status. These remarks do not apply to the Moslem minorities in Leh and Zanskar or to the people of the wholly Moslem Sum valley, who are unaffected by Buddhist taboos on killing. Although some hunting goes on all over Ladakh, it is on a small scale, and in most of the country there has been no systematic attack on the wildlife as a whole. Leaving aside Sum, guns are the exception in villages; shooting is mainly done for meat, and there is no real economic necessity to hunt. There are no villages in central Ladakh or Zanskar where most of the men spend the winter hunting, as was reported for west Nepal by Jackson (1979). Access to many mountain areas is difficult and the greatest hunting pressure has so far occurred along the Indus valley, and the main victim has been the Ladakh urial (Mallon 1983). The killing of all animals in Ladakh is illegal and the Forest Department is responsible for enforcing this. However, it is not an easy task for a small number of personnel to police effectively the whole of Ladakh, which consists of small villages scattered over a wide area. The vigilance of the Forest Ranger in Leh has acted as a deterrent to would-be poachers in the Indus valley and nearby areas, but in Zanskar and Sum protection has been less effective.

It is virtually impossible to set out to hunt the snow leopard specifically and I know of no-one in Ladakh who does so; snow leopard are shot when met by chance while hunting ibex or bharal. A very few may be caught in wolf traps but there is no systematic killing by the use of poisoned spears as in west Nepal (Jackson 1979), or trapping by other methods.

There is still an illegal trade in snow leopard skins in Srinagar and it is usually possible to obtain a small number of skins in the fur shops there. While preparing this paper I received information that three full-length snow leopard coats were on sale in a single shop (D. Weiss in litt.). I was also told by a tour guide that one of his clients, a Canadian tourist, had purchased snow leopard skins for $ 700 each in the summer of 1983. He intended to take them back to Canada sewn inside marmot skins. There is no doubt that many of these skins originate from Ladakh, either from animals killed by livestock owners or those shot by hunters. Not all skins obtained in Ladakh are sold; sometimes they are stuffed and kept as a kind of trophy. One hunter in Zanskar told me that a good skin was worth up to $ 200, but the usual price paid to local people for skins appears to be $ 50-80. I do not think that the total number of snow leopards shot by hunters in Ladakh is very great. 6 were killed in Suru over 5 winters up to 1980-81 (Osborne et a1. 1983), but I did not come across a single case in central Ladakh, and only one or two in Zanskar, in the four years in which my visit took place. Except in Sum, direct hunting has not had a serious effect on the snow leopard population in Ladakh.

Hunting of the large ungulates is done for meat, but again on a small scale and some areas are so remote that hunters never bother to go there. Outside Sum-Kargil, I found no evidence that bharal or ibex have been affected by shooting to a significant degree. In the border areas, which are closed to foreigners, and which contain many soldiers and police personnel - all armed - the situation could be worse, but I was unable to check it.

A system of national parks and sanctuaries proposed by the Jammu & Kashmir Forest Department includes several areas in Ladakh, one of which is the Hemis High Altitude National Park which will cover over 300 km2
to the south of the Indus valley. During a month-long survey by personnel of the Forest Department in Ladakh, over 1000 bharal were counted here and in an adjoining valley also designated as a reserve. Equally important, if not more so, are certain areas of almost uninhabited country, which although not
designated reserves, have the practical effect of sanctuaries. The largest of these areas covers some 3500 km2 and contain a human population of 570 persons (1971 figures) who live
in a few settlements situated on the margins, so human disturbance is minimal. It is an area of precipitious mountains and cliffs and access to it is extremely difficult; one route crosses it and is used annually by a few people in the autumn and winter. The whole area can be entered only in the autumn, when the water level in the gorges is low enough to allow passage, and in mid-winter, when the rivers are partially frozen over and may provide a
pathway on the ice. It is not easy to carry out fieldwork there owing to the practical difficulties of moving about, but I managed to make five visits to the area. Bharal probably number 2-3000 at least, and perhaps 5000, and ibex are also present. I would estimate that there are 15-25 snow leopards in this area. There are other, smaller areas of similar, undisturbed country in Ladakh, which all offer protection to the snow leopard and prey animals.

12. THE SNOW LEOPARD IN NEIGHBOURING AREAS

a) Northern Pakistan

Scully (1881) describes the snow leopard as "fairly common" in Gilgit and Hunza, and Fulton (1903) used the same description for the snow leopard in the upper Chitral valley, but there has been a steady decline since then. Schaller (1977) listed a wide distribution in northern Pakistan, but both he and Roberts (1977) reported a reduction in snow leopard numbers as a result of hunting.

b) Jammu and Kashmir

An increasing human population, deforestation

and hunting have had an effect on wildlife in Jammu and Kashmir, with reductions in many species. Ward (1923) reported seeing eight snow leopards in Kashmir, of which he shot four and captured two, both cubs, so presumably at that time they occurred in reasonable numbers. Green (1982) said that few, if any, survived in the hills around the Vale of Kashmir. The Chief Wildlife Warden of Jammu and Kashmir, Mir Inayat Ullah, reports (in litt.) that during the winter 1983-84 he received reports of snow leopard from Lidderwat, Tarsar, and Marsar (upper reaches of the Dachigam National Park), as well as from Ladakh. Dachigam is well-wardened and could provide secure conditions for the conservation of the snow leopard.

In the south-east of Jammu and Kashmir lies the district of Kishtwar, which occupies the southern slopes of the Himalayas, adjoining Zanskar. Stockley (1936) noted the presence of snow leopard here, occasionally on the same ground as P. pardus. Several of my informants in Zanskar who have travelled over the passes to Kishtwar report that snow leopard still occur there, on the southern slopes of the main Himalayan range. Indeed, local reports suggest that snow leopard occur, at least occasionally, along these slopes on the right bank of the river Chenab from Kishtwar to Lahul, a distance of some 140 km.

c) Lahul and Spiti

These two adjacent areas, both Transhimalayan in character, are situated in the south and south-east of Ladakh. Lahul lies between Zanskar and Kulu-Manali. Tyacke (1893) said that snow leopard could be me with in almost every valley in Lahul, and Whistler (1924) said they were numerous there. I made a brief journey through the area in 1980, but it was too short to do any significant fieldwork. On the basis of reports from local informants it is clear that snow leopard still occur quite widely in Lahul, but are not common. Good stocks of prey (bharal and ibex) apparently survive.

Spiti, which borders Tibet, has been closed to foreigners since 1947. The only reference to snow leopard in the area that I have found, was by Burton (1926). Indian officials and military personnel who had visited Spiti told me that large numbers of bharal are still found there and that snow leopard occur too. If the reports of good prey stocks are correct, there is the possibility that reasonable numbers of snow leopard are found there. In view of this, and the isolation, lack of disturbance, and low human population, it would make an ideal site for a reserve.

d) Manali

Gaston, Garson & Hunter (1983) said that the snow leopard was last seen in the Manali area in 1965 and had since disappeared there. They also reported reductions in the number of several prey animals and repopulation of the area by the snow leopard in the near future is unlikely.

e) Tibet

All the general works on the snow leopard include Tibet in its distribution, but I have found no specific information relating to western Tibet (which borders Ladakh), except for Baldwin (1877) who reported the killing of a female and the capture of two cubs, north of the Niti Pass.

f) Xinjiang (Sinkiang)

I found very little information on the snow leopard in that part of China which adjoins Ladakh to the north. Przewalski (1879) said it was very rare in the Altyn Tagh mountains; Nazaroff (1935) mentioned a captive animal in Kashgar (which, he said, had been easily tamed), and Roosevelt & Roosevelt (1926) saw snow leopard tracks in the Kun Lun mountains, while travelling from Leh to Yarkand.

13. CONCLUSIONS

There are certain disadvantages facing the snow leopard in Ladakh. The combination of climate and relief has produced a highaltitude, semi desert environment, with a narrow range of habitats; the barrenness and low productivity limit both the variety of species and the numbers of potential prey animals, particularly when seen in the context of lower, wetter and ecologically more diverse areas to the west and south; many (though not all) attacks on livestock result in the death of snow leopards; there are some hunters who will shoot them and there is a market for skins in nearby Srinagar.

On the positive side, several factors favour

the snow leopard: a small human population is expanding slowly; hunters are comparatively few; many of the local people, thanks to their religion, are predisposed towards protecting wildlife; sanctuaries have been designated and there are several areas of remote mountain habitat which are undisturbed and completely unsusceptible to expansion by farmers; good stocks of prey animals exist and there is a viable snow leopard population at present.

it seems likely that snow leopard have never been numerous in Ladakh, but in most of the area, their numbers have remained stable and it cannot be considered as endangered there. Although this a favourable conclusion overall, there are some measures which could be taken to increase the protection of the snow leopard, and these are set out below.

14. RECOMMENDATIONS

To be most effective, sanctuaries need to cover a very large area in order to protect viable prey and snow leopard populations. At present, within the Himalaya-Karakoram mountain complex only Bhutan and Ladakh (and possibly Spiti and northern Sikkim) can offer these conditions. Although it is a good thing that some secure areas will allow the survival of small numbers of snow leopard, in the long term, an overall plan is needed, which will protect whole areas where snow leopard occur. Therefore programmes will have to be devised which allow the co-existence of people, their flocks, snow leopard and their prey.

In Ladakh, some obvious measures could be taken: a programme of education, building on the religious sentiments of the people; regular surveys to monitor the levels of the snow leopard and prey population and any changes; hunting could be curbed further by stricter controls in Sum and Zanskar, and the open sale of snow leopard skins in Srinagar could be prevented.

However, more snow leopards are killed attacking livestock than by hunting, and it is important to prevent this too. As noted above, carelessness on the part of the local inhabitants often allows marauding snow leopards to gain easy entry to sheep and goat pens, which result firstly in the death of many domestic animals, and, all too often, in the death of the snow leopard also. It would be comparatively simple and inexpensive to improve the defences of the villages. Each house's sheep and goats are kept at night in a small room containing a small

air-hole; the problems are usually caused when this hole is too large. Reducing these to a smaller size, such as by inserting one or two crossbars would keep out the snow leopards and take little trouble, though it would be necessary to persuade people of the need to do this. Deprived of the chance to force an entry, fewer snow leopards would be caught and killed; in the long term, as attacks on their animals become rarer, local people may come to regard the snow leopard as less of an enemy.

An alternative scheme has been proposed that would compensate farmers for the cost of animals killed by snow leopard. However, this would have certain disadvantages: it would be hard to verify claims made in remote villages, and, more importantly, it would do nothing to prevent the killing of the snow leopards. A compensation scheme may possibly be useful in certain circumstances, but only when all measures have been taken to protect the flocks of sheep and goats.

As far as reintroduction of captive-bred snow leopards to the wild is concerned, it would be pointless to commence such a scheme in any area where full protection from man could not be assured. A further consideration to be taken into account is the nature of the snow leopard itself. Knowles (1982) referred to the sensitive and individualistic nature of the snow leopard, and how even amove from one enclosure to another can take months of adjustment. Amove from captivity back to the wild would obviously be far more demanding.

15. SUMMARY

The snow leopard is distributed throughout Ladakh. **In** most of Ladakh there is a small, but stable population which has good prospects for survival. The main prey species of the snow leopard in Ladakh are the bharal Pseudois nayaur and ibex Capra ibex sibirica; good stocks of both these species exist. Hunting is not a major threat outside the Sum valley. More snow leopards are killed by owners of livestock they have attacked, than by hunters. Snow leopard predation on domestic stock varies from place to place. The population of snow leopards in Ladakh probably numbers 100-200.

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