Leopard Problems in India

Forest Department officials in the Pune (Poona) region of India, east of Bombay, reported the capture in October 2003 of their 101st leopard in a campaign to reduce attacks on people and livestock in Rajgurnagar.

Most attacks on people were found to take place in the sugarcane harvest season between October and March. During 2002-03, about 20 people were attacked, and 11 died. The tall and thick sugarcane provides secretive leopards with ideal shelter, so that there are confrontations when people enter the fields during the harvest.

In 2001-02, there were 382 attacks on cattle, and about 189 in 2002-03.

Most of the captured animals have been released in distant forests, but the Forest Department has nine in captivity.

A Forest Department official said that security had been increased and sugarcane crops would be combed for leopards during the harvest. Eightyone cage traps have been set up and the department has also established a control room to maintain a vigil.

Although most Asiatic leopards have become rare and threatened, the big cat remains common in the Indian subcontinent and attacks on people and livestock are quite frequent.

(Source: Times of India, 18 Sept 03)

Persian Leopard in Khosrov Reserve, Armenia: Ecology and Conservation

by Igor Khorozyan[1] (contact), Alexander Malkhasyan[2] and Massimo Pizzeti[3]

Armenia is located at the junction of the Middle East and Europe within the Caucasus biodiversity hotspot and a "Vulnerable" ecoregion recognized by WWF and Conservation International. The leopard (*Panthera pardus*) has been the rarest and most charismatic species of Armenia's fauna and is listed as "Endangered" in the National Red Data Book. Its national stronghold is the Khosrov Reserve, which enjoys the richest national biodiversity (Fig. 1).

Although its conservation is implied by national legislation (Law on Specially Protected Areas, 1991 and Law on Animal World, 2000), the leopard is not studied in Armenia and no special ecological research of this extremely elusive and rare species has ever been undertaken. Meanwhile, this predator needs to become a target of a single-species approach of biodiversity conservation in Khosrov Reserve, which by definition would capture endangered charismatic and flagship species to justify the existence of this protected area for public benefit and to provide economic leverage to negotiations between the government, policymakers, conservationists, scientists, donors and general public.

Below, we describe the first scientific attempt to assess feeding habits and predator-prey relationships of the local leopard population and its feeding competition with brown bears (*Ursus arctos*) and Eurasian lynx (*Lynx lynx*) in Khosrov. A further aspect studied is habitat use by leopards and their distribution as assessed by GIS mapping and analysis of scat distribution. We consider implications of all these issues for conservation of the leopard in this protected area.

Feeding habits

The total number of leopard scats analysed was 201. The bezoar goat (*Capra aegagrus*) made up the bulk of the leopard diet, as estimated by its frequency of occurrence in scats (F_i, 91.5%) and contribution to total live biomass consumed (B_i, 92.5%). Female goats occur most frequently in scats (F_i = 45.3%), followed by males (27.2%) and juveniles (19.0%). In respect of their significant live body mass, the goats of different sex/age categories make only 7.4% (males) to 14.2% (females) of all prey killed (total 31.2%), but contribute 16.4% (juveniles) to 45.1% (females) of total live biomass consumed (total 92.5%). The role of alternative prey species, namely wild boar (*Sus scrofa*), European hare (*Lepus europaeus*), rodents and buckthorn (*Frangula* spp.) berries, is negligible and can be ignored (F_i = 1-5.8% and B_i = 0.7-4.3%).

There is a geographical difference in preying on goats. In Garni district (N Khosrov), the males, females and juveniles are taken in proportions F_i = 40.7%, 51.8% and 3.7%, respectively. In Khosrov district (central Khosrov), the males, females and juveniles are taken in similar ratios (F_i = 28.7-35.2%). In Khachadzor district (E Khosrov), females are strongly preferred (F_i = 80.0%) and European hares become an important food item (F_i = 32.0%).

In relation to the sex/age structure of the living population, only female goats have been positively selected by local leopards (Ivlev's selectivity index D varies from 0.09 in Khosrov district to 0.79 in Khachadzor, mean 0.29). The males are selectively taken only in Garni district (D = 0.10), non-selected in Khosrov (D = -0.09) and not taken at all in Khachadzor (D = 0). Their mean D = -0.12. The juveniles are taken less than they are available (not selected) in all study ar-

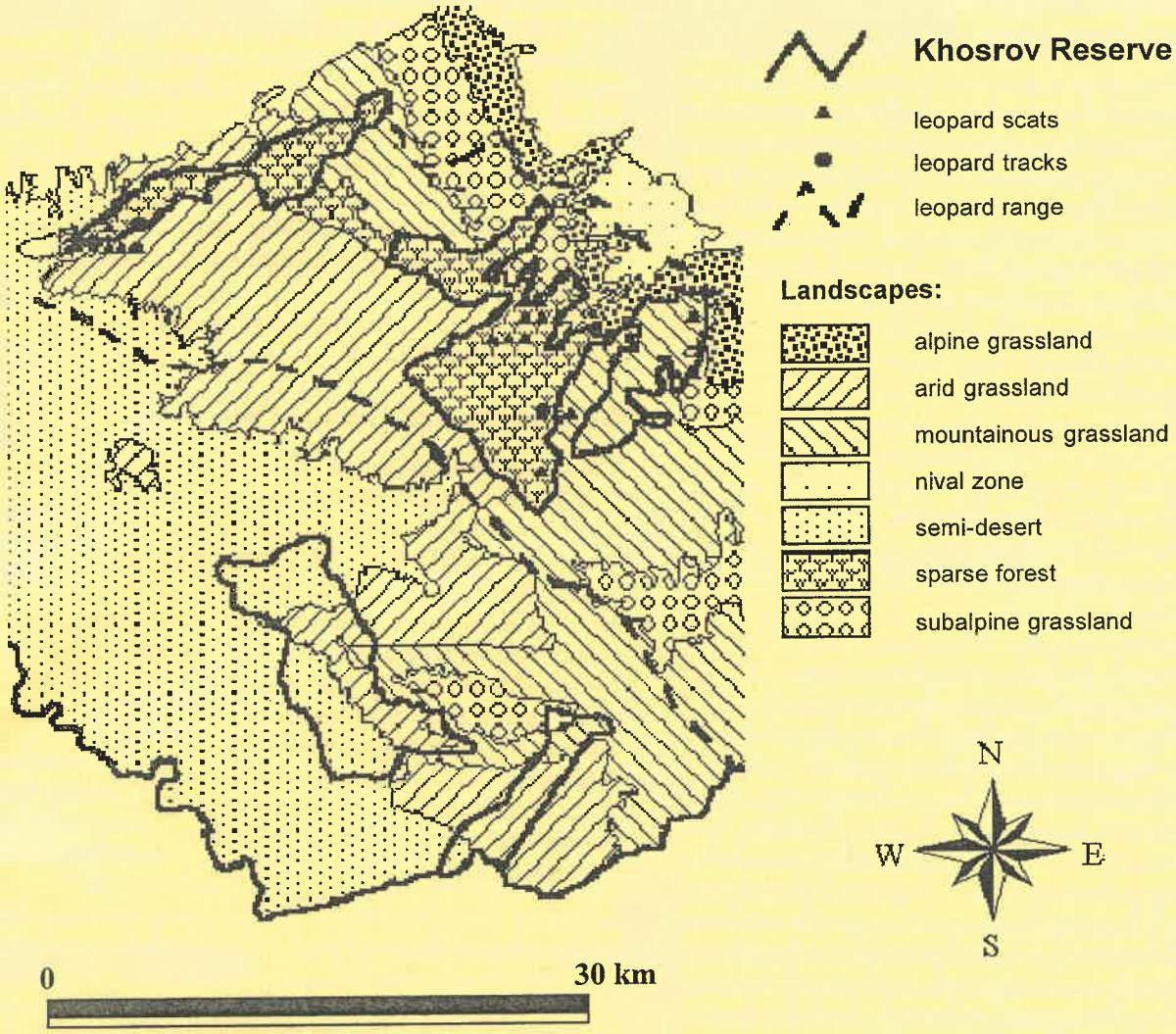

Fig. 1. Location of Khosrov Reserve in Armenia (A); distribution of landscapes, leopard signs and range in Khosrov Reserve (B).

eas (D = -0.12-0.87, total mean = -0.45). This sex- and area-related difference in D was statistically significant ($P<0.05$).

So, we have found out that the leopards in Khosrov Reserve have a very narrow prey base, feeding overwhelmingly on the goats. Here, this predator-prey pair is strongly associated with cliffs and rocky highland habitats and local people have justly named the leopard "the goat shepherd".

The reason for this monophagy lies in the fact that the goat ideally meets all requirements of the leopard as its staple prey: prey availability, abundance, size, vulnerability and behavioural response. No other species can substitute this prey for the leopards in Khosrov.

Selectivity for certain sex/age categories of prey can give an insight into the leopard population structure in a certain area. For example, in Garni district the male goats are preferred. This can be caused by use of this area (vicinities of Eranos Mt., 1,824.3 m) by one male leopard as a marginal part of its home range. No female, subadult leopards or cubs have been recorded here for a long time, possibly due to the lack of permanent water sources and safe breeding sites, and a high level of human disturbance (proximity to urban landscapes).

On the other hand there is the Khachadzor district with the most pristine habitats. The main part of the local leopard population must have been concentrated here and used this area as a secluded breeding site. Here, only female and juvenile goats and European hares are taken, possibly indicating the preference of slender female goats and small wildlife by subadult and female leopards, especially when hunting with cubs.

We do not have grounds to speculate that small wildlife are actually much more frequently taken by leopards than detected from their scats. Generally, it is believed that rodents and other small animals are eaten by predators completely without leaving a trace in fecal material, leading to underestimation of their role in a predator's diet. This rule does not work in Khosrov, as the undigested remains of rodents and European hares (hairs and pieces of skull, limbs, claws, ribs and backbone) were frequently found by us in well-preserved condition in the scats of lynx. So, we suppose that local leopards act as typical energy maximisers and do not hunt especially on small wildlife, preferring high-calorie and available goats, but may take them opportunistically.

Predator-prey Relationship

According to different guestimates, all suffering from some kind of subjectivity as they are based on "word-of-mouth reports", no more than 10 leopards (adults, subadults and cubs) may live in Khosrov Reserve and beyond it within the study area of ca. 780 km^2. According to the mean values of daily prey consumption rate of the leopard, 70 g meat/kg body wt/day, body mass of the leopard, 45 kg and the proportion of edible biomass in whole prey body mass, 75%, they will eat 15,330 kg of prey per annum. Of these, 14,180 kg will be of the goats, including 4,752 kg males, 6,914 kg females and 2,514 kg juveniles. In numbers, this biomass will translate to 128 males, 247 females and 168 juveniles, in total 543 individuals removed by the leopards per annum.

Among the big cats living in prey-rich environments, the predator-prey ratio varies from 1:90 to 1:300, so the sufficient number of the goats for the leopards in Khosrov Reserve should be 900-3,000.

It is hard to say precisely how many goats are living now in Khosrov, but obviously they remain common in all areas visited and studied by us, as shown by numerous sightings of groups of animals (5-22 per group), abundance of kids and juveniles (on average, two per adult female), very frequent records of goat tracks and pellets claimed by local people and rangers. This population is strictly resident and little affected by poaching and livestock grazing. Wire leg and neck snares have been set mainly near cave entrances in areas close to human settlements, and shooting is very reluctantly done as it demands substantial physical effort from the poachers. Livestock grazes in habitats other than those used by the goats; cattle and horses graze mainly in riparian lowlands with lush vegetation and never go up to the mountains, whereas the sheep graze on alpine plateaus and do not move far from the shepherd camps.

We have estimated that 900-3,000 goats may live in Khosrov to remain the staple prey of leopards using our approximate guesstimate of the predator numbers – no more than 10 individuals. This information contradicts the published data that no more than 700 goats live today throughout Armenia. This urgently demands in-depth, up-to-date census of these ungulates in Khosrov Reserve and other regions of Armenia.

Also, it is really essential to estimate carefully how many leopards, and of what demographic structure, are living now in Khosrov. The best way would be to employ camera phototraps and/or use the relative abundance index (No. scats/10 km of trails walked) to correlate with the real density.

Feeding Competition

We have collected and analysed 236 faeces of brown bears and 94 scats of lynx. The brown bears living in Khosrov are predominantly vegetarians, feeding on roots, fruits, berries and green biomass. Hence, the index of the food niche overlap between the leopard and the bear is negligible (0.013) as shown by the occurrence of buckthorn berries in several leopard scats in winter. The lynx feed mainly on European hares and rodents and the index in the pair leopard-lynx is also insignificant (0.02) from the occurrence of European hare remains in the leopard scats.

This separation of food niches is based on use of different micro-habitats within the same habitat: bears and lynx live in the blocks of sparse forest and dense thickets, and the leopards in blocks of rocky massifs. Actually, the physical traits of the leopard make it an exclusive goat-taker in its precipitous and rocky ecosystem in Khosrov: cunning, strength and exceptional climbing skills of this carnivore leave no chances for other predators that occasionally visit this habitat.

The grey wolf (*Canis lupus*) and raptors do not compete with the leopards for food.

Distribution and Habitat Use

The area studied by us (ca. 780 km^2) is three times larger than Khosrov Reserve itself (258.6 km^2) which makes inevitable leopard movements outside the protected area and clashes with rural people. This makes the "edge effect" the highest threat to the survival of local leopards. (The "edge effect" is defined as the increased chance of large predators being killed by people along the reserve borders when moving out of safety zones). The chance is directly proportional to the ratio reserve perimeter/reserve area, thus increasing dramatically with fragmentation. In Khosrov Reserve, the "edge effect" is significant because of its fragmentation into districts embraced by agricultural land, high values of perimeter/area in those districts where the leopards live (Garni – 1.4 km^{-1}, Khachadzor – 1.26 km^{-1} and Khosrov – 1.24 km^{-1}), relatively high proportion of rural population in all (66.5%) and high human density (144 people/km^2) in Ararat Province, where this reserve is located.

We paid special attention to the critical habitat, defined as the specific area within the geographical area occupied by the species in which are found those physical or biological features essential to the conservation of the species, and which may require special management consideration or protection. For the leopards in Khosrov, this applies to the juniper (*Juniperus* spp.) sparse forest with blocks of precipitous outcrops along the ridge tops, which provide abundant prey (goat and European hare), shelter and observation-posts for spotting prey grazing below. This is shown statistically by the habitat preference ratio PR, which is much higher for the juniper sparse forest (3.0) than for arid and mountainous grasslands (0.7) and subalpine grassland (0.4).

Implications for Conservation

Food resources are sufficient and exclusive for the leopards in Khosrov Reserve and the principal factor threatening their survival is the "edge effect" defined above and confined to the lack of space and poverty-driven low level of public awareness in rural areas. Here, we separately discuss these issues.

Lack of Space

There are three measures to minimize this limitation for local leopards:

1. Acquisition of surrounding agricultural lands for enlargement of the existing protected area;

2. Maintenance of natural corridor(s) linking Khosrov Reserve with southern Armenia through which the leopards and other wildlife could move, principally Noravank Canyon area; and
3. Stringent control of the status of "buffer zones" fringing the reserve border.

Poverty and Low Public Awareness

Apart from the shepherds and their livestock, which are present most of the year and even in winter, Khosrov Reserve has frequently been subject to trespass from late spring to mid-autumn by individual poor villagers who harvest herbs, wild fruits, mushrooms and berries and shoot small wildlife, mainly hares and chukars partridges (*Alectroris graeca*), for food. In November-December, dead wood biomass is collected and distributed among the reserve rangers for household heating. The reserve directorate stringently ensures that no live trees are cut and no profit is made from selling the cut trees, but existing capacities are limited. However, relentless and devoted conservation efforts by Samvel Shaboyan, Director of Khosrov Reserve, and his team have resulted in a relatively good status for the reserve compared with other protected areas of Armenia where conservation measures are really nil.

What is essentially needed to be done here is:

1. Development of ecotourism, ecodevelopment projects (e.g., marketing of local handicrafts) and protection enforcement programs, i.e. efforts oriented to creation of economic motivation for local villagers to avert use of the reserve's biological resources; and
2. Development of educational campaigns providing local people with more knowledge about the leopard and environment.

Additional Conservation Measures

A very important issue is wild fire. The junipers and other xerophylic vegetation of local sparse forest contain minimal amounts of water in their tissues and can burn over vast areas from a single dropped cigarette, match or piece of glass. Control and timely firefighting is extremely difficult in local mountains due to insufficient resources.

References

Khorozyan, I. and Malkhasyan, A. (2002). Ecology of the leopard (*Panthera pardus*) in Khosrov Reserve, Armenia: implications for conservation. Sci. Rep. Zool. Soc. "La Torbiera" 6: 1-41.

[1] Armenian Leopard Conservation Society and WWF Programs Office in Armenia, Yerevan, Armenia. <leopard_am@yahoo.com>
[2] WWF project "Conservation of the leopard in the Caucasus Ecoregion", Yerevan, Armenia. <taipan@ysu.am>
[3] Societa Zoologica La Torbiera, Novara, Italy. <m.pizzetti@tin.it>

Quantitative Analysis of Leopard Tracks

Summary of the original paper

by H. Rüther, T.Stuart[1] and C.T. Stuart

Introduction

A population survey of the leopard (*Panthera pardus*) was undertaken in the Cedarberg Wilderness, Western Cape province, South Africa, from October 1990 to May 1991. The objective was to find an inexpensive, accurate and readily repeatable method to monitor the numbers of leopard in the area over a longer period of time. In September 1991, we undertook a survey of the leopard population in the western Soutpansberg in Limpopo Province of South Africa.

Much work using tracks to identify individual cats has been undertaken in India on tigers (*Panthera tigris*), with less extensive work on other species. Seidensticker, Sunquist and McDougal (1985) used tracks to distinguish male from female leopards in the Saurah area in Nepal. Fitzhugh and Gorenzel (1985), and Smallwood and Fitzhugh (1993), have investigated the use of tracks for mountain lion (*Felis concolor)* in California (USA).

The Cedarberg and Soutpansberg work has provided the data for a feasibility study on the use of tracks for the identification of individual leopards during censusing programmes.

Material and Methods

Study Areas

The Cedarberg Wilderness Area, encompasses 651 km² (6,5100 ha) between Citrusdal and Clanwilliam.

The Soutpansberg mountain range is located in the northern Limpopo Province, South Africa. This study was undertaken on Lesheba Wilderness, which lies in the west of the mountains. A control series using tracks of captive leopards was analysed: two adult females in Tygerberg Zoo, and seven adult animals (two females, five males) at Chipangali Wildlife Orphanage.

Recording and Data Acquisition Methods

The following methods were employed for this study:

1. manual tracing onto perspex;
2. single-image photography with scale placed next to track; and
3. stereo photography with reference frame placed over track.

Manual Tracing

A sheet of perspex 21 cm x 30 cm was placed over the track. With a felt-pen the outline of the track was traced, looking vertically onto the sheet at all points. Locality, date, time and estimate of when the track was made was recorded.

Eighteen tracks were traced in the Cedarberg Wilderness Area. This was used to draw eight tracks of two captive females at Tygerberg Zoo. The left front track of both females