

# The Persian Leopard Prowls Its Way to Survival



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## Abstract

The Persian leopard (*Panthera pardus saxicolor*) is endangered throughout its distribution area in the Middle East. In this article, we briefly describe its global range and then emphasize the status, distribution, and threats in Armenia. The principal factors jeopardizing the long-term survival of the Persian leopard in Armenia are disturbance, poaching, and wildfire. Currently, the work is underway to identify and describe the coarse-scale range, fine-scale range, and the Priority Leopard Conservation Areas (PLECAs) in the country. Because the leopard distribution is spatially exclusive of inhabited human settlements, the fine-scale range is defined as the coarse-scale one without villages and towns. The statistical information on both ranges is presented. Its comparative analysis has shown that the fine-scale range contains, with statistical significance, a smaller area of the mountain meadows and much shorter lengths of the main asphalted roads than its coarse-scale counterpart. The PLECAs are areas of permanent presence of the predator, which therefore must be granted the highest priority for conservation. The first candidates for the status of PLECAs in Armenia are identified.

## Resumen

El leopardo perso (*Panthera pardus saxicolor*) está en vías de extinción en toda de su distribución en el Oriente Medio. En éste artículo, describimos brevemente la distribución mundial y enfatizamos el estado, la distribución, y las amenazas en Armenia. Los factores principales que hacen peligrar a la supervivencia del leopardo perso en Armenia son los disturbios, el cazar, y el incendio fuera de control. Ahora el trabajo está en progreso a identificar y describir la habitación de escala aproximada y la de escala precisa, y las Áreas Principales de la Conservación del Leopardo (PLECAs) en el país. La habitación de escala precisa se defina como la aproximada sin las pueblas y las aldeas, porque la distribución del leopardo no incluye espacialmente los asentamientos humanos. Se presenta la información estadística en ambas distribuciones. El análisis ha mostrado que la habitación de escala precisa contiene, con un significado estadístico, un parte más pequeño de los prados montañoses y unos tramos mucho más cortos de las calles principales que la habitación de escala aproximada. Las PLECAs son áreas de presencia permanente del depredador, y por eso se deben darlas la prioridad más alta por la conservación. Se identifican los primeros candidatos por el status de las PLECAs en Armenia.

## Introduction

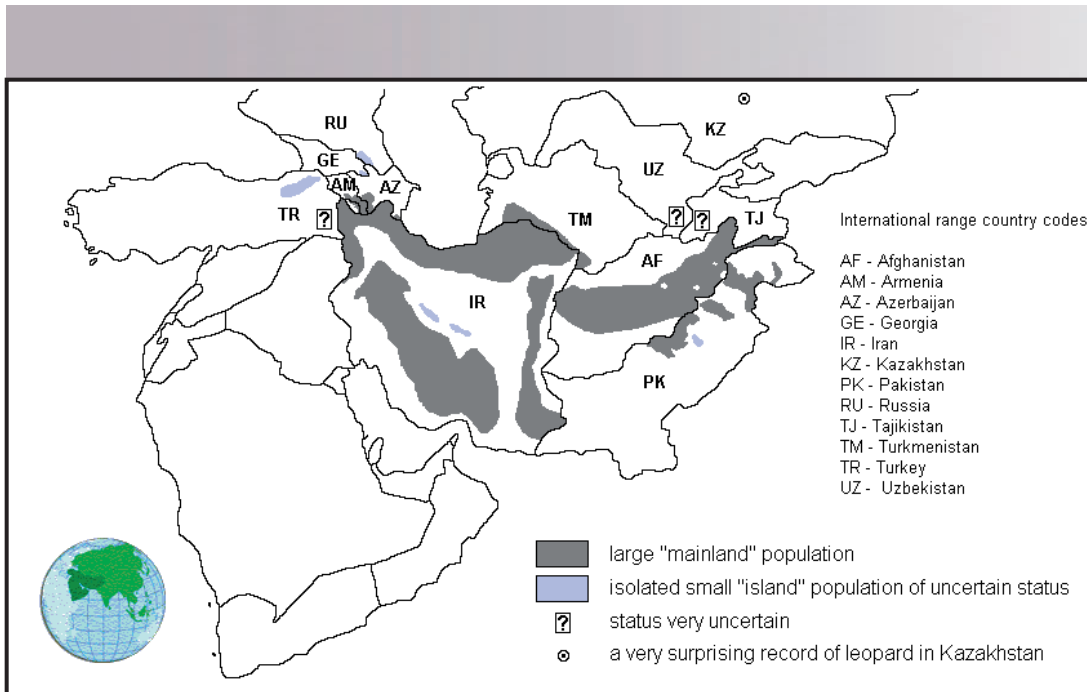
The leopard (*Panthera pardus*) has been traditionally recognized as a common species due to its frequent appearance in the popular wildlife TV programs. In practice, however, this wild cat can be regarded as common only in savannas and tropical rain forests of Sub-Saharan Africa where it is widely filmed and even somewhere allowed for trophy hunting within the official quotas (Anonymous 2003). In the meantime, eight leopard subspecies are listed in the 2004 IUCN Red List of Threatened Species as either “endangered” or “critically endangered” and seven of them are living today in Asia (IUCN 2004). Without taking active, targeted, and large-scale conservation measures, they are in imminent danger of extinction from the Earth. The Persian leopard (*P.p. saxicolor*) is one of the subspecies in danger of disappearance (figure 1).

The Persian leopard’s current range extends over the Middle East and its total number does not exceed 1,300 individuals. Most of the cats are found in Iran (550–850 animals) and especially in its northwestern portion adjoining southern Armenia and Azerbaijan (160–275; Kiabi et al. 2002). The number in Afghanistan is unknown, but should be at least several hundred (Habibi 2004); however, today’s rampant

leopard fur trade on the Kabul market and overharvest during and after the long-term civil unrest pose the greatest threat to survival of this predator in the country (Mishra and Fitzherbert 2004). In northeastern Iraq contiguous to western Iran and southeastern Turkey and elsewhere in the country, the leopard was considered rare as early as the late 1950s (Hatt 1959), and now this war-torn country is believed to no longer contain the carnivore. The southern edge of Turkmenistan holds 78 to 90 leopards (Lukarevsky 2001). The most recent and highly mysterious case of killing an old male leopard in southern Kazakhstan (Shakula 2004) raises an important question about the cat’s status in Uzbekistan and Tajikistan from where the animal could have come, but since the late 1970s virtually nothing is known about the leopard in either of these countries (Lukarevsky 2001). Pakistan’s North-West Frontier Province also holds the Persian leopard population, but of unknown size (Zulfiqar 2001). Armenia and Azerbaijan together are unlikely to harbor more than 30 cats, of which a maximum of 10 to 20 may live in southern and southwestern Armenia (Khorozyan 2003) and the others roam over Azerbaijan’s Naxcivan Republic and in the Talis Mountains (Askerov 2002). Some transient individuals can penetrate to Georgia; recently, a good-looking young male was captured by photo-traps in Vashlovani Reserve in the extreme southeast of the country (Butkhuzi 2004). The presence of the leopard in European Russia’s North Caucasus mountains is questionable (Semenov 2002), but a sort of evidence was recently reported for the triangle between the republics of Dagestan and Ingushetiya, southeastern Georgia, and northwestern Azerbaijan (Anonymous 2004; V. Lukarevsky and E. Askerov, pers. comm.). It is unknown whether the leopard from northeastern Turkey close to Georgia belongs to the Persian

**Figure 1.** The Persian leopard (*Panthera pardus saxicolor*) captured by photo-trap on 9 March 2005 at 1:54 a.m. on Meghri ridge, southern Armenia. Authors: A. Malkhasyan, I. Khorozyan, M. Boyajyan. Financial support: Aalborg Zoo, PTES, WWF.





**Figure 2.** The Persian leopard range in the Middle East. The outline map is retrieved from [www.worldatlas.com](http://www.worldatlas.com) and the references are those indicated in the text. Produced by I. Khorozyan.

subspecies (Baskaya and Bilgili 2004), but it should be separated from the Caucasus because there are no records from adjoining parts of southwestern Georgia and western Armenia. The map of the Persian leopard range is depicted in figure 2.

There is much debate on how many leopard subspecies exist in the Middle East, but we do not discuss this topic in detail here. Before 1990, when Armenia, Azerbaijan, Georgia, Russia, and Turkmenistan were the Soviet republics, the scientific names of the leopard used in these countries were *P.p. tulliana* (Valenciennes 1856) and *P.p. ciscaucasica* (Satunin 1914), whereas the name *P.p. saxicolor* (Pocock 1927) had been traditionally used by the western specialists for the cats in Iran and, partially, Afghanistan. Current international regulations consider both *ciscaucasica* (Caucasus leopard) and *saxicolor* (Persian leopard) as synonyms and use only one, *saxicolor* (IUCN 2004) because these races are identical morphologically (Khorozyan 1999) and should be so genetically (Miththapala

et al. 1996), and because the leopards occasionally move between Iran and Armenia. The name *tulliana* (Anatolian leopard) applies to the leopard in southwestern Turkey.

Historically, the Caucasus<sup>1</sup> was inhabited by three big cats: Asiatic lion (*P. leo persica*), Caspian tiger (*P. tigris virgata*), and Persian leopard. Moreover, until 15 A.D. the Armenian princes imported the Asiatic cheetahs (*Acinonyx jubatus venaticus*), tamed them, and used in high-rank hunts (Nowell and Jackson 1996). The lion disappeared here in about 10 A.D. (Nowell and Jackson 1996) and the last tiger was shot in 1932 near Prishib village in Talis, Azerbaijan (Gadjiev 2000). The principal reasons of their disappearance were extermination of predators and their prey and habitat destruction. Later, this tiger subspecies had vanished forever and the Asiatic lion is confined now to a single population in west India. The leopard has outlived them all, but can be wiped out if the authorities at all levels do not express more political will and support.

In Armenia, the leopard has co-

<sup>1</sup> Here, we consider "Caucasus" as a geopolitical region which includes Armenia, Azerbaijan, Georgia (all – South Caucasus) and south of European Russia (North Caucasus). This notion is not the same as the "Caucasus Biodiversity Hotspot" and the "Caucasus Ecoregion" introduced recently by WWF and Conservation International which include also the parts of northeastern Turkey and northwestern Iran.





**Figure 3.** The leopard hunt on the bezoar goats (*Capra aegagrus*) carved on rock by prehistoric people. Mt. Azhdaak, Geghama ridge. Picture by A. Malkhasyan.

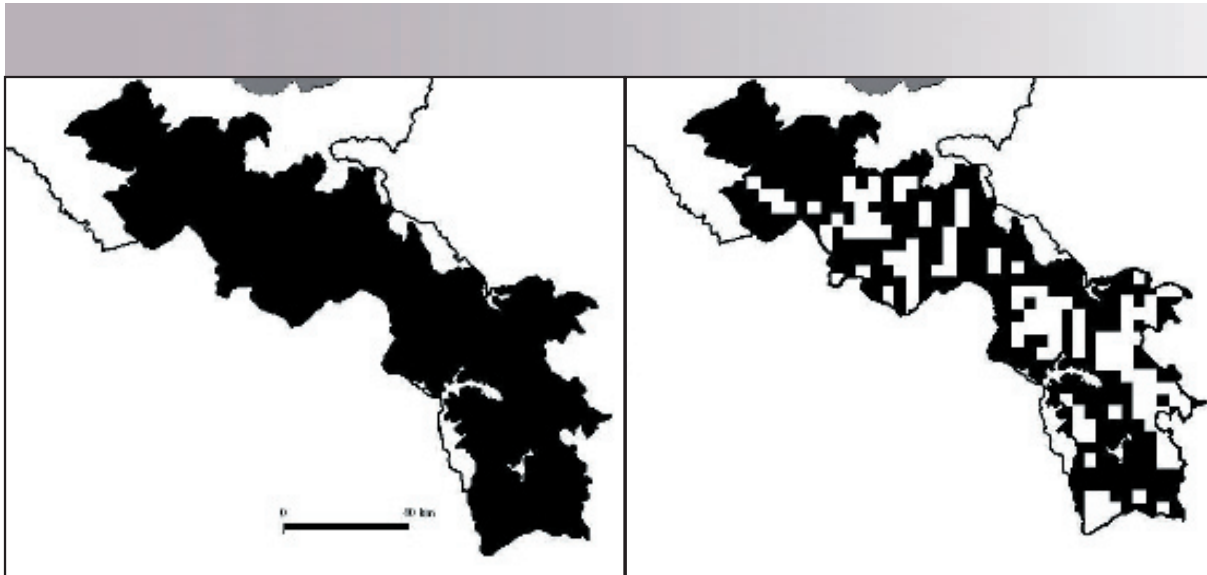
existed with humans since the Holocene (ca. 5,000 years ago) and carvings and paintings of it made by prehistoric people from approximately 3,000 years ago are not uncommon (Mezhlumyan 1985). Most of them depict the predator hunting its staple prey, the bezoar goat (*Capra aegagrus*), or being hunted by men (figure 3). It was common until the large-scale eradication of all large carnivores began in early 1900s when Armenia and other regions of the Russian Empire were struck by political turmoil and most of adult population was armed. Before 1972, when at last the leopard was declared an officially protected mammal and entered the Red Data Books of Armenia and the USSR as “endangered,” it was officially killed as vermin and for its valuable skin, which was sold by hunters to the governmental stocking centers (Gasparyan and Agadjanyan 1974). As a result, in the mid-1970s the cat has disappeared from northern Armenia and its entire range shrank to its present status (*ibid.*).

### Current State

Today, the leopard’s coarse-scale range extends over southern and southwestern Armenia from Garni district of Khosrov Reserve down to Armenian-Iranian

state border (figure 4). It is bounded by the Vardenis and Geghama ridges in the north, by the Azat river in the northwest and by plain semi-deserts and croplands of the Ararat Valley in the west. The landscapes used by the leopard are juniper sparse forests, arid and mountain grasslands, and subalpine and alpine meadows, whereas the semi-deserts, nival, and harsh nival zones are ignored as unfavorable with no proper prey and shelter. The alpine belt is expected to be suitable only in snow-free time, as the predator’s high footing pressure makes it plod and fail to hunt in deep snow (Pikunov and Korkishko 1992). The weather in these habitats is cold and misty in winter, rainy and warm in spring and fall, and very hot and dry in summer. The terrain is very rough, with an array of canyons, cliffy massifs, and stony substrates (figure 5). The rugged relief does not enable leopards to do long stalking, but provides plenty of opportunities for them to lurk and kill prey by ambush.

Prey sufficiency is the key factor, apart from human impact as described below, underlying the carnivore’s existence. The bezoar goat is quite common throughout the leopard range, but especially in Khosrov Reserve, where it makes over 90% of the predator’s diet (Khorozyan and Malkhasyan 2002). The wild boar (*Sus scrofa*) is widespread, but is taken very reluctantly in Khosrov and more frequently elsewhere in southern Armenia (Khorozyan and Malkhasyan 2002; unpubl. data). The roe deer (*Capreolus capreolus*) lives in southern Armenia and is absent in Khosrov, and is readily fed upon by the leopard (unpubl. data). The Indian crested porcupine (*Hystrix indica*) and European hare (*Lepus europaeus*) are taken opportunistically. That the wild prey base is sufficient for the leopard in Armenia is indirectly proved by the fact that the livestock losses to leopard predation are sporadic and negligible



compared to those inflicted by the gray wolf (*Canis lupus*) and brown bear (*Ursus arctos*).

The long-term persistence of the small, but definitely resident, population in Armenia implies its connectivity with the much larger population in northwestern Iran. There are several places along the borderline Arax river where this river is narrow and shallow and where the mountain ridges descend from both countries to the riverside, making them ideal linkages with fords.

### Threats

The leopard in Armenia is threatened by disturbance, poaching, and wild fire, but which of these factors are most stressful for this cat is still unclear.

Human disturbance is widespread, especially in spring and early summer when local people gather edible plants and mushrooms, in fall when occasional hunts take place in some favorite haunts, and in late fall when villagers cut trees and collect branches as fuelwood for winter. Gathering is a century-old tradition of rural Armenians, which possibly reflects the efforts to compensate the deficiency of plant proteins and vitamins in their diet. The most popular plants gathered are horse fennel (local name "bokhi," *Hippomarathrum microcarpum*), falcaria ("sibekh," *Falcaria vulgaris*), and *Astrodaucus orientalis* ("mandak")

(Takhtajyan 1973) and the mushrooms are field blewit (*Lepista personata*), *Pleurotus eryngii*, St. George's mushroom (*Calocybegasombosum*), and field mushroom (*Agaricus campestris*) (Nanagulyan 1987). The gatherers disperse over the slopes and communicate to one another by shouts, so their behavior poses a serious harassment to animals, particularly to the ungulates fed upon by the leopard. In response, they become more vigilant and shy, but rarely escape to other places (pers. observ.). The numbers of gatherers in the period from April to June are significant. For example, between May 5 and 13 of 2004, we recorded 50 gatherers in Khosrov Reserve. Most of them arrived on foot (42%), horseback (28%) and on motorcycles (14%), whereas fewer used vehicles and donkeys (8% each). This information implies that the roadblocks, which are easily rounded by hikers and horse-riders, would be an inefficient way to close up the villagers' access to the gathering sites. Potentially, this problem could be solved by raising public awareness, but people's motivation to gathering is very strong.

Poaching is traditionally believed to be an important factor of risk for the leopard, other large carnivores, and its prey, especially since early 1990s when the newly independent Armenia waged the war with neighboring Azerbaijan over Nagorno Karabakh and which has eventually left numerous firearms

**Figure 4.** The coarse-scale (left) and fine-scale (right) ranges of the leopard in Armenia. White quadrats represent the grid cells that contain inhabited settlements and are thus excluded from the coarse-scale range. Produced by I. Khorozyan and S. Asmaryan.



**Figure 5.** Juniper sparse forest on the ridgetops, the typical habitat of the leopard in Armenia. Khosrov Reserve, with the biblical Mt. Ararat on the background. Picture by A. Malkhasyan.

in local people's hands. Currently, the narrow isthmus of southern Armenia, which is squeezed from both sides by Azerbaijan has been officially considered a "borderline territory." According to anecdotal information, one leopard has been killed in Armenia every year or two, mainly as a result of snow tracking. As the leopard is officially protected and the poacher will be fined and jailed, all cases are treated in a "shoot, shovel, and shut up" fashion provoked by human fear.

Wildfire destroys the leopard's favorite habitats and forces it to move away to other places. The main reason of fire is human neglect, which can cause ignition during the extremely dry months of June–September from a single match, piece of glass, campfire ember, or ashes left by livestock keepers or plant gatherers. The habitat's propensity for burning is increased because of xeric vegetation, scarce precipitation, significant tracts of lands covered by coniferous sparse forests (junipers), strong winds blowing alongside the slopes and the lack of technical capacities in local conservation entities to timely quench the fire. Some small plots can be deliberately burned down, as this practice is still strongly believed by villagers to stimulate the growth

of fodder for their livestock. Instead, it destroys soil structure and kills soil invertebrates, small mammals, and ground-nesting birds.

All these threats are expected to closely correlate with human densities, i.e., the higher densities will intensify pressure and thus decrease the probabilities of occurrence of the leopard and its prey. In the meantime, we agree that human activities can affect the carnivore populations also in remote areas with low human densities, so human attitudes and practices can be more important than density *per se* (Cardillo et al. 2004; Woodroffe 2000). However, in most of today's developing countries where human behavior and resource use have not been properly controlled or managed, the probability of large carnivore extinction is positively related to human density until favorable wildlife management practices are introduced and enforced (Linnell et al. 2001). We have found out that livestock breeding present in the leopard range in Armenia at the temporary shepherd camps located far away from the villages has been tolerable by the leopard, but is a serious threat to its long-term survival if not properly managed (Khorozyan 2003). Meantime, the leopard distribution is spatially completely separated from inhabited settlements (*ibid*).

## Methods

Within the project supported by People's Trust for Endangered Species (UK), we have been using GIS technologies, particularly software programs ArcView GIS 3.2, 3D Analyst and Spatial Analyst, to outline the fine-scale leopard range and identify the Priority Leopard Conservation Areas (PLECAs) in Armenia, which would then be recommended to the national government and international foundations for the enforcement of predator research and conservation. The coarse-scale range defined above



contains inhabited human settlements with their vicinities where the leopard does not live, so there is a need to define where it lives certainly (fine-scale range), permanently (PLECAs) and occasionally during movements (linkages between PLECAs). Correspondingly, the PLECAs will be granted the highest

priority for conservation, linkages – high, lands fringing the PLECAs and their linkages – medium, and all other lands – low priority. This approach is similar to that employed for defining the priority areas for the tiger (*Panthera tigris*) (Wikramanayake et al. 1998).

To define and quantify the coarse-

| Parameter                           | Coarse-scale range | Fine-scale range | Notes |
|-------------------------------------|--------------------|------------------|-------|
| Natural features                    |                    |                  |       |
| Arid grassland, km <sup>2</sup>     | 1052.4             | 657.5            | 1     |
| Sparse forest, km <sup>2</sup>      | 1318.3             | 838.5            | 1     |
| Mountain grassland, km <sup>2</sup> | 2335.0             | 1438.8           | 1     |
| Subalpine meadow, km <sup>2</sup>   | 1911.9             | 1673.6           | 1     |
| Alpine meadow, km <sup>2</sup>      | 879.6              | 834.3            | 1     |
| Total area, km <sup>2</sup>         | 7497.2             | 5442.7           | 1     |
| % of Armenia                        | 25.2               | 18.3             |       |
| Landscape diversity                 | 1.6                | 1.5              | 2     |
| Terrain ruggedness                  | 8.0 ± 0.2          | 7.6 ± 0.2        | 3     |
| Anthropogenic features              |                    |                  |       |
| Human population, people            | 235165             | > 250            | 4, 5  |
| density, per km <sup>2</sup>        | 31.4               | > 0.05           |       |
| No. towns                           | 10                 | 0                | 4     |
| No. villages                        | 150                | 0                | 4     |
| Cattle, heads                       | 65176              | > 156            | 4, 6  |
| density, per km <sup>2</sup>        | 8.7                | > 0.03           |       |
| Sheep and goats, heads              | 87443              | > 438            | 4, 6  |
| density, per km <sup>2</sup>        | 11.7               | > 0.08           |       |
| Distance to the nearest village, km | -                  | 6.7 ± 0.2        | 1, 7  |
| Main asphalted roads, km            | 1044.4             | 463.1            | 1     |
| density, km <sup>-1</sup>           | 0.1                | 0.08             |       |
| Dirt roads, km                      | 3444.0             | 2518.9           | 1     |
| density, km <sup>-1</sup>           | 0.5                | 0.5              |       |

**Table 1.** Some key characteristics of the coarse-scale and fine-scale leopard ranges in Armenia.

**Table 1 Notes:**

- As measured on our GIS maps which were built on a basis of georeferenced topobase map of Armenia of scale 1:200000.
- Landscape diversity was calculated as Shannon's index  $H = -\sum_{i=1}^n P \ln P$ , where  $P_i$  is the proportion of the area of the  $i$ -th landscape to the area of all landscapes (Sutherland 2000).
- Terrain ruggedness index ( $TRI$ ) was calculated as  $= TNC \times TNF / (TNC + TNF)$ , where  $TNC$  is total number of topographic 40-m distance contours intersecting the selected transect (top-right corner to down-left corner diagonal of the grid cell) and  $TNF$  is total number of changes in topographic aspect along the same transect (Fjellstad et al. 2003). Its value is given as arithmetic mean ± standard error of index values across the grid cells.
- This information valid thru Jan. 1 of the years 2000, 2001, 2002, 2003 and 2004 derives from our databases on individual settlements compiled from statistical information provided by Manasyan et al. (2002), regional authorities and departments of the National Statistical Service (Armstat), and The Results ... (2003) in Ararat, Vayots Dzor and Siunik provinces encompassing the leopard range in Armenia. The livestock data on one village in Ararat are lacking.
- People in the fine-scale range include those living temporarily at shepherd camps and permanently outside of towns and villages, e.g. Khosrov Reserve rangers and the staff of outreach border facilities. About 150 people are estimated to live in Khosrov Reserve alone (Khorozyan 2003).
- We do not have yet complete information on numbers of livestock maintained by people seasonally or permanently outside of towns and villages across the entire fine-scale range (see Note 5). Up to 156 cattle and up to 438 small livestock are estimated to graze seasonally in Khosrov Reserve alone (Khorozyan 2003).
- We did not measure the distance to the nearest village in the coarse-scale range, because its grid cells themselves contain the inhabited settlements. In the fine-scale range, it was measured from the center of the cell to the center of the village and is given as arithmetic mean ± standard error of values across the grid cells.

scale and fine-scale leopard ranges in Armenia, we have produced the grid of 16 km<sup>2</sup> quadratic cells covering the map of southwestern and southern Armenia. We defined the fine-scale range as the coarse-scale one without the cells with inhabited settlements, but the cells containing only outskirts of one village (not town) were not excluded from the fine-scale range. Both types of ranges are illustrated in figure 4 and their characteristics are provided in table 1.

### Results

The statistical comparison of the ranges for parameters listed in table 1 has shown that the fine-scale range contains a smaller area of the mountain grasslands ( $t = 2.38$ ,  $df = 1030$ ,  $P < 0.05$ ) and much shorter lengths of the main asphalted roads ( $t = 4.85$ ,  $df = 1048$ ,  $P < 0.001$ ) than the coarse-scale one. The natural features do not differ significantly between ranges ( $P > 0.05$ ). As expected, the most striking difference between the ranges is the significant numbers and densities of people and livestock in the coarse-scale range and their negligible values in the fine-scale range. We used two-sample t-test assuming equal or unequal variances, and the variances were checked by F-test. All relevant procedures were done in Microsoft Excel 2003.

This result makes sense for several reasons. The mountain grassland is the most suitable habitat for animal husbandry and, not surprisingly, 44% of all towns and villages of the range are located just within this landscape zone; therefore, its significant portion was left behind the fine-scale range with exclusion of the settlements (figure 4, table 1). Similarly, as the main roads connect the settlements their most important legs lie outside the fine-scale range. In general, population of these settlements makes only 7.3% of all Armenia's population and consists of 61% urban and 39% rural people.

Thus, the fine-scale range, which

makes almost three-quarters (72.6%) of the coarse-scale one, represents the environment least disturbed by human activities and located quite distantly from the settlements. Because both ranges do not differ in the key natural characteristics, we could anticipate that the leopard might have been able to expand its distribution by 2054.5 km<sup>2</sup> from the fine-scale to the coarse-scale range, provided that much more conservation activities are implemented to enforce the man-leopard coexistence in human-dominated landscapes. This would be a great achievement for such a small and land-deficient country as Armenia. Both ranges are sufficiently large to maintain the leopard population in the long run, being much larger than the threshold area, i.e., the minimum area known to support a population of particular species (412 km<sup>2</sup> for the leopard; Smallwood 2001).

In order to identify and map the PLECAs, we plotted the leopard scat sites found during our regular field trips. Assuming that, by definition, the PLECAs must contain the predators with detection probability close to 1, meaning their constant and current presence there, we visited certain study areas at intervals approximately every 5 months to allow the animals of a low-density population to revisit the area.

The first candidates for holding the status of PLECAs in Armenia are central and eastern Khosrov Reserve in the northwesternmost part of the range and the locality to the north of Shvanidzor and Nuvadi villages in the extreme southeast. We walked 93.8 km in April and October 2004 in Khosrov and 94.6 km in May and November 2004 in the Shvanidzor-Nuvadi area and collected the scats. After the fecal bile acid thin-layer chromatography of these samples gives us an answer on their unambiguous leopard origin by the end of the project, it will be possible to determine if these areas are real



PLECAs and then to describe them in detail. We use the PRESENCE software ([www.mbr-pwrc.usgs.gov/software](http://www.mbr-pwrc.usgs.gov/software)) to calculate the detection probability, which enables us to discriminate between presence with detection, presence without detection, and absence without detection (Henschel and Ray 2003). Since we used the same sampling techniques in all trips, no other field researchers were involved (i.e., no observer bias) and the habitats and weather conditions do not generally differ much between study areas and seasons (other than winter), we assume that the scat detection probabilities in our work were unbiased. We have been doing this work also in other study areas in an attempt to find more PLECAs.

## Conclusion

Research of endangered wildlife makes no sense without conservation. The first efforts to promote the leopard conservation in Armenia were launched in 2002 by two projects supported by the Rufford Small Grant for Nature Conservation program (UK) and the World Wide Fund for Nature (Switzerland). The former project was targeted on seven species of large mammals and has identified the leopard, bezoar goat, and Armenian mouflon (*Ovis orientalis gmelini*) as taxa that deserve the most urgent conservation actions in the country. The latter project provides practical measures, from technical assistance to outreach education campaigns.

In 2004, our Whitley Awards project (UK) expanded and deepened the conservation of the leopard and these two ungulates and included the technical assistance and large-scale education and training of rural people, soldiers, and military personnel at the Armenian-Azerbaijani and Armenian-Iranian state borders. Bringing real change and success, such conservation activities must be enforced and expanded throughout the leopard

range in close cooperation between the scientists, practitioners, local people, border military, local and national conservation entities, and authorities (Khorozyan 2004).

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