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# news



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# Persian leopards in the Iranian Caucasus: a sinking 'source' population?

**Persian leopards *Panthera pardus saxicolor* in the Caucasus have suffered a major decline in numbers and extent of occurrence, and are now restricted to a few populations in north-western Iran. This perception bases on sporadic field observations and a sign survey conducted in 2004. To establish an updated basis for the current status of Iranian Caucasus leopard, we carried out field surveys in June-October 2012 using non-invasive genetic sampling of faeces combined with searches for signs and non-structured interviews with key local informants at five priority reserves in north-western Iran. Within approximately 285 km of trails evaluated in 33 survey days (435 man-hours) we found only six potential leopard scats, three of which were of sufficient quality for mitochondrial DNA analysis but none confirmed as originating from leopard. We recorded no fresh leopard signs and interviews suggested very little reliable proof for the species' presence in all but Kiamaky Wildlife Refuge and Agh Dagh Protected Area. We caution that leopards in the Iranian Caucasus are in unfavourable status, and that prompt conservation actions are needed. It is unlikely that the assumed source population of leopards in north-western Iran is presently able of supporting the natural re-colonization of the Caucasus.**

Persian leopards in the Caucasus have undergone catastrophic declines because of poaching and reduced abundance of natural prey and habitat (Heptner & Sludskii 1972, Khorozyan & Abramov 2007). Expert estimations indicate that the total number may not exceed 30-65 mature individuals (Lukarevsky et al. 2004, Khorozyan et al. 2005, Lukarevsky et al. 2007) over the entire Caucasus

Ecoregion of >580,000 km<sup>2</sup>. The leopard population in north-western Iran, the only region with recently confirmed reproduction, is believed to support the leopard presence in neighbouring countries (Lukarevsky et al. 2007, Khorozyan & Abramov 2007, Breitenmoser et al. 2010). The Caucasian Leopard Working Group (CLWG 2011), an international initiative of the ecoregional countries,

considered conservation of the Iranian population as highest priority. Five reserves in north-western Iran were therefore recommended for baseline surveys (Fig. 1).

The priority reserves of the Iran Department of the Environment (DoE) are considered the major leopard reserves in the Iranian Caucasus. Yet, the current state of knowledge is restricted to limited one-time sign surveys conducted in 2004 (details in Lukarevsky et al. 2007) and anecdotal field observations (e.g. Sanei et al. in press). To repeat the 2004 survey with a more robust scientific method and to test the capacity of genetic sampling for future monitoring programmes, we carried out a pilot non-invasive faecal-DNA sampling in the priority reserves in 2012. Additional information was obtained from extensive non-structured interviews of key local informants at each site. In this paper we: (1) present new data on occurrence of leopards, (2) compare our observations with the 2004 survey, and (3) discuss conservation needs for the Iranian leopard population.

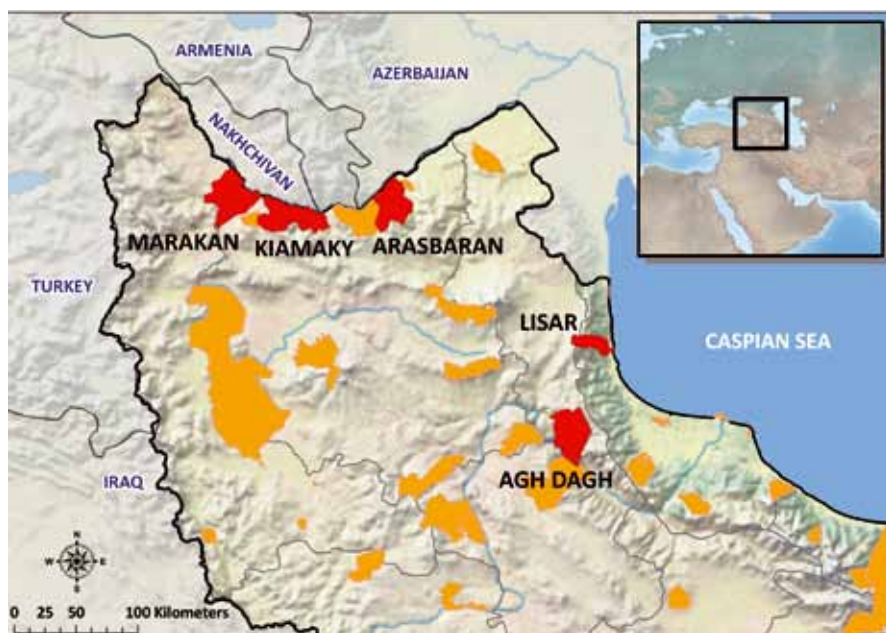
## Study area and methods

### Survey sites

The leopard reserves surveyed in north-western Iran include: Lisar Protected Area (LPA), Agh Dagh Protected Area (ADPA), Arasbaran Biosphere Reserve (ABR), Kiamaky Wildlife Refuge (KWR), and Marakan Protected Area (MPA) (Fig. 1, Supporting Online Material SOM Table 1). Located in Qara Dagh Landscape, MPA, KWR, and ABR are adjacent to Armenia and Azerbaijan along the Aras River, and habitats predominantly consist of forestless high mountain ecosystems (Fig. 2, SOM Fig. 3-5). ADPA expands into the transition zone between Talysh and Alborz Mountains. LPA lies within the Talysh eastward to the Caspian Sea and has, like ABR, relatively large tracts of temperate broadleaf and Hyrcanian mix forests (SOM Fig. 4-5). Climate varies from dry continental in MPA eastward to semi-humid Mediterranean at LPA, with mean annual rainfall from 200 to 1,035 mm. Further details are given in SOM Table 1.

### Field surveys

Field surveys were carried out by the first author between 18 June and 1 October 2012. Our aim was to apply opportunistic genetic sampling through a wide area where leopard occurrence was likely. Prior to fieldwork we interrogated local wardens on leopard presence (i.e., sightings or signs such as scra-



**Fig. 1.** Priority leopard reserves surveyed in this study (red) and main protected areas (orange) in north-western Iran. The rectangle on the inset indicates the location of the Caucasus Ecoregion.

pes, tracks, kills, and livestock depredation). Promising local field sites were identified based on this information and availability of leopard habitats (e.g. natural areas, rocky outcrops, ungulate hotspots) with mountain ridges and human/wildlife trails to run transects. We included all paths searched by Lukarevsky et al. (2004). On each site, we were assisted by local wardens or knowledgeable residents. We conducted non-structured interviews with local informants like herders, hunters, farmers, and bee keepers (usually in the local language). Sampling method, DNA extraction and species identification are outlined in SOM. Leopard records were classified according to their reliability (hard evidence: direct detection with physical evidence or genetic sample, soft evidence: reliable observations or indirect evidences from reliable sources).

## Results

A total of 33 survey days or 435 man-hours in the field with 285.7 km of walking transects were conducted (Table 1). The majority of effort was in ABR with 72% of the total surveyed trails (Table 1). Only six potential leopard scats were found (ABR:  $n = 1$ ; ADPA:  $n = 1$ ; KWR:  $n = 4$ ). All the scats were judged to be old because of being completely dry with very weak or no odour, and only samples collected in KWR were associated with leopard scrapes. Three samples (50%) were successfully sequenced for a part of the cytochrome b (*cytb*) gene, but none confirmed as originating from leopard. In total, we interviewed 43 local wardens, 21 herders, and 30 reserve residents. Hard evidences resulted only from KWR and ADPA. No reliable report of leopard presence was obtained from LPA and ABR. Although all leopard reserves were legally protected, destruction and alteration of natural areas continued for many years. People and domestic livestock dominated the reserves outside core zones, and wild ungulates often persisted in small numbers (SOM Table 1).

### Lisar Protected Area (LPA), Gilan Province

LPA includes 22 inhabited villages and is surrounded by human settlements, crop fields, and roads. Anthropogenic impact is stronger in lowlands and has fragmented the once contiguous forested area into degraded complexes. Law enforcement is minimal, almost no restriction on livestock herding is applied, and illegal logging occurs throughout the reserve. Our survey produced no evidence



**Fig. 2.** Typical leopard habitat in north-western Iran: Kantal, Kiamaky Wildlife Refuge (Photo E. Moqanaki).

for either leopard or co-predators presence. We interrogated five wardens and 11 locals. None of them had experienced, or heard of leopard observations. Livestock losses were attributed to wolves *Canis lupus* and occasionally brown bears *Ursus arctos*. Red deer *Cervus elaphus* went extinct long ago, and there was no recent reliable record for wild goat *Capra aegagrus* and roe deer *Capreolus capreolus*. Wild pigs *Sus scrofa* were however said to be common.

### Agh Dagh Protected Area (ADPA), Ardabil Province

ADPA hosts several villages usually surrounded by fruit orchards and grazing pastures. We found only one scat of possible leopard origin, but later genetically confirmed to be wolf. None of the local wardens ( $n = 3$ ) had any information regarding leopard presence. We interviewed 13 reserve residents, yet no livestock loss to leopards was reported. However, villagers informed us that nomadic pastoralists claimed several such incidents. The local DoE office confirmed two cases of leopard depredation since 2011, yet major livestock conflicts are due to wolves. A local hunter reported that a male leopard had been poached by nomadic herders near the reserve in 2001. We were also shown footage of a leopard surrounded and chased by several villagers and herd dogs in vicinity of Karnaq village in 2011. Our search for wild goats in their prime habitat was unsuccessful, but we observed relatively large groups

of wild pigs in three different locations. Interviews suggested they were common.

### Arasbaran Biosphere Reserve (ABR), East Azarbaijan Province

More than 66 villages with approximately 12,000 people live on ABR with very high livestock density. Conversion of forested habitats to agricultural lands and pastures occurred for many years. ABR experienced the sharpest decline of wild ungulate numbers based on annual total counts between 2008 and 2011 (Iran DoE, unpublished report). Illegal hunting of wildlife is common, and the reserve's wild goat population is now restricted to three isolated core zones. Red deer went extinct in 1960-70s, and roe deer are very rare (rediscovered only in 2007). Wild pig numbers have plummeted in recent years allegedly due to foot and mouth disease *Aphthae epizooticae* and intensified persecution by farmers. Recently, a new national park was declared by merging the reserve's core zones.

We intensively searched ABR but no evidence of leopard was found. The single possible leopard scat we collected was genetically confirmed to be of wolf. We interviewed all 24 reserve wardens and 26 local informants. No leopard information was obtained, and all livestock losses were attributed to wolves and occasionally to bears. Only one warden claimed to have observed leopards in five separate occasions in ABR since 2010, including one female with cub. Given the unusual high number of observations in such short

**Table 1.** Comparison of survey details for the leopard on the five Iranian priority reserves of the Iranian Caucasus in 2004 (Lukarevsky et al. 2007) and this study (June-October 2012).

|                                     | MPA  |      | ABR  |      | ADPA * |        | LPA  |      | KWR   |      |
|-------------------------------------|------|------|------|------|--------|--------|------|------|-------|------|
|                                     | 2004 | 2012 | 2004 | 2012 | 2004   | 2012   | 2004 | 2012 | 2004  | 2012 |
| Trails walked (km)                  | na   | 15   | na   | 206  | -      | 27     | na   | 21   | na    | 17   |
| Leopard evidence <sup>a</sup>       | soft | none | soft | none | -      | hard   | none | none | hard  | hard |
| Likelihood of leopards <sup>b</sup> | 2-3  | low  | 7-9  | none | -      | medium | low  | none | 10-12 | high |

a. Soft: reliable observations or indirect evidences; hard: direct detection with physical evidence, or genetic sample (this study). b. Lukarevsky et al. (2007) provided expert estimates for leopard numbers in each reserve in 2004.

\* ADPA was not surveyed in 2004.

period and the fact that neither the warden's colleagues nor local DoE office were informed about the incidents, we classified these observations as not reliable. Another three wardens reported sighting of a large-spotted cat in 2009, and a wild goat kill in 2010 probably by a large felid. None of these reports included any physical evidence to assess their reliability.

#### *Kiamaky Wildlife Refuge (KWR), East Azarbaijan Province*

Our survey in KWR focused on one of the reserve's core zones declared as National Park in late 2012, namely Kantal. The 70-km<sup>2</sup> Kantal is adjacent to Armenia and Azerbaijan inclusive Nakhchivan, where a leopard was photo-captured recently (Avgan et al. 2012). Opportunistic camera-trapping has been applied in Kantal since 2009 and produced all hard leopard evidences in KWR so far (M. Masoud, unpubl.data). A female leopard was live-trapped in winter 2011 but escaped before fit with a radio-collar (M. Masoud, unpubl. data). We found old and weathered leopard scrapes and scats (n = 4) in three different locations. The *cytb* sequence from one of the samples matched with red fox *Vulpes vulpes*, possibly resulting from a contamination after defecation (e.g. urine marking). The remaining (n = 3) showed no result after several amplification attempts. We interviewed 6 wardens and one local villager; four reported direct observations of the leopard in the past two years. We observed different groups of wild goat and signs of wild pig. No livestock grazing and recreational hunting is permitted in Kantal and the reserve appeared to be undisturbed.

#### *Marakan Protected Area (MPA), West Azarbaijan Province*

MPA is the largest reserve in north-western Iran. Many villages occur within the reserve, livestock are high in numbers, and the area outside core zones is grazed year-round. An international free trade zone between Iran

and Armenia has recently claimed some portions of MPA. Consequently several human settlements and road constructions are underway within the reserve.

No carnivore sample was encountered during our survey in MPA. We interviewed five wardens and two herders. Along one of the trails we searched, one warden reported a leopard-like scrape from 2010, and his colleague claimed to have spotted a female leopard with one cub in 2009. We could however verify none of these observations. Herders interviewed believed that leopards are either extremely rare or already extirpated in MPA as they were not aware of any leopard attack on domestic stock. We observed moderately-large groups of wild goat in vicinity of the Aras River to Nakhchivan. MPA also supports one of the last remnant populations of Asiatic mouflon *Ovis orientalis* in the Iranian Caucasus (SOM Table 1), and wild pigs are known to be common.

### Discussion

We recognize that our field survey data are insufficient to assess the status of the leopard. Yet evidences presented here suggest that leopard populations on the Iranian priority reserves are either extremely small or may already have gone extinct. Lukarevsky et al. (2007) conducted a leopard survey in these reserves (i.e., Survey Sites excluding ADPA; Table 1) in February 2004 and they found soft evidence of leopard presence (tracks and/or scats) in ABR, KWR and MPA. The authors assumed that a population of 19-24 leopards occurred in these reserves, but no resident leopard population may exist in LPA (Table 1). Eight years later, there is still no hard evidence for presence of leopards in LPA, ABR, and MPA. Our genetic sampling was hampered by unusual wet weather and it was consequently only possible to survey MPA and KWR once. Nonetheless, our fieldwork in ABR was particularly intensive (Table 1), yet even soft records were lacking. Despite large

communities of nomadic pastoralists graze LPA, ABR, and MPA year-round with almost no restrictions, given the depletion of natural prey, no stock breeder claimed livestock loss to leopard during the last decade. Thus, we think there is reasonably strong evidence that resident leopards currently do not occupy, at least, LPA and ABR.

It is impossible to evaluate the decline in abundance of Iranian Caucasus leopards because robust scientific data is lacking. But if we assume that the presence/absence of leopards was correctly assessed in 2004, the distribution would now be even more restricted. However, vast non-protected areas remain to be surveyed. Modelling of suitable habitats (e.g. Zimmermann et al. 2007) indicates that leopard areas in the Iranian Caucasus expand beyond the network of protected areas. Farhadinia (unpublished data, cited in Breitenmoser et al. 2010) reported that leopards occur in 10 "areas" across this region, and argued that 10-20% of the presumed total population of 550-850 leopards in Iran (Kiabi et al. 2002) live in the Iranian Caucasus, hence 50-100 individuals. This perception basically follows the older expert estimates (Table 2 in Kiabi et al. 2002 [excluding "better studied areas" in the Kopet Dag-Alborz range]) which was considered an overestimation by other experts (e.g. Lukarevsky et al. 2007). Even the estimations by Lukarevsky et al. (2007) seemed, in the light of new findings (or rather "not-findings") overly optimistic. We are unable to verify either of these perceptions, but we strongly believe that the present status of the leopard in the Iranian Caucasus is alarming and currently few (protected) areas seem to have the potential to host reproducing leopard nuclei.

With a sound landscape-scale conservation policy and appropriate management strategies, and their implementation, large carnivore populations are well-capable of flourishing in humanised areas (Linnell et al. 2001). The designation of new protected areas and promoting the protection status of reserves in north-western Iran (e.g. in East Azarbaijan province and the transboundary Friendship and Peace Park between Iran and Armenia) hopes that more remaining fragments of the leopard and wild ungulate habitats will be conserved and prey populations can recover. Nevertheless, there is growing concern that connectivity to populations in the Alborz range determines the long-term persistence of leopards in the Iranian Caucasus (Zimmermann et al. 2007, Sanei et al. in press). In-

stead of hosting a source population for the recovery of the leopard in the whole ecoregion, the Iranian Caucasus seems today to be a sink depending itself on immigration from further eastern and southern populations. Overall, the inconvenient truth is that without recovery of the Iranian populations (prey and leopard) little hope is left for natural re-colonisation of the leopard across the Caucasus.

#### *Challenges in monitoring leopards in the Iranian Caucasus*

The challenges for monitoring leopards in the Iranian Caucasus, and the entire ecoregion, include low effectiveness of (affordable) survey methods, insufficient coverage of potential habitats, logistic restrictions due to the region's remoteness, and limited funding. Providing logistic and financial support for fieldwork in Iran is particularly very problematic. Above all, the rarity and extremely low density of leopards in the Caucasus – the matter of concern – impedes the collection of high quality data for robust population estimates (e.g. camera-trapping or genetic sampling). Therefore, a decision-making framework for allocating resources and prioritizing areas for future surveys might be particularly helpful.

All the available data suggest Kantal National Park as candidate to conduct the first systematic population surveillance in the Caucasus (CLWG 2011). Nevertheless, such small-scale monitoring would not allow assessing the population parameters in a scientifically meaningful manner. Thus, in Kantal, and all areas where cross-border populations may occur, a coordinated monitoring programme between the neighbouring countries would improve long-term prospects for a leopard conservation programme. Furthermore, the surveys have to include the prey species (a prerequisite for leopard presence) and co-predators (e.g. as a control). Our understanding of the leopard status, distribution, and conservation needs in the Iranian Caucasus needs to be continuously improved. In our pilot study we used faecal-DNA sampling for determining presence of the leopard, but there is room for improvement of this method for in-depth studies; we just set a baseline for future surveys. The advantages of scientific robust methods are obvious, but systematic and wide-spread collection of soft data is also needed. Concomitantly, a multiple-data source approach combining data from several methods (e.g. interviews and collection of chance observations as cheap and camera-

trapping and genetic sampling as more reliable methods) for leopards, co-predators and prey should be tested and established.

#### *The way forward: urgent need for action*

In parallel to establishing a stratified monitoring approach, we recommend the following conservation priorities for the leopards in the Iranian Caucasus: (1) raising awareness among reserves' wardens and local communities (inside and outside reserves), not only targeting the leopard but for all wildlife; (2) training wardens in monitoring techniques and wildlife identification; (3) implementation of law enforcement measures especially against poaching of leopard prey; (4) taking measures against further deterioration of habitats; and (5) securing the connectivity to the supposedly better leopard populations further east. Future presence/absence surveys should also target potential leopard habitats outside the network of protected areas to provide better baseline data for a landscape-scale monitoring programme. However, for leopards in the Iranian Caucasus no further research is needed to confirm that it is time for immediate conservation action.

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Supporting Online Material is available at [www.catsg.org/catnews](http://www.catsg.org/catnews)

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