

# Project Persian Leopard (*Panthera pardus saxicolor*) in Sarigol National Park, Northeastern Iran



## *Final Report*

Submitted to Conservation Leadership Program  
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## **Project Persian Leopard (*Panthera pardus saxicolor*) in Sarigol National Park, Iran**

**Project ID:** 000306

**Host country:** I.R.Iran

**Site location:** Sarigol National Park

**Dates in the field:** 2006-2008

**Names of any institutions involved in organizing the project or participating:**

- Iranian Department of Environment (DoE)
- North Khorasan Provincial Office of DoE
- Forough Women's Society of Esfarayen
- Esfarayen Governor Office
- Conservation Leadership Programme
- Iranian Cheetah Society (ICS)

**The overall aim:**

Obtaining a scientific base of knowledge about the Persian leopard ecology and population status to establish conservation measures in Sarigol

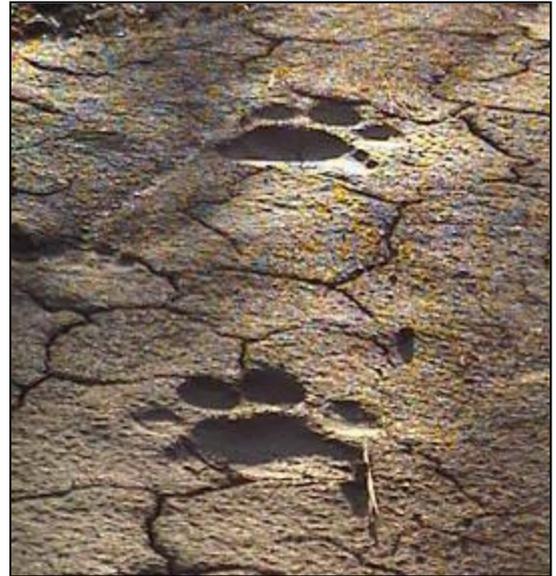
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**Date which the report was completed:** Summer 2012



**Iranian Cheetah Society (ICS)** is an Iranian, independent, non-profit NGO established in Aug 2001 in order to save the last remains of the Asiatic cheetah, just living in Iran. As a result of several year investigations, it was concluded that the not only the cheetah, but large carnivores are in conflict with local people, therefore, it is necessary to have a broader point of view on the large carnivores, including the critically endangered cheetah as the flagship species. Thus, we defined our target species as “The Iranian Five Big Carnivores” which are supposed to have a gloomy future, including Persian leopard, grey wolf, striped hyena and finally, the brown bear.



### **Missions**

- Investigation on biology, ecology and status of five large carnivores through an ecosystem-based approach;
- Public awareness about the Iranian Large Carnivores and their associated biota through education mainly at the local communities;
- Reducing human-large carnivores conflicts via implementing socio-economic plans;
- Conserving the large carnivores in their natural habitats, particularly through public participation.

Due to lack of wildlife science on the Iranian species, particularly the Five Big, ICS has focused a remarkable part of its activities on field investigations in order to apply its results to public awareness campaign among local communities. Accordingly, local applicable solutions are developed to reduce human-carnivore conflicts. Meanwhile, juveniles and youths are the main educational targets, particularly at local communities and should be satisfied to co-exist with them. Further detail on ICS activities is available on [www.wildlife.ir](http://www.wildlife.ir).

### **Preferred citation:**

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Several ICS's staffs and volunteers participated in implementation of this project, including Ali Asghar Hosseinzadeh, Morteza Eslami, Kaveh Hatami, Taher Ghadirian, Sara Bagheri, Safura Zavarani, Ehsan Mohammadi, Keyvan Aghillou, Melika Ghelichpour and Leila Amigh whose help during field surveys is not ignorable. Finally, we feel a privilege to express our frank sympathy and respect to the game guards, particularly Mohammad Taghdisi, Abbas Sirghani, Alireza Azadi, Hasan Bakhshabadi, and Baratali Bakang as local partners of this project due to their kindly cooperation in field surveys.

### Project Summary

Iran is home to more than two third of population of the Persian leopard in West Asia. However, the species has been rarely studied in the country making it as one of the least known mammals of the country. Established in 2005, the Project Persian Leopard in Sarigol National Park aimed to provide a base of scientific knowledge about Persian leopard ecology and population status and to enhance the conservation status of the Persian leopard in SNP in north-eastern country. It is composed of three main strands which aim to promote conservation of the area. Ecological research was mainly conducted within the national park to explore population parameters, food habits, reproduction, and prey demographics. Totally, we identified six leopards during the survey period in SNP which around half of their food was provided by predation on the national park's dominant ungulate, Urial (*Ovis orientalis vignei*). Meanwhile, a partnership was formed with local stakeholders and educational programs were implemented. As a result, local communities around SNP are now more familiar with the leopard. Finally, the project results were reported to the Iranian Department of Environment (DoE) for consideration in formulating protection measures, such as the area's Mass Plan. The project's outcomes and results have been shared with DoE other organizations as a model for protection of the leopard through a multi-disciplinary approach.



## Introduction

The endangered Persian leopard *Panthera pardus saxicolor* ranges over remote mountains and rugged foothills of West and Central Asia (Breitenmoser et al. 2007; Gavashelishvili & Lukarevskiy 2008). Experts estimate that its current population size does not exceed 1,300 individuals (Khorozyan et al. 2005) of which, around two-thirds occur in Iran (Kiabi et al. 2002, Khorozyan 2008). In fact, the Iranian leopards are central to regional conservation efforts as the country is believed to host the majority of source populations (Khorozyan 2008; Breitenmoser et al. 2010). However, human-caused mortality has become a major concern in recent years, paired with habitat loss threatens the Persian leopard populations across almost their entire range (Kiabi et al. 2002; Ziaie 2008; Breitenmoser et al. 2010). North-eastern Iran is supposed to hold the highest density of the Endangered Persian leopard (IUCN 2008) with a number of well-known sites (e.g. Golestan, Sarigol, Tandureh, etc.) which one of the them, Sarigol National Park (SNP) hosted the first systematic research on the species in NE Iran.

Generally, the species is known to mainly prey on wild goat *Capra aegagrus*, wild sheep *Ovis orientalis* and wild boar *Sus scrofa* (Etemad 1985; Khorozyan & Malkhasyan 2003; Ziaie 2008) with high range overlap with that of the wild goat throughout Iran (Harrington 1977; Ziaie 2008). Urial wild sheep has been cited as the main prey of leopards in Kopet-Dag region (located in Iran-Turkmenistan borderland) (Heptner & Skudskii 1992), while bezoar goat, wild boar and roe deer *Capreolus capreolus* are considered as key prey species in southern Lesser Caucasian region (Khorozyan et al. 2008) together with tur *Capra cylindricornis* and red deer *Cervus elaphus* in Greater Caucasus (Lukarevsky et al. 2004).

Sarigol is composed of hilly terrains without rocky mountains where wild sheep lives as the main ungulate in the park (Bijani 1997). According to Bijani (1997), it was believed by the Iranian Department of the Environment that 23 Persian leopards exist in whole the former Sarigol protected area and due to high abundance of the species in the area. 3 hunting permissions were issued in 1994 which only one of them was successfully hunted, an adult male. Also, in 1997, a young leopard was killed by herders at western borders of the area (Fig.1).



Fig 1: An adult male trophy in 1994 (right; Photo: B. Zandyan) and a young leopard poached in 1997 (left; Photo: M. Bijani)

The Project Persian Leopard in Sarigol National Park has been initiated since March 2005 with support of the Iranian Department of the Environment (DOE) in order to provide a base of scientific knowledge about Persian leopard ecology and population status and to enhance the conservation status of the Persian leopard in SNP in north-eastern country. In 2006, the

project won an award from BP Conservation Program which enabled ICS to continue this project into 2007 with more focus on camera trapping efforts and public awareness campaign.

Although a number of research-based projects have recently been implemented, most of these have failed to publish their results nationally or internationally and their outcomes have rarely been translated into an improved conservation status of the animal in the area.

Northeastern Iran still holds some of the highest density populations of the Persian leopard, including SNP which is well known for its leopard population (Bijani 1997).

We report briefly the trends, achievements and outcomes of the first half-decade of the project. It is hoped that this multi-disciplinary conservation approach could be applied as a model for other Persian leopard habitats within the country as well as abroad.



Persian leopard in Sarigol (Photo courtesy of ICS)

### Project Site

With an area of more than 7037 ha, SNP is located some 20 km east of the city of Esfarayen, North Khorasan Province (Fig.2). It was part of Sarigol Protected Area, which was established in 1973, and was then separated and promoted to national park status in 2002 by the Iranian Department of Environment (DoE). The altitude range of 1400-2940 m, mean annual temperature of 14<sup>0</sup> C and annual precipitation of 273 mm give the region a temperate semi-arid climate (Darvishsefat 2006). The area is mainly composed of hilly terrain fading to high rolling mountains aligned in a north-south direction. Highest elevations can be found in north central parts of the park (Fig.3).

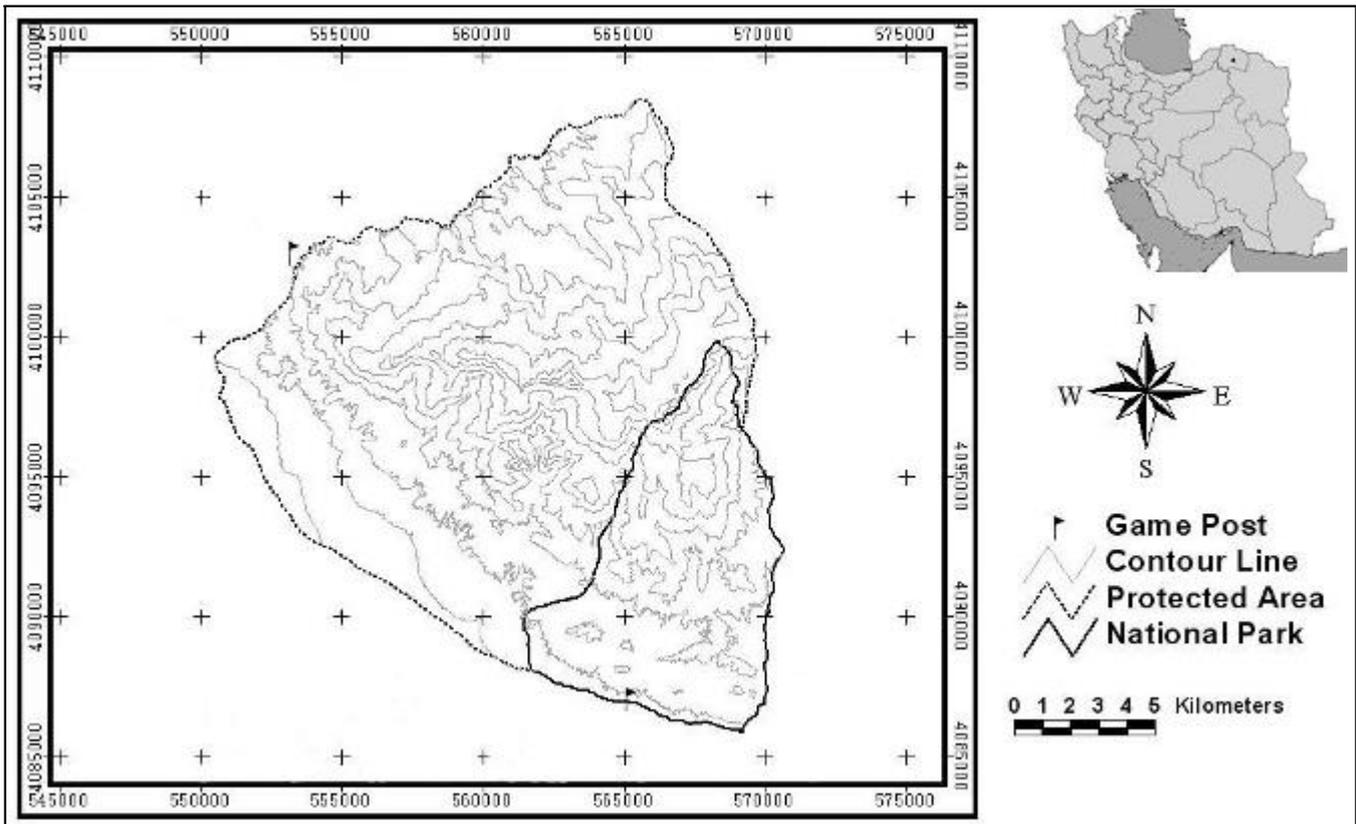


Fig 2: Map of the Sarigol NP & PA and its location in Iran.

The main ungulate inhabiting the area is the urial sheep *Ovis orientalis* together with a low density of wild boar *Sus scrofa* and occasional sightings of wild goat *Capra aegagrus* outside the SNP boundaries. Stone marten *Martes foina*, grey wolf *Canis lupus*, red fox *Vulpes vulpes*, manul *Otocolobus manul* and Asiatic wild cat *Felis sylvestris ornata*, as well as Persian leopard, are the main representatives of the order Carnivora confirmed in the area (Fig.4)



Fig 3: Various landscapes of the Sarigol National Park (Photos: M.Farhadinia)



(Fig 4 from left to right) First row: Afghan pika (© M.Farhadinia) and common fox (© ICS), second row: Asiatic wild cat and grey wolf (© ICS), third row: urial wild sheep (© M.Farhadinia) and wild boar (© ICS), fourth row: Persian leopard (© ICS).

## Project Members

The project was implemented by a group of 7 people from the ICS as below:

**Table 1: Details of project members**

<u>No</u>	<u>Member</u>	<u>Role</u>	<u>Age</u>	<u>Qualification</u>
1	Mohammad Farhadinia	Project Coordinator	31	MSc Environmental sciences
2	Alireza Mahdavi	Field coordinator	35	BSc Environmental sciences
3	Fatemeh Hosseini-Zavarei	Documentation & databases	30	MSc Environmental sciences
4	Kambiz Baradarani	Field biologist	27	BSc Natural Resources
5	Safura Zavarani	Conservation educator	27	BSc Environmental sciences
6	Morteza Eslami	Administrative affairs	29	BSc Environmental sciences
7	Asghar Hosseinzadeh	Field biologist	30	BSc Environmental sciences

## Aims and Objectives

The Project Persian Leopard in Sarigol National Park has been initiated in order to provide a base of scientific knowledge about Persian leopard ecology and population status and to enhance the conservation status of the Persian leopard in SNP in north-eastern country. In 2006, the project won an award from BP Conservation Program which enabled ICS to continue this project into 2007 with more focus on camera trapping efforts and public awareness campaign to pursue the following objectives:

1. Surveying throughout the park to identify the leopard and its relevant species present range and GIS mapping their distribution;
2. Determining the leopard diet as a basis for prey-availability investigation;
3. Surveying the leopard ranging and dispersal in the park which has a key role to re-consider the park boundaries;
4. Investigating the leopard population parameters using the camera trapping technique which enables the park's authorities to monitor the population;
5. Assessing the local people's attitude toward the leopard as the main predator in the area;
6. Increasing awareness in local community to reduce the possible human-leopard conflicts;
7. Defining a basic leopard conservation strategy to help to the leopard survival in Sarigol and similar habitats;
8. Preparing a scientific report to share the knowledge.

## Start of Project

The project was started by surveying on literature and unpublished reports (grey literature). Preliminary expeditions in 2005 helped to define the most appropriate and adaptive survey protocols to the local conditions, in which general parameters such as topography, soil (for tracking), fauna and flora were investigated. Reports and documents in Sarigol Office of Environment 1990 were reviewed and verified with game guards and experts to obtain a perception about the leopard status in the past.

After gathering the basic information about the area and species, local forces and local community, basic maps have been prepared based on topographic maps, satellite images and field GPS records. As a main tool in this project, the camera traps were used to capture the leopards and other species. Also, the knowledge learnt in BP training course in the UK (May 2006) was shared with other team members as well as the ICS volunteers (Fig.5).



Fig 5: One of the project staff meetings in ICS office, Tehran (Photo: ICS)

## Methods, Outputs and Results

The Project Persian Leopard in the SNP was planned composing of three functional aspects. In this section, methods, activities and their associated outputs are described in their relevant part.

### Step 1: Ecological Surveys

Basic ecological data are of great significance in developing conservation projects. Because of the scarcity of information on various aspects of Persian leopard ecology, collecting this data was emphasized as an important objective of the project.

Understanding the position of the SNP leopard population in relation to other Iranian leopard populations was essential, and this was studied through genetic and craniometric analysis (Farhadinia 2010). Moreover, the government has often considered SNP as one of the best reserves in which to release problem leopards captured in other habitats, so it was important to be aware of the genetic status of the SNP leopard population. Various ecological aspects of the leopards were studied as following:

#### *Leopard demography*

The area has a high density of Persian leopard which roam across trails and dried watercourses in search for prey, shelter, etc. Meanwhile, despite of intensive patrolling by the game guards, the leopards are rarely seen and it seems that they are mainly active during night-time.

We developed a database of pugmark size inside the National Park to identify different individuals on the basis of their pugmark size (maximum length and maximum width). However, due to high variability of pugmark sizes in different conditions, we found it a very inaccurate approach to estimate the leopard population size. Therefore, we tried to measure different linear variables and found the least variability in maximum *pad* width (Fig.6 and 7).



Fig 6: Measuring and recording leopard tracks (Photo: E.Moqanaki)



Fig 7: Sample leopard pugmarks in SNP (Photos M.Farhadinia & A.R.Mahdavi)

In order to monitor leopard population trends, camera trapping was used, a technique described by various authors (e.g. Karanth et al. 2004; Ghoddousi et al. 2010). In order to implement the procedure effectively, we followed the guidelines set out by Henschel and Ray (2003) and Sanderson (2004).

We carried out a reconnaissance survey for a period of 18 months (March 2005-October 2006) to identify optimal camera trap locations within the study area (Fig.8). The main trails and animal travel routes were searched regularly to define three types of camera trap locations based on presence of leopard scats and scrapes (excellent points), pugmarks (good points), and signs of other carnivores (week points). A total of 25 potential camera trap sites were found, which were then monitored opportunistically using camera traps to test if the sites were appropriate for maximizing leopard photo-captures, to examine the points' security against thieves, and to check battery life.



Fig 8: An adult male who was the first photo-trapped leopard in SNP during reconnaissance surveys which was later found to be poached in September 2005 (Photo courtesy of ICS/North Khorasan DoE)

During spring and summer, the area's adjacent elevations host flocks of livestock which made any camera trapping study unsecure against thieves. Therefore, we selected winter time when we were told by the game wardens that leopard's prey come inside the national park to avoid snowfall in higher surrounding elevations (the latter could cause higher density estimation as bias).

In winter seasons of 2006/2007 and 2007/2008, we carried out our capture-mark-recapture survey (Karanth & Nichols 1998) in a total of 12 selected sites (9 excellent, 2 good and 1 weak point) using one DeerCam camera (DC-200 model, Park Falls, WI) at each station so to capture only one flank of the leopard in each photograph. We placed cameras approximately 2-4 m apart across the trails or sign sites, generally faced north direction to avoid false trigger by the sun (Fig.9). We programmed the cameras with a 15-30 second delay, and each independent photograph/event was defined as following O'Brien et al. (2003). Using leopard rosette pattern as a unique identifier, we created photo-capture histories based on the time of individual capture, with each 10 days considered a unique trapping occasion. Program CAPTURE was used to estimate the abundance  $N$  based on model proposed by Otis et al. (1978).



Fig 9: Installing camera traps along the leopard trails in SNP (Photo: K.Baradarani)

Capture-recapture models were used to estimate the leopard population for each sampling season independently (Table 2). A total of 6 adult leopards were photo-trapped in the area (4 males, 1 female and 1 with unknown gender (seemingly an adult male)) which one male was poached in August 2006 (Fig.10). Also, we failed to confirm presence of cubs using camera traps, but our continuous tracking approved existence of one cub in 2005 and two cubs in 2007 within the national park. Also, 9 other species were photographed during two seasons in SNP (Table 3).

During both years, we used only right flank captures of the leopard as we had more captures. During the first capture season (winter 2006/2007), 21 images of leopards in 18 captures corresponding to one adult male, one adult female and one individual of non-identified gender (assuming to be an adult male due to his large and thick body features; Balme et al. 2012) were obtained (13 right vs. 4 left captures) whereas one was left excluded from analysis due to its low quality. In the second capture season (winter 2007/2008), 14 images in 14 captures corresponding to one adult female and three adult males were obtained (8 right vs. 6 left captures). Three males captured by their right flank, while there was an adult female on her left flank. Therefore, we included the female in the capture history to sum up with 4 identified individuals.

With Z-value of 1.464 (P=0.93) and 1.594 (P= 0.94) for two consecutive sampling winters, the population was considered statistically closed for both years. Program CAPTURE proposed  $M_{tbh}$  (1.00) and  $M_0$  (0.97) followed by model  $M_h$  incorporating individual heterogeneity in capture probabilities (score 0.90) whose population estimator is known to be robust and more biological meaningful for solitary felids in comparison with  $M_0$ , (Karanth & Nichols 1998, Karanth et al. 2004). We believe that model  $M_h$ , where each leopard has a different capture probability that do not vary of time, most accurately reflects leopard spatial behavior. This model was the model of choice in other leopard camera-trapping studies (e.g. Balme et al. 2009, Chapman & Balme 2010, Ghoddousi et al. 2010). Based on model  $M_h$ , population estimate is 4 (SE=1.36) leopards, with the 95% confidence interval 4-10 individuals (table 1). Program CAPTURE computed average capture probability ( $\hat{p}$ ) for this model as 0.28.

In 2007-2008, the maximum value for model selection was obtained by the null model  $M_0$  (1.00) and  $M_h$ (0.82) which the latter was selected. Average  $\hat{p}$  was calculated as 0.20 and the interpolated jackknife population estimate was 5 (SE=1.36) with a 5-11 leopards 95% confidence interval (Table x).

Table 2: Results from camera trapping of leopards conducted in two consecutive winters of 2006/2007 and 2007/2008 in Sarigol National Park.

	<u>Winter 2006/2007</u>	<u>Winter 2007/2008</u>
No. of trap stations	16	12
No. of trap nights	770	530
No. of wildlife images	113	103
No. independent wildlife captures	87	86
No. of leopard photographs	21	14
No. independent leopard captures	18	14
No. leopard photos/100 trap nights	0.02	0.03
No. of different leopards (male, female, unknown sex)	3 (1/1/1)	4 (3/1)

Abundance N ( $\pm$ SE)	4 ( $\pm$ 1.36)	5 ( $\pm$ 1.36)
Model (score)	M <sub>h</sub> (0.90)	M <sub>h</sub> (0.82)
P-hat	0.28	0.20

Table 3: Brief results of camera trapping surveys in two consecutive winters of 2006/2007 and 2007/2008 in Sarigol National Park.

Species	Winter 2006/2007		Winter 2007/2008	
	No. of photographs	No. independent captures	No. of photographs	No. independent captures
Persian Leopard	20	23	14	14
Wild Cat	13	19	3	3
Wolf	3	3	0	0
Dog	1	1	1	1
Fox	23	24	31	35
Stone Marten	0	0	1	1
Urrial	21	36	23	35
Wild Boar	3	4	8	8
Chukar	3	3	4	4
Viper	0	0	1	2
<b>Total</b>	<b>87</b>	<b>113</b>	<b>86</b>	<b>103</b>

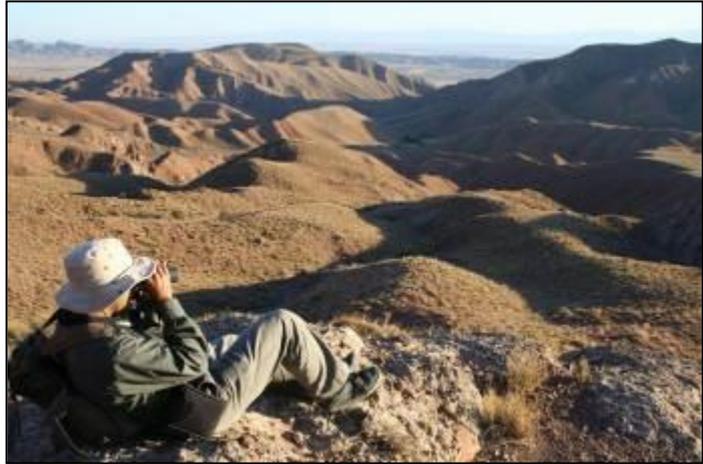


Fig 10: Several images of the leopards in SNP (Photos courtesy of ICS)

### Ungulate density and biomass

As the main ungulate in SNP, Beside DoE's annual censuses, ungulate surveys were conducted across SNP in order to estimate ungulate abundance using distance sampling method described by Buckland et al (2001). As the encounter rate with wild goats and wild pigs were extremely low (see Results), and this might not be linearly related to their densities (Buckland et al. 2004), we

Designed and analysed our distance sampling survey for only urials. As a result, during urial's rutting season in fall 2007, when they are the most active, four transects varying in length between 3 and 10 km were laid in the study area to cover various parts of the park. The total transect length of 24 km was monitored four times by teams of at least two experienced people between 06.00 and 11.00 resulting in ca. 95 km. During a given



transect all urial sightings including time, location, sex/age structure (using 12x42 binoculars), distance to the group (visually estimated), and angle to the transect line (with a compass) were recorded, so as to compute the perpendicular distance for each observation and through the fitting of a detection function to the distance data, thus an estimate of density can be made (Buckland et al. 2001). Data were analysed using the software DISTANCE (version 5, release 2; Laake et al. 2006) after truncation and grouping, as recommended in Buckland et al. (2001).

Accordingly, detection probability was 7.1 with ESW of 255.4 meter. The estimated density of urials was calculated ( $\pm$ SE) as  $15.78 \pm 6.20$  (CI 95% 7.36 -33.82) individuals/km<sup>2</sup>. The population size was estimated to be 1111.0 ( $\pm$ SE 436.7) (CI 95% 519.0 -2381.0). Together with minimum numbers of wild pig and Persian ibex, a total biomass of 47,696.4 kg for wild ungulates in the national park was estimated (Table 4).

**Table 4. Total ungulates biomass (kg), categorized by age and sex class in Sarigol (70.4 km<sup>2</sup>)**

	<u>Total count</u> <u>(Percentage)</u>	<u>Average live</u> <u>body weight (kg)</u>	<u>Biomass (kg)</u>
Total Urial population	1,111		
Adult ram (>4 years)	144 (7.6)	57.5	8,496.4
Young ram (1< ≤4 years)	89 (13.3)	49	4,137.4
Ewe	767 (69.3)	39	30,027.0
Lamb	111 (9.8)	15	1,633.2
<u>Total Urial</u>			<u>44,293.9</u>
<u>Total wild goat population</u>	<u>25</u>	<u>36*</u>	<u>900</u>
<u>Total wild boar population</u>	<u>35</u>	<u>71.5**</u>	<u>2502.5</u>
Total biomass			47,696.4

\*Wild goat weight has been calculated based on available literature (Valdez 1976) and various weight measurements of different age/sex groups.

\*\*Mean body mass was obtained from 41 adult samples of both sexes in Golestan National Park ( $x=95.3$ , Goshtasb 2002) multiplied by  $\frac{3}{4}$  (following Schaller 1972) to account for sub-adults and young which are preferentially selected by leopards for biomass calculation.



Fig 11: A herd of urial rams in SNP (Photo: M.Farhadinia)



Fig 12: An adult wild boar in SNP (Photo: M.Farhadinia)

### *Feeding ecology and livestock depredation*

During April 2005 to March 2007, scats were collected primarily along the four main valleys of different habitat types in SNP to assure that the sampling area can be considered representative for the park. Leopard scats were identified based on their characteristic shape (cat-like segmentation and pointed ends) and size (range: 2.0->3.0 cm) (Johnson et al.

1993). We collected almost all the samples at leopard scrapes as olfactory and visual markers along home range boundaries (Sunquist & Sunquist 2002) to minimize the chance of misidentification with those of sympatric large carnivores.

Samples were washed in running water through a fine-mesh sieve to remove surface oil and to separate the hair from other undigested organic matter. Afterward, all remains were air-dried for further analyses. To create slides for mammalian species identification, hairs were selected randomly from each sample (20 hairs/sample), centred parallel on the slide, and mounted with cover slip using DPX mount. Statistical quantification was followed after Ackerman et al. (1984) (Fig.13).



Fig 13: Scat collection and analysis process (Photos: M. Farhadinia)

During the survey period, a total of 129 leopard scats were gathered (Table 5). The scats contained 151 different food items, yielding an average of 1.17 prey items per scat for the entire survey period. Only 2% of prey items could not be identified, and birds and rodents were merely identified to taxon level. The remainder of prey items was identified to species level.

Leopard scats contained 12 different species (assuming that all bird and rodent remains belonged to single species), and diet was dominated by medium-sized ungulates during the survey period (Table 4). Eighty eight percent of leopard scats contained single prey species and 12% contained two prey species. No scat had remains of more than two prey species.

Excluding non-food items and non-nutritive plant materials, 56.3% of total food items were medium-sized mammals. A highly significant difference was seen among medium-sized food items ( $\chi^2=141.00$ ,  $df=3$ ,  $p<0.001$ ). 76.5% of medium-sized mammals comprised wild ungulates (Table 4), while the rest represented domestic ungulates (i.e. sheep and goat) ( $\chi^2=64.45$ ,  $df=1$ ,  $p<0.001$ ). Worthy to mention that urial wild sheep as the dominant ungulate in SNP scored the highest frequency of occurrence FO in entire survey period as 48%. Leopard hair was identified twice in scats, presumably due to hair ingestion while grooming.

In terms of relative biomass consumed, urial was the single most important prey species for leopards in the study area, making up 47.2% of the total biomass consumed (Table 4). Domestic animals comprised 17.6% of biomass consumed, followed by wild pig (10.0%).

The most important prey taxa for leopards in SNP are wild ungulates, making up 58.6% of the biomass consumed (Table 5). Afghan Pika was also important with proportion of consumed biomass of almost 20.8%; however, this prey item was mainly used during 2005. Conversely, in terms of the numbers of prey consumed, leopards consumed more Afghan Pika, followed by urial and livestock (Table 4).

Table 5: Frequency of food items of the leopard based on scat analysis in SNP, 2005-2006.

Food Item	Total			Assumed weight of prey (kg)	% biomass consumed	No. of individuals eaten
	N	FO (%)	PO (%)			
<b>Large-sized food items</b>						
Domestic horse	2	1	1			
<b>Medium-sized food items</b>						
Wild sheep	90	48	36	34	47.16	0.031
Wild goat	5	3	2	36	1.45	0.001
Wild boar	22	12	9	71.5	10.00	0.003
Livestock	25	13	10	35	17.64	0.011
<b>Small-sized food items</b>						
Common fox	11	6	4	5	2.24	0.010
Hare	2	1	1	3	0.31	0.002
Afghan pika	39	21	15	0.5	20.80	0.940
Porcupine	5	3	2	18	0.39	0.000
Rodents	9	5	4			
Birds	8	4	3			
Reptiles	1	1	0			
Unknown	6	0.03	0.02			
<b>Non-food items</b>						
Stone	9					
Plant material						
<b>No. of food items</b>	15					
	1					
<b>No. of scats</b>	12					
	9					
<b>No. of food items/scat</b>	1.1					
	7					

In order to obtain information on sex and age-class of prey at a finer level, leopard kills were sought while searching the trails for the leopard's scats. Accordingly, remote areas far from the trails were searched as the leopards used to hide their kills far from the trails among trees or inside valleys. Meanwhile, the kill samples were biased toward larger preys. In addition to the species of prey killed, sex and age were also recorded (Fig.14).



Fig 14: Assessing leopard kills (Photos: M.Farhadinia)

A total of 65 kills made by the leopards were found indicating 6 different species eaten by the leopards in Sarigol which urial wild sheep formed main bulk of the kills (89.3%,  $n=59$ ) ( $\chi^2=198.84$ ,  $df=4$ ,  $p=0.000$ ), followed by the wild boar as the second species found (4.5%,  $n=3$ ) (Table 5).

Among urials, adults composed the main proportion of the kills comparing to lambs ( $\chi^2=38.72$ ,  $df=1$ ,  $p=0.000$ ), significantly skewed toward urial rams ( $\chi^2=13.29$ ,  $df=1$ ,  $p=0.000$ ) (Table 6). We were able to age 34 of rams killed in Sarigol aged which showed significant difference between age categories ( $\chi^2=15.88$ ,  $df=7$ ,  $p=0.026$ ) (Fig.16).

Positive selection of leopards of rams could be related to behavioural differences among urial's sexes. Rams seem less vigilant particularly during rutting season and their heavy horns make them less agile compared to ewes. Also, males normally live in smaller groups compared to females and lambs (Schaller & Kang 2008) and group size is supposed to be conversely associated with predator avoidance (Ruckstuhl & Festa-Bianchet, 2001) when comparing the two sexes of each species. Hence, more gregarious ewes and lambs seem less vulnerable to predation. Also, it is in accordance that adult rams (>3-4 years) when they leave maternal groups become more susceptible to predation by the leopards.



Fig 15: Wolf remains found to be dragged by the leopard in SNP (Photos: A.Hosseinzadeh)

Table 6: Leopards kills found in SNP April 2005 to March 2007

Species	Kill abundance
Urrial wild sheep	59
Wild goat	1
Wild boar	3
Horse	1
Dog	1
Total	65

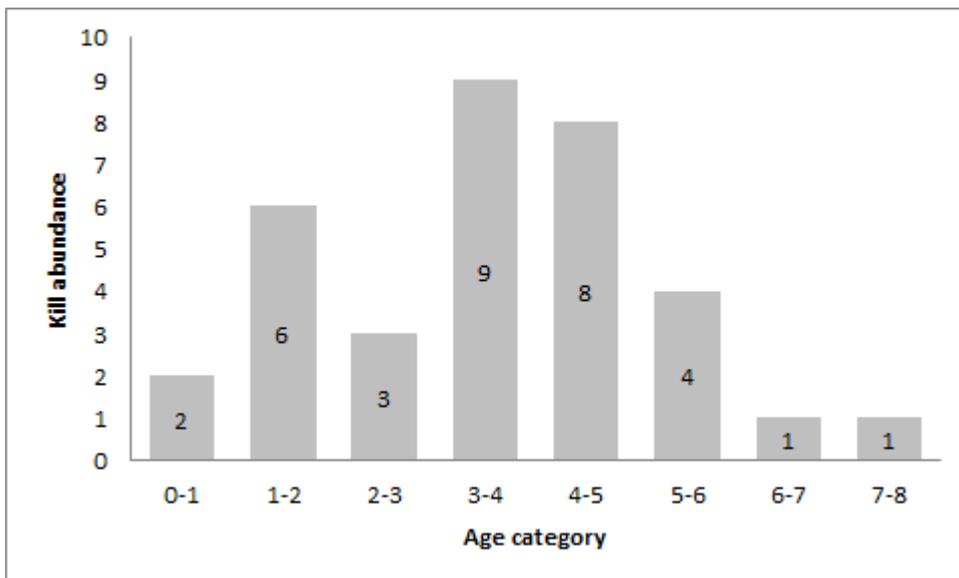


Fig 16: Characteristics of aged rams killed by the leopards in Sarigol (n=34)

Also, interview surveys were opportunistically conducted whenever any herder was encountered in the field to gather more data about leopard observation as well as any possible livestock depredation as in indication of human-leopard conflict. However, our limited interview surveys with local nomads indicated no significant conflict with the leopards.



### Reproduction

Beside other ecological topics studied in SNP, invaluable data were gathered about reproductive ecology of the Persian leopard in the area. Our limited data indicate that the mating season of the Persian leopard in the Sarigol National Park is from mid-January to a peak in mid-February, which is similar to general belief that the Persian leopards' mating season peaks in mid-winter (Sunquist 1991, Ziaie 1996, Khorozyan & Malkhasyan 2005).



Fig 17: A rare image of a pair of adult leopards during mating season in Sarigol (Photos courtesy of ICS)

However, we are not sure if the mating season extends beyond this period. Males and females associate briefly during mating periods which may last for two to seven days (Guggisberg 1975, Hamilton 1976, Bailey 1993) and just after the short mating period, they separate.



Fig 18: An adult male leopard spaying urine on a *Berberis* tree and sniffing for several nights during mating season (Photos courtesy of ICS)

After a gestation period of 96 days (ranging from 90 to 106 days), the animal gives birth (Sunquist & Sunquist 2002), which is supposed to be in late April/May in the Sarigol National Park. In Central Alborz Protected Area (northern Iran), a local guide reported seeing a female with 2 newborn cubs in late April 2004.

During the survey period, we identified a total of four families across the national park (Table 7). Moreover, we verified 3 more reports of leopard families prior to our research. No females with more than two cubs have ever been recorded in Sarigol. As a result of similar surveys in Central Alborz Protected Area, a total of four sightings of different leopard families were verified each time with 2 cubs, based on camera trap results as well as interviews with local people. Persian Leopards in the Sarigol National Park normally have 1-2 cubs. While larger litter sizes have been reported for leopards elsewhere (e.g. three: Sunquist & Sunquist 2002, four: Eaton 1977), it seems that the Persian Leopard is not likely to raise more than 2 cubs in our study area.

**Table 7: Number of Persian Leopard cubs in Sarigol National Park**

No. of cubs in family	Abundance		
	Juvenile (<1 year)	Adolescent (1 year till independence)	Total
1	1	2	3
2	3	1	4

Tracks of leopard families were usually found within the home range of particular males, based on track measurements. Meanwhile, direct observation of leopards accompanied by cub(s) was a small proportion of total number of observations made by game guards/local people (less than 7%), but it made up a higher percentage of the total individual tracks (17%) we found during the survey period. It seems that mothers with small cubs are extremely vigilant and avoid humans, and are maybe more active during night time.

Most female leopards with cub(s) were regularly found in areas of high prey density; we never found any sign/report of leopard cub presence in marginal habitats as well as the Protected Area where prey base has depleted significantly. Meanwhile, leopard cubs have never been encountered during spring and early summer, which coincides with the likely early maternal period when the cubs are inside dens in more safe areas. Several studies conducted in Africa have found that female leopards tend to configure their home ranges around important resources, such as patches of prey-rich habitat, den sites and possibly water-points (Bailey 2003, Mizutani & Jewell 1998) and male ranges typically encompass those of several females (Stander et al. 1997, Bailey 1993, Marker & Dickman 2005).

In November 2004, an adult leopard accompanied by 2 full grown cubs was seen a few times by game guards in central national park. On 29 October 2005, two sub-adult leopards were sighted at the same area from a close distance by game guards, who reported that one was larger, probably a sub-adult male. It is supposed that the pair was recently independent offspring, which still roam inside the maternal home range together; however, after at least 10 months of independence, they were never again sighted together. Our small sample is in agreement with Skinner & Smithers (1990) that siblings may remain together for several months before separating. Bailey (1993) found that sub-adult females stayed in their natal ranges but made exploratory movements elsewhere, whereas sub-adult males had unstable home ranges and explored over vast areas. In Namibia, two male cubs remained close to their mothers' home range for approximately 8 and 6 months before dispersing from maternal range (Stander et al. 1997).

## Step 2: Local Empowerment and Participation

SNP is surrounded by around 20 villages and the city of Esfarayen. As the first stage, it was considered essential to prepare a baseline composed of socio-economic data on the circumstances of local communities. The baseline was later used to identify the most relevant targets and stakeholders and their needs.

Also, research was carried out in the area and nearby cities to identify NGOs that could be involved in data gathering and so make public awareness efforts more effective. Their capacity for partnership in a local participatory approach was evaluated according to their previous activities, organizational structures and interests.

Negotiations were held with local government authorities and important companies to illustrate the project objectives. After setting the objectives and analysis of stakeholders, given the constraints of time and budget, education in schools inside the national park marginal villages was expected to have the highest interaction with the reserve was given the first priority. Such a high ranking was given based on the village distance to the park as well as number of poachers and herders living inside them. An educational plan was developed and more funds have been raised from a few local governmental organizations GOs for educational phase and the operational phase was initiated inside 9 villages with more than totally 800 junior students (Table 8).

As a result, a local NGO, the Forough Women's Society of Esfarayen who are devoted on cultural & educational affairs, mainly on women was recognized as eligible to participate in the project. Their volunteers received training related to the leopard by conservation educators from the Iranian Cheetah Society (ICS) and game guards and they had a chance to visit the area to gain more practical knowledge (Fig.19).



Fig 19: Training of local NGO's volunteers (Photo: M. Farhadinia)

Finally, a Coordination Core Group (Fig.20) was formed composed of representatives of the Iranian Cheetah Society (ICS), Esfarayen Office of Environment and the local NGO to design and implement educational activities to design and implement educational activities.



Fig 20: Local Coordination Core Group (Photo: ICS)



Fig 21: Meeting other governmental authorities to attract their attention and support for community works (Photo: A.Hosseinzadeh)

The Group developed lesson planned and designed two educational manuals for local students, specifically for primary and high schools (available at [www.wildlife.ir](http://www.wildlife.ir)) (Fig.22). The manuals were designed based on local circumstances of Sarigol National Park where has been one of the main sits of leopard research and educational programs by the Iranian

Cheetah Society (ICS). The readers will learn various aspects of the Persian leopard through games, puzzles, stories, etc. Also, a number of educational materials were designed for dissemination among local people.

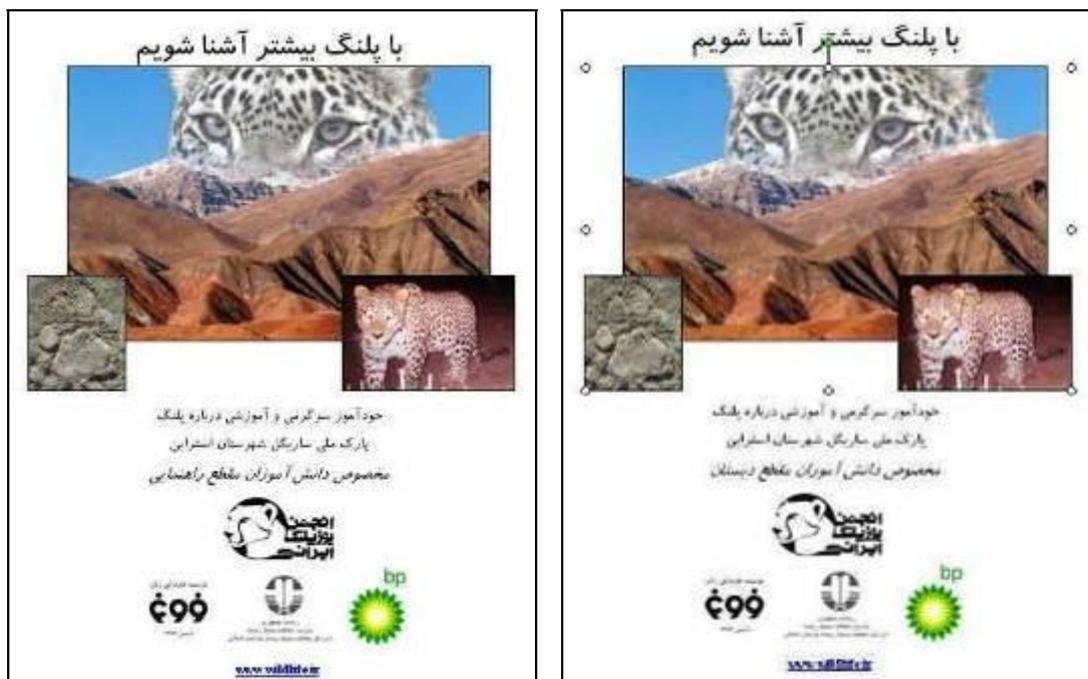


Fig 22: Covers of Persian leopard educational manual designed for local people in the Sarigol National Park for primary (right) and junior high school students (left)

According to local inquiries, livestock depredation by leopards is not significant in SNP, but it is more common outside the park. This conclusion was also confirmed by scat analysis. Accordingly, a prey-poaching problem was identified as having the highest priority for public awareness efforts which was mainly originated from marginal villages. Therefore, nine villages were selected for educational activities in the first phase and totally around 800 school kids were educated.

Public meetings and workshops were held in local communities to discuss the leopard, mainly in schools and in accordance with Ministry of Education. We found a combination of educational procedures was highly useful (e.g., events, games, leopard theatre, etc.). Particular attention was paid to highlighting the role of game guards in protecting SNP and the leopards.

Also, a number of art and cultural events were organized for people living in the city of Esfarayen in close partnership with the city Governor's Office as well as the Municipality.



Fig 23: Various educational and outreach programs for local villagers around SNP  
(Photos M.Farhadinia & F.Hosseini-Zavarei)



Fig 24: Group photos within different villages (Photos M.Farhadinia & F.Hosseini-Zavarei)

Table 8: Summary of educational activities within marginal villages of Sarigol National Park

No.	Village	Position to SNP	Where outreach programs implemented	
			Primary School	Junior High School
1	Nasr Abad	South	*	*
2	Hesari	South	*	
3	Dahaneh Ojagh	South	*	*
4	Izi	South	*	
5	Ordoghan	North	*	*
6	Ghahreman Abad	South	*	
7	Fartan	West	*	*
8	Parkanlou	North	*	
9	Noushirvan	West	*	

### Step 3: Law Enforcement



This is normally a government task carried out by the Iranian DoE through enhancing the conservation status of habitats and establishing conservation units inside the reserves.

Our surveys revealed that the leopards mainly prey on urial sheep, especially males, in SNP. The DoE used to issue legal permits to hunters, so our data was presented to the decision-makers to reconsider the

question of hunting permits as these are only issued for adult rams. However, low number of hunting permissions is still issued for the protected area as well as free areas around the SNP.

The North Khorasan DoE is trying to increase protection facilities in the area, and special attention has been paid towards Sarigol Protected Area which is the most important buffer zone adjoining the national park.

It is recommended the game guards be trained in regular workshops, where they can discuss findings and get mutual feedback in order to increase their knowledge about the species.



Fig 25: SNP's game warden s d u r i n g t h e i r d a i l y a n t i - p o a c h i n g p a t r o l s

### **Achievements and Impacts**

The Sarigol Leopard Project has been a mid-term effort for conservation of the endangered leopard in one of the species's hotspots in the northeast of the country. Undoubtedly, the final success of this project will best be judged on the basis of its conservation achievements in securing the long-term future of the leopard in the area.

Since 2006, when an adult male was killed by local people, no leopard has been reported to be poached within the national park. Previously, urial, the main prey of the leopard, were more concentrated around the central game post, mainly because of active poaching throughout SNP, but, as a result of significant anti-poaching activities in recent years coordinated and managed by North Khorasan Department of Environment, they are now more widespread across SNP, which increases prey availability for the leopards. The number of game posts has been increased from two to four (one temporary seasonal post in high elevations) within the national park and the protected area, and the DoE plans to establish a visitor centre and museum to educate local people and visitors.

Also, the project has had a significant role in enhancing our knowledge of the Persian leopard's ecology and population trends in Iran. Moreover, a few university theses have been conducted within the area at graduate/postgraduate levels. The DoE has approved compilation of Sarigol Mass Plan into which the results of Project Persian Leopard in the SNP can be integrated.

Relevant knowledge were shared with local people around SNP in order to make them more familiar with the leopard. Also, the DoE has produced a documentary movie about SNP to be broadcast on national TV and disseminated among local people. Meanwhile, the ICS has initiated a new film focused on the Persian leopard. The local NGO that was empowered during this project tried to continue with its plans to concentrate on other environmental issues and is trying to establish itself with local objectives and funding. Also, the area has been advertised in the Iranian mass media several times with the aim of drawing the attention of national and local authorities to supporting conservation.

So far, two papers have been published and the third is in preparation as:

1. Reproductive ecology of Persian leopard in Sarigol National Park, *Zoology in the Middle East*, 48 (2009):13-16.
2. Conservation model for the Persian leopard: Lessons learned from Sarigol National Park, northeastern Iran. *IUCN Cat News*, 53 (2010):36-38.
3. Predator-Prey Relationships in a Middle Asian Montane Steppe: Persian Leopard versus Urial Wild Sheep in Northeastern Iran

## Conclusion

The present project was the first effort in Iran within a single area in which a multi-functional approach was applied to conserve the Persian leopard. Accordingly, the project provided a model for other conservation programs in the country to apply such a comprehensive agenda.

The leopard density in SNP is much higher than other known mountainous habitats in Asia, such as Iran, Oman, Russian Far East, Armenia, and Bhutan. However, since our study area is quite small which hardly encompass home range of several identified leopards; it is likely that our density estimation based on capture method has been overestimated. Our project illustrated the leopard's feeding habits for the first time in Iran, revealing predation of at least 13 different prey taxa. Meanwhile, urial wild sheep was the most frequently taken prey, followed by livestock. Wild pigs and wild goat were rarely used, which is in accordance with their abundance. Meanwhile, we concluded that frequency of livestock depredation by leopards is not remarkable in SNP. Our opportunistic inquiries with local people and nomads also supported it since no local efforts to eradicate leopards due to conflict occurred during the past decade.

Our research provided the first comprehensive insight into various aspects of ecology of the Persian leopards in northeastern Iran. Our research findings can provide reliable understanding about the status of the endangered Persian leopard within the SNP and can be a pilot for further studies about the population status and structure of the species in similar mountainous habitats in Iran.



Fig 26: Leopard range in Sarigol and surrounding areas (Photo: M.Farhadinia)

### **Problems Encountered and Lessons Learnt**

The educational component of the project was a good case of how involvement of local partners since start of the project can be helpful to facilitate the process. Community programs were developed and implemented well, thanks to our local Coordination Group and also, our local NGO partner which we trained them to be part of the project.

Different research programs were also successful and we think that regular monthly visits to the SNP, well-established research protocols and continuous M&E were helpful. However, similar projects should assign a dedicated person for maintaining research databases in order to be useful across the time.

During the project, since management of local governmental offices involving in the project changed, we had to re-store permissions and relationships which created some delays in the project. However, it was solved based on proper project presentation.

Another problem was stealing of camera traps by poachers and thieves, so it imposed a financial problem for the project. We almost lost 10 units of camera traps during the project which made us remove the cameras from some important places and affected our sampling design.

Long distance of the project site to Tehran (our base) was an obstacle because had to drive some 12 hours every months which affected adversely, our function during hiking and climbing in this mountainous landscapes.

We believe that methodologies we applied during this project were on a good level comparing to many other similar projects across the world. We tried to use various methodologies like tracking, scat analysis, kill monitoring, camera trapping and distance methods so we can obtain the highest amount of data during our field efforts. However, we have to emphasize on combination of these methods which provide added value to overall results of the project, enabling us to answer a combination of questions and objectives. Our community outreach programs were also properly designed and managed, particularly its participatory approach was effective during implementation. Meanwhile, if we could integrate more eco-tourism component, we could secure its sustainability better.

### **In the Future**

We recommend that in order to ensure the leopard long-term survival in north-eastern Iran, it is critical to enforce protective measures against the two major threats, poaching and non-evaluated development plans which cause habitat fragmentation. However, due to increasing human population, it is very difficult to find human-free areas between leopard nuclei to establish new fully protected areas as migration corridors. Therefore, to ensure corridors and buffer zones, the most urgent and achievable solution is perhaps to designate “No Hunting Areas”, where the main objective is to empower anti-poaching measures, unlike national parks and fully protected areas, where development and land use should be omitted or controlled, respectively. These areas might be sink populations – compared to the source population in the national parks – but would play an important role as buffers and corridors and hence allow saving the regional Persian leopard population under a meta-population framework. *Accordingly, it is essential that ranging pattern and dispersal routes of the leopards would be explored in the region which should be done through equipping several individuals with radio collars and monitoring them to identify their routes.*

### Project Visitors

Beside the main investigators, more than 10 people from the Iranian Cheetah Society (ICS) collaborated in field trips throughout this project. Actually, it was an invaluable opportunity for university students willing to do a short field exercise as a capacity building program.



Also, Dr George B. Schaller from the New York-based Wildlife Conservation Society (WCS) had a short visit from the National Park in May 2006 (photo below right) and Jose Garcia (photo below left) from Barcelona Zoo accompanied the project investigators during one field visit in September 2006.



In February 2010, the ICS renowned film crew, Fathollah Amiri also visited the SNP to assess feasibility of producing a movie about the areas with emphasis on the leopards. He was lucky to hear leopard roaring from a short distance. Now, after getting high cinema prize for the “In Search for Persian Leopard” in 2012, we are thinking about a leopard movie in northeastern Iran.



## Appendix 1: Full account of income and expenditure

The project was implemented based on CLP fund as well as additional funds received in cash or kind from Iranian Department of Environment (DoE), Esfarayen Governor Office and North Khorasan Provincial Office of DoE.

Itemized expenses	Other Sources (USD)	CLP (USD)	Total (USD)
<b>PHASE I - PROJECT PREPARATION</b>			
<b>Administration</b>			
Maps (satellite, topographic, digital inc. GIS)	0.00	0.00	0.00
Sony laptop plus GIS software	0.00	0.00	0.00
<b>Reconnaissance</b>			
Food in field	500	400.00	900.00
Stipend for field biologists	380	810.00	1,190.00
Stipend for outreach experts	450	348.00	798.00
Local guide	150	280.00	430.00
Medical insurance	250.00	840.00	1,090.00
<b>Equipment</b>			
Deercam camera traps	0	2,000.00	2,000.00
Custom and shipment	0	1,060.00	1,060.00
Nikon Monarch binocular	0	990.00	990.00
Garmin GPS	250	250.00	500.00
Tent	0	130.00	130.00
Sleeping bags	0	105.00	105.00
Backpacks	0	120.00	120.00
Sampling materials	0	140.00	140.00
Sherman traps	0	0.00	0.00
Photographic equipment (AA Alkline)	350	200.00	550.00
Photographic equipment (films)	120	180.00	300.00
Photographic equipment (9 volts batteries)	80	400.00	480.00
<b>PHASE II - IMPLEMENTATION EXPENSES</b>			
<b>Administration</b>			
Fieldwork in towns expenses (telephone calls, internet, public transport)	180.00	250.00	430.00
Project documentation, photography and data storage	50.00	300.00	350.00
<b>Transportation</b>			
Travel from Esfarayen to Sarigol	150	150.00	300.00
<b>Workshops</b>			
Holding educational workshops for local people	150	1,560.00	1,710.00
Educational materials	680	0.00	680.00
Educational awards	0	300.00	300.00
<b>PHASE III - POST-PROJECT EXPENSES</b>			
<b>Total</b>	<b>4,355.00</b>	<b>11,773.00</b>	<b>16,128.00</b>

original contribution

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## Conservation model for the Persian leopard

Lessons learned from Sarigol National Park, northeastern Iran

The endangered Persian leopard *Panthera pardus asiaticus* has recently attracted numerous research efforts in Iran; however, it is highly important that research projects support and improve the conservation status of the cat's habitats. Established in 2005, the Project Persian Leopard in Sarigol National Park is the oldest, but still ongoing, effort in Iran to save the species. It is composed of three main strands which aim to promote conservation of the area. Ecological research was mainly conducted within the national park to explore population parameters, food habits, reproduction, and prey demographics. At the same time, research was carried out in local communities, a partnership was formed with local stakeholders and educational programs were implemented. Finally, the project results were reported to the Department of Environment for consideration in formulating protection measures.

The Persian leopard once had a wide distribution in western Asia, from the Caucasus through Iran to Afghanistan, Pakistan and Turkmenistan (Newell & Jackson 1988). However, it is 'guaranteed' that 571 to 1200 animals are at present left within its former range (Chorramy et al. 2005). The range of the leopard is still believed to include large areas of Iran, and it was 'guaranteed' that there were 550-650 specimens in the country (Klats et al. 2003). Accordingly, it seems that more than two thirds of the wild population of Persian leopards occurs in Iran.

As an endangered subspecies (IUCN 2008), the Persian leopard was formerly abundant across most mountain and forest habitats of Iran, but it is now decreasing in most of its

ranges, mainly because of poaching, conflict with local people and loss of habitat (Klats et al. 2002, Farhadina et al. 2008a).

Although a number of research-based projects have recently been implemented, most of these have failed to publish their results nationally or internationally and their outcomes have rarely been translated into an improved conservation status of the animal in the area.

Northeastern Iran still holds some of the highest density populations of the Persian leopard, including Sarigol National Park (SNP) which is well known for its leopard population (Sijon 1987). As the oldest continuing leopard project in Iran, Project Persian Leopard in SNP was initiated in 2005, its aims being to

obtain a base of scientific knowledge about Persian leopard ecology and population status and to enhance the conservation status of the Persian leopard in SNP.

We report briefly the trends, achievements and outcomes of the first half-decade of the project. It is hoped that this multi-disciplinary conservation approach could be applied as a model for other Persian leopard habitats within the country as well as abroad.

### Project Site

With an area of more than 7,237 ha, SNP is located some 20 km east of the city of Zanjan, North Khorasan Province. It was part of Sarigol Protected Area, which was established in 1971, and was then separated and promoted to national park status in 2002 by the Iranian Department of Environment (DoE). The altitude range of 1,400-2,940 m, mean annual temperature of 14° C and annual precipitation of 272 mm give the region a temperate semi-arid climate (Farhadina 2008).

The area is mainly composed of hilly terrain leading to high rolling mountains aligned in a north-south direction. Highest elevations can be found in north central parts of the park (Fig 1).

The main ungulates inhabiting the area is the Urial sheep *Ovis orientalis* together with a low density of wild boar. Six animals and occasional sightings of wild goat *Capra aegagrus* outside the SNP boundaries. Snow marten *Martes foina*, grey wolf *Canis lupus*, red fox *Vulpes vulpes*, marmot (*Marmota marmota*) and Asiatic wild cat *Felis silvestris asiatica*, as well as Persian leopard, are the main representatives of the order Carnivora confirmed in the area.

### Steps to Conservation

The Project Persian Leopard in the SNP was planned as a multi-disciplinary conservation project with three functional aspects:

#### Step 1: Ecological Surveys

Basic ecological data are of great significance in developing conservation projects. Because of the scarcity of information on various aspects of Persian leopard ecology, collecting this data was emphasized as an important objective of the project.

Understanding the position of the SNP leopard population in relation to other Iranian leopard populations was essential, and this was studied through genetic and taxonomic analysis (Farhadina 2010). Moreover, the government has often considered SNP as one

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Fig. 1. Landscape of Sarigol National Park (Photo: M. Farhadina)



## Reproductive ecology of Persian leopard, *Panthera pardus saxicolor*, in Sarigol National Park, northeastern Iran

Mohammad S. Farhadinia, Alireza Mahdavi, Fatemeh Hosseini-Zavarei

**Abstract.** According to our surveys carried out between April 2005 and March 2008 in the Sarigol National Park, northeastern Iran, the mating season of the Persian Leopard *Panthera pardus saxicolor* extends from mid-January to a peak in mid-February. Males and females associate briefly and just after the short mating period, they separate. We never found the leopards to raise more than two cubs. Most observations of leopard families were made in areas of high prey density. Our data verified by camera trapping indicate that track size alone is not reliable for the accurate identification of leopard age/sex categories.

**Key words.** Persian Leopard; *Panthera pardus saxicolor*, reproduction, Sarigol, Iran, Middle East.

### Introduction

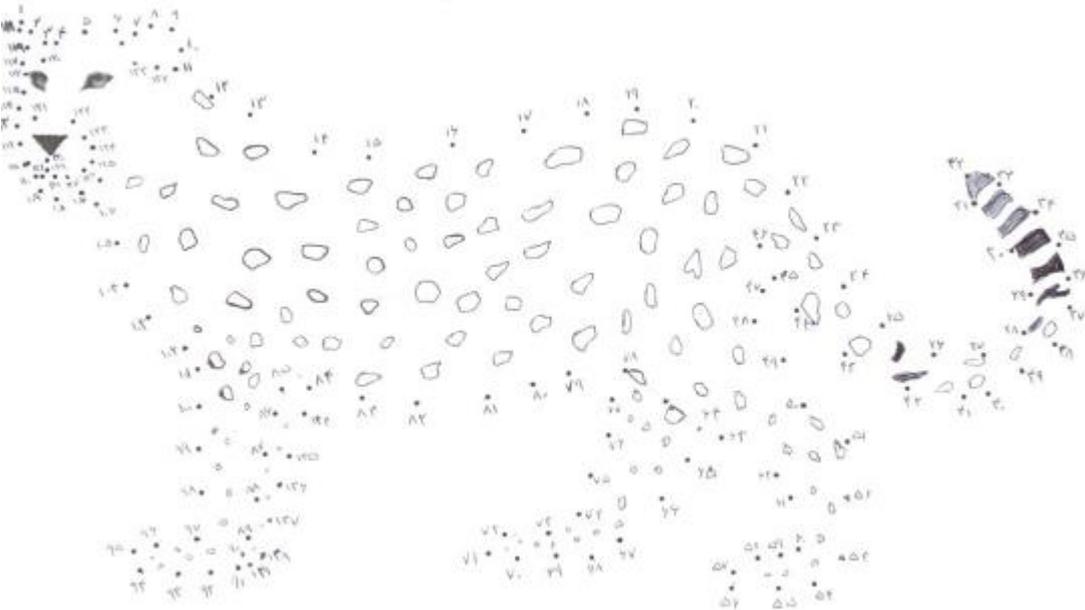
The Persian Leopard *Panthera pardus saxicolor* Pocock, 1927 is one of the least studied subspecies of the Leopard. It was once abundant across most mountainous and forest habitats of Iran (JOSLIN 1990), but it is now regarded as *endangered* by IUCN 2008. While Iran is home to more than 65% of the taxon's population (KHOROZYAN et al. 2005), little is known about the Persian leopard's biology, which makes development of effective conservation strategies difficult. For this purpose, we studied reproduction biology at Sarigol National Park in northeastern Iran.

### Study area and methods

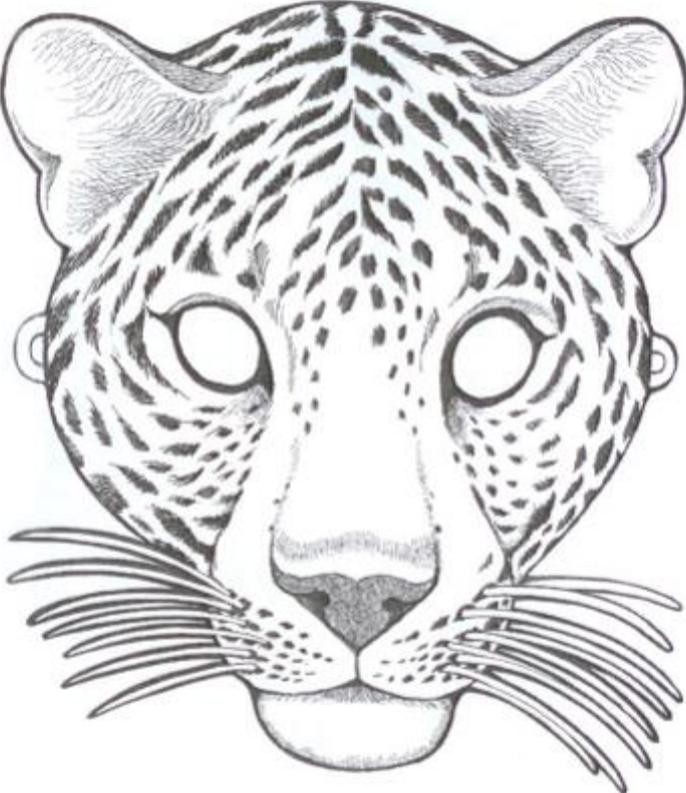
With an area of more than 7037 ha, Sarigol National Park is located some 20 km east of the city of Esfarayen, North Khorasan Province. It has been part of Sarigol Protected Area, which has been protected since 1973, and separated and promoted to a national park in 2002. An altitude range of 1400 to 2940 m, a mean annual temperature of 14°C and a mean annual precipitation of 273 mm give the region a temperate semi-arid climate (DAKVI-SHESHAT 2006). The area is mainly composed of hilly terrain merging to high rolling mountains aligned in a south-north direction. Highest elevations can be found in north central parts of the National Park.

Leopard surveys were carried out intermittently from April 2005 until March 2008 along trails and routes known to be used by leopards. We measured all leopard tracks encountered, recording maximum track length, width and pad or "heel" width, following LUKARISVSKY et al. (2004). All measurements were taken by one of us (MSF) during the entire survey period in order to avoid bias caused due to variation between different tracers' abilities, as noted by SHARMA et al. (2005) for tigers. Camera trapping was applied during the survey period in order to estimate leopard density as well as to verify real owners of the tracks measured at the camera trap stations. Since leopards occupy ranges that probably exclude other adults of the same sex (HAMILTON 1976, BERTRAM 1982, SUNQUIST & SUNQUIST 2002), adult tracks accompanied by a constant number of

**Appendix 4: Some educational samples designed for the students**



**Leopard spot drawing**



**Leopard mask**

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## Distribution list

The project periodical reports have been submitted to all the project partners, including Iranian DoE as well as local NGO in order to learn more about progress and activities. Also, the ICS's newsletter published the project outcomes regularly which was sent to all Iranian experts and game wardens not within Sarigol, but most of the country to share the project results. The ICS newsletter is mailed to many Iranian experts, authorities and students which is a reliable target-oriented media to share wildlife knowledge. At international level, the project story as a model for conservation was published in IUCN Cat Specialist Group's Cat News in 2012.



**Fig 27: Start of Sarigol Leopard Project in the ICS newsletter (2006)**





*To be continued ....*