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Persistence of Persian leopard in a buffer habitat in north-eastern Iran

An investigation on Persian leopard *Panthera pardus saxicolor* was carried out from September 2007 to October 2008 in Ghorkhod & Behkadeh Reserve, northeastern Iran. The area is the main buffer habitat around the core (source) population in Golestan National Park, but it suffers severe depletion of natural prey species due to lower level of protection measures, and is probably a sink population. We conclude that to ensure corridors and buffer zones, the most urgent and achievable solution is perhaps to designate additional "No Hunting Areas"and to implement anti-poaching measures, which may help the regional Persian leopard population to survive under a meta-population framework.

Northeastern Iran is supposed to hold the highest density of the Edangered Persian leopard (IUCN 2008) with a number of well-known sites (e.g. Golestan, Sarigol, Tandureh). The subspecies has on the whole been experiencing a loss of habitat over a wide part of its range which inevitably will lead to its fragmentation into small, genetically isolated populations (Joslin 1990). However, the range of the leopard is still known to include large parts of Iran and there may be 550–850 specimens in Iran, some 55% of which live in protected areas (Kiabi et al. 2002).

Golestan National Park is one of the most outstanding habitats of the subspecies in Iran (Kiabi et al. 1993), connecting to Ghorkhod Protected Area in the east and Behkadeh Razavi No Hunting Area in the northeast (Fig. 1). These areas possess suitable leopard habitats, and we suppose that they play a buffer role for Golestan. We call them hereafter "Ghorkhod & Behkadeh Reserve".

The leopard survey in Ghorkhod & Behkadeh Reserve has been part of the research and conservation efforts by the Iranian Cheetah Society (ICS) on Asiatic cheetah and Persian leopard in northeastern Iran, which has been initiated since 2003. The present publication describes some ecological aspects of the Persian leopard in a low-density buffer habitat, a sink population where the leopards suffer from serious poaching as well as prey depletion. With this article, we hope to create a more comprehensive perspective among the Iranian wildlife conservation parties in order to consider the necessity of buffer habitats when establishing leopard core reserves to ensure the long-term survival of the subspecies.

Fig. 1. Location of Ghorkhod & Behkadeh Reserve among some of the main leopard sites in north-eastern Iran. Leopard track signs indicate confirmed incidents of leopard poaching in recent years.

Study Area

With an area of 433 km², Ghorkhod Protected Area is located in the most eastern part of the Caspian forests in the territory of North Khorasan Province. Altitudes from 1000 to 2700 meters, mean annual precipitation of 660 mm, and mean annual temperature of 9 °C produce a Mediterranean and temperate sub-humid climate in Ghorkhod PA (Darvishsefat 2006). Behkadeh Razavi No Hunting Area is smaller (ca. 230 km²) and connected to the north boundary of Ghorkhod. The area includes two distinct biomes, the plains (1/3 of the total area) and mountainous terrain (Fig. 2; Mansouri 2005).

Ghorkhod was added to Golestan NP in 1976, but declared an independent protected area in 1982. Behkadeh Razavi was designated a No Hunting Area in 2006 and merged into Ghorkhod PA due to the presence of goitered gazelle *Gazella subgutturosa* and the Critically Endangered Asiatic cheetah *Acinonyx jubatus venaticus*. These twin areas are home to a diversity of carnivore species, including brown bear *Ursus arctos*, caracal *Caracal caracal*, wild cat *Felis silvestris* and grey wolf *Canis lupus*. It is supposed that lynx *Lynx lynx* exist in the area, but we did not find any evidence.

Methods

The leopard survey was carried out from September 2007 to October 2008 in Ghorkhod & Behkadeh Reserve. Main valleys and trails in both areas were searched for leopard signs. We recorded leopard presence based on signs, including tracks, scrapes, scats, and kill remains. Leopard scats were characteristically segmented into several lobes, with a mean diameter of 2.7 cm (2.0–3.0 cm) and pointed ends (Johnson et al. 1993). Furthermore, leopards are more likely to defecate on trails or on grassy areas along the trails to mark their presence, normally on scrapes (Sunquist & Sunquist 2002). All excrements were inspected for the presence of hairs, bones, nails, and other remains. Hairs were identified using a reference collection compiled by Sepasi & Falahatkar (2006).

During the entire study, we recorded all direct leopard sightings, both by researchers and local residents, and leopard tracks and scrapes. We also made inquiries about leopards with local people, mainly shepherds who visit frequently most parts of the study area. Leopard observations by local people were only accepted after proper confirmation, mainly by assessing the observer's ability to describe the animal's morphology. Behaviour of the animal, as described by the observer, sometimes helped to reveal the identity of the species. However, as other large carnivores present in the area differ markedly from leopards, the verification of the local people's observations was not

contentious. In parallel, 2 to 4 camera traps were set (Fig. 3) to photo-capture animals, including the leopard.

Results and Discussion

In more than 850 camera nights in the reserve, of which about 300 nights in leopard habitat, several carnivore species were photo-captured (Table 1). An adult male leopard was photographed on 7 December 2007 after sunset (Fig. 4), south of the area where usually livestock is grazing. From interviews with local people and sign surveys, we verified 23 leopard observations across the area for the past 5 years. Based on an assessment of time and location of verified leopard observation, we guesstimated that at least 5 leopards existed in the two areas.

We also found 7 leopard scats and compared their contents with the hair key references. Urial (wild sheep) was found to have the highest occurrence in the scat samples (Table 2). Based on 30 interviews with local people, leopard hunting efforts were characterized as summarised in Table 3. In addition to the scat analysis, the interviews revealed that the leopards attack domestic animals such as livestock and dogs.

The leopards mainly hunted urials, and wild boars. Furthermore, due to the presence of wild goats within their habitat, it is highly expected to be one of their food items, too. Furthermore, they kill livestock occasionally whenever it is available. Since Behkadeh is mainly wild sheep habitat and Ghorkhod is normally inhabited by the wild goats, it is natural that the leopards rely on the available ungulate species to hunt. In most areas the leopard's diet appears to track the relative densities of ungulate prey, with the most abundant species being their principal prey (Sunquist & Sunquist 2002).

Due to our small sample size, our results do not allow a robust conclusion regarding the leopard's feeding ecology in this buffer habitat. The relatively high percentage of leopard attack on herd dogs and livestock is a consequence of the important role of interviews with locals to gather the data. Meanwhile, the leopard's taste for dogs is well known (Sunquist & Sunquist 2002). It was even reported that the leopards had killed domestic cats around the village Kastan in Ghorkhod.

During the past two years, one male and one female leopard were killed around the area, both not fully mature animals. Moreover, three more leopards were poached (two males, one unknown) in three years in a distance of 150 kilometres south of our study area, which all of them were not fully adult. They were killed in proximity to Saluk NP, another important leopard area in north-eastern Iran. The principal problems of leopards in Ghorkhod & Behkadeh Reserve are prey depletion and contradicting of habitats by rural areas which can not prevent these highly mobile carnivores from movement, particularly by dispersing young animals. According to Woodroffe and Ginsberg (1998) the most serious threat to the existence of the large mammalian predators in protected areas is the "edge effect", that is the increased risk of being killed by rural people

Fig. 2. Typical landscape of Ghorkhod & Behkadeh Reserve (Photo M. Farhadinia).

Table 1. Results of camera trapping survey in Ghorkhod & Behkadeh Reserve.

Species	Total captures	Mountainous terrain	Plain area
Persian leopard *(P. p. saxicolor)*	1	1	0
Caracal *(Caracal caracal)*	1	0	1
Wild Cat *(Felis silvestris)*	3	1	2
Brown Bear *(Ursus arctos)*	5	5	0
Common Fox *(Vulpes vulpes)*	1	0	1
Stone Marten *(Martes foina)*	1	1	0

Fig. 3. Setting a camera trap at a trail used by carnivores (Photo M. Farhadinia).

Fig. 4. Adult male Persian leopard in Yekkeh-Chenar Valley, Behkadeh No Hunting Area captured by camera trap (Photo Iranian Cheetah Society).

when moving out the protected zones. The risk is directly proportional to the ratio reserve perimeter to reserve area. The leopard is known for its use of habitat edges and even marginal habitat, and its ability to live in close proximity to people (Seidensticker et al. 1990).

Table 2. Results of leopard scat analysis (n=7) from Ghorkhod & Behkadeh Reserve.

Food item	Abundance
Urial *Ovis orientalis*	5
Wild boar *Sus scrofa*	2
Plant material	1

Due to lower level of protection measures comparing to Golestan NP, Ghorkhod & Behkadeh suffers severe depletion of natural prey species. Nevertheless, the reserve is the principle buffer habitat around the core population in Golestan and law enforcement actions against poachers have allowed a few hundred mountainous ungulates to survive, and leopards benefit more security and more diverse food items in comparison to not protected areas. Also, Ghorkhod & Behkadeh Reserve offers spatial continuity preventing the fragmentation of the local leopard population as the leopards can easily commute between adjacent areas (e.g. Golestan NP in west and Saluk NP through Darkesh & Havar forests in south).

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 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 metapopulation framework.

Table 3. Hunting efforts by the leopards in Ghorkhod & Behkadeh Reserve as observed by local people (30 interviews).

Prey species	Number of observations	Percent %
Wild boar *Ovis orientalis*	2	15
Livestock	5	35
Herding dog *Canis familiaris*	7	50

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