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Abstract: Popularly considered a wholly African species, the cheetah *Acinonyx jubatus* once had a distribution that extended across the Middle East and Central Asia, extending north into southern Kazakhstan and east into India. Today outside of Africa, the cheetah has been extirpated from its entire Asiatic range except for a small and critically endangered population in the Islamic Republic of Iran. Estimated at 200 animals in the 1970's, the last Asiatic cheetahs are now thought to number around 60-100 animals restricted to the arid central Iranian plateau (roughly 30- 35° N, 52-60° E). To investigate the detailed ecology of the cheetah in Iran, we plan to capture eight cheetahs and fit them with GPS collars.

Conserving the Asiatic Cheetah in Iran: Launching the First Radio-Telemetry Study

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Popularly considered a wholly African species, the cheetah *Acinonyx jubatus* once had a distribution that extended across the Middle East and Central Asia, extending north into southern Kazakhstan and east into India. Today outside of Africa, the cheetah has been extirpated from its entire Asiatic range except for a small and critically endangered population in the Islamic Republic of Iran. Estimated at 200 animals in the 1970's, the last Asiatic cheetahs are now thought to number around 60-100 animals restricted to the arid central Iranian plateau (roughly 30-35° N, 52-60° E).

Iran considers the cheetah an important part of its natural and cultural heritage and the species has become a symbol of the country's conservation efforts. In 2001, Iran's Department of the Environment (DoE) launched a 5-year initiative in conjunction with the UNDP-GEF program and the Wildlife Conservation Society (WCS) entitled "Conservation of the Asiatic Cheetah, Its Natural Habitat, and Associated Biota in the I.R. of Iran" (abbreviated as the 'Conservation of the Asiatic Cheetah Project', CACP). Between 2001 though 2006, the CACP-WCS effort emphasized the implementation of emergency measures to mitigate threats to cheetahs and their prey, including reducing the killing of cheetahs and ungulate species by people, increasing protected areas staff numbers and training, increasing the provision of equipment for protected areas, and controlling livestock numbers and overgrazing in protected areas. Additionally, the project has conducted continual surveys to determine the distribution and abundance of cheetahs, other large carnivores and ungulates in the five protected areas identified by the CACP as the most important areas for cheetahs, namely Kavir National Park, Khar Turan National Park, Naybandan

Wildlife Refuge, Daranjir Wildlife Refuge and Bafgh Protected Area (Fig. 1).

The ecology of the Asiatic cheetah is poorly known. Although the species has been comprehensively studied in the open savannas of East and southern Africa, we have only a very rudimentary understanding of their ecology and conservation biology in Iran. There are no detailed data available on movement patterns, area requirements, habitat preferences, feeding ecology or reproductive biology. The most recent phase of the CACP-WCS project is attempting to address this deficiency by embarking on the first radio-telemetry study of Asiatic cheetahs. This paper summarizes the current threats to cheetahs in Iran, and describes the objectives and early progress of the telemetry effort since its implementation in February 2007.

Threats to the cheetah in Iran

The key factor affecting cheetah numbers in Iran is the disappearance of prey. Since the Iranian Revolution in 1979, goitered gazelle *Gazella subgutturosa* and jebeer gazelle *G. bennetti* have suffered drastic declines in range and numbers from human hunting, and loss of habitat due to overgrazing and drought (Karami 1992, Asadi 1997, Farhadinia 2004). Cheetahs in Iran have been observed preying upon Cape hares *Lepus capensis* but hares may be too small to sustain cheetahs (especially females with cubs) and are scarce in some areas of cheetah range. From opportunistic records of carcasses, urial *Ovis orientalis* and wild goat *Capra aegagrus* appear to form the primary prey today but both species inhabit mainly

which likely limit cheetah hunting success.

Cheetahs are strictly protected by law in Iran but direct persecution by people is also a significant threat. Cheetahs are killed for sport, for profit, or for protection of livestock (Karami 1992, Schaller & O'Brien 2001, Hunter 2004). In Namibia, farmers reported higher livestock losses to leopard, caracal, and jackal than to cheetah, yet removed more cheetahs than leopards (Marker 2003), partly because cheetahs were easy to trap and kill. Although the evidence for livestock predation by Asiatic cheetahs is scant, it is not unusual for local people in Iran to confuse leopard and cheetah (Asadi 1997). Cheetahs may be killed when confused for leopards or simply because they are feared or despised as carnivores. A herder who killed three cubs near Bafgh PA in 2003 claimed not to know they were cheetahs but killed them because they were 'small cats.' Additionally, numerous major highways and national roads traverse cheetah range in Iran, including through or adjacent to most protected areas where the species is found. Annually, at least 1-2 cheetahs are killed by vehicles on roads.

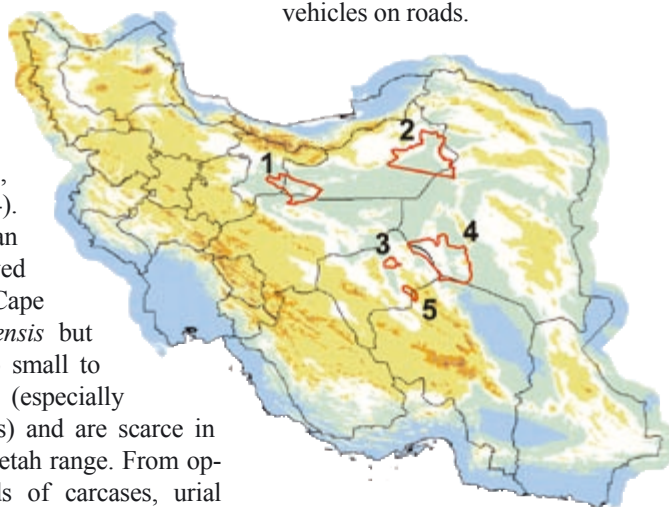


Fig. 1. Map of Iran, showing CACP reserves. 1. Kavir NP; 2. Khar Turan NP; 3. DarAnjir WR; 4. Naybandan WR; 5. Bafgh PA.

In Iran, herders and their livestock are legally permitted into most protected areas. Grazing in protected areas is restricted to 'buffer' zones of protected areas, though legally that may comprise up to 80 % of the park. There is conflicting evidence on the response of cheetahs to the presence of people. Herders generally report that cheetahs are not bothered by their presence (Hunter 2004) but our observations indicate that cheetahs avoid any human activity assiduously. Cheetahs are intensely shy in Iran and flee rapidly whenever they encounter people. Perhaps of greater consequence, the presence of people with livestock and dogs probably displaces wild ungulates. The extent to which this disturbance constitutes a significant threat to cheetahs and their prey is currently unknown.

A major limiting factor for Serengeti cheetahs is competition from, and juvenile mortality caused by other large carnivores, mainly lions and spotted hyenas (Durant 2000). Models based on two decades of cheetah data from the Serengeti have shown that population growth is most strongly influenced by adult survival followed by the survival of juveniles (Kelly & Durant 2000). In Iran, sympatric large carnivores with the potential to adversely affect cheetahs are Persian leopards *Panthera pardus saxicolor*, striped hyenas *Hyaena hyaena*, grey wolves *Canis lupus*, caracals *Caracal caracal* and golden jackals *Canis aureus* but nothing is known of their inter-relationships. In central Iran, all six species appear to concentrate in similar habitat, the watercourses and foothills of mountains, so considerable potential for competition exists. Cheetahs, leopards and wolves concentrate on medium-sized ungulates and may compete for prey. Leopards, wolves, and possibly striped hyenas and groups of jackals may drive cheetahs from their kills. All five species are potential cub predators while leopards and wolves are capable of killing adult cheetahs as well.

Research objectives.

To investigate the detailed ecology of the cheetah in Iran, we plan to capture eight cheetahs and fit them with GPS collars (Vectronics, Germany; see Methods). The specific aims of the study are:

1. To determine ranging patterns of Asiatic cheetahs. Home range size, the area required by cheetahs to meet their ecological needs, is generally related to the density of available prey. Prey density in Iran is among the lowest recorded anywhere in the distribution of the cheetah (Schaller & O'Brien 2001) and it is likely that Iranian cheetahs have extremely large home ranges.
2. To determine habitat preferences of Asiatic cheetahs. Cheetahs are likely to show preferences for certain habitats and features of the landscape rather than utilizing equally the entire area in which they occur. For example, prey concentrations occur (periodically, at least) in the dry watercourses and in the foothills of mountains; these are areas in which cheetahs are likely to concentrate their hunting effort. Similarly, female cheetahs require areas which have suitable den sites to bear and raise their cubs. Identifying and protecting these features is crucial.
3. To investigate the connectivity between cheetah populations. Cheetahs are presently concentrated around the edges of the central Iranian plateau (Farhadinia 2004) though reports indicate they exist elsewhere in the region. Some of the known cheetah areas are hundred of kilometers apart and may be isolated from all others. We aim to determine the extent to which interchange occurs between cheetah populations and investigate the availability of suitable habitat corridors between populations.
4. To investigate the effect of seasonal presence of livestock and herders on cheetah movements and behavior. Cheetahs and their prey probably avoid people but whether they abandon an area entirely or simply move away from the immediate proximity of people is a key question. We will investigate the response of telemetered cheetahs to the presence of herders and livestock.
5. To establish reproductive parameters of Asiatic cheetahs. From camera-trap photographs and opportunistic sightings, we know that cheetahs are breeding but we know little else about their reproduction. Anecdotal reports indicate the possibility of seasonal breeding in Iranian cheetahs coinciding with birth flushes of ungulate species, though the species is not known to be seasonal anywhere in its African range. In future

phases of the project, we hope to monitor the dispersal of independent adolescents.

6. To investigate the feeding ecology of Asiatic cheetahs. Historically, cheetahs in Asia probably concentrated on gazelles as their main prey species but calamitous declines in gazelle numbers in Iran means that cheetahs appear to have switched to less preferred prey (Farhadinia 2004). In particular, cheetahs appear to be reliant on urial sheep and wild goat, both of which inhabit mountainous areas largely unsuitable for the cheetah's cursorial hunting method. We will investigate what cheetahs eat, how often they kill and where in the landscape they make their kills. Can cheetahs make a living on wild goat and urial when those species appear to spend only a small proportion of their time away from mountainous habitats where cheetahs are ill-equipped to hunt?

7. To investigate the inter-relationships of Asiatic cheetahs with leopards, striped hyenas, wolves, caracals and golden jackals. By collaring individuals of each species, we aim to quantify the degree of overlap in habitat use and diet between them, and attempt to investigate the extent of competition over food resources. We will also attempt to assess whether predation of adult and juvenile cheetahs by other carnivores takes place.



Fig 2. Game trail with cheetah tracks. Wildlife thoroughfares such as this were targeted for the setting of foot-snares (Photo L. Hunter).



Fig. 3. Cheetahs were relatively calm in foot-snares and did not struggle violently when captured. All cats captured by foot-snares were unhurt by the process (Photo WCS/CACP/ZSL/A. Ghoddoosi).



Fig. 4. Guy Balme fitting GPS collar to anaesthetized male cheetah (Photo WCS/CACP/ZSL/A. Ghoddoosi).

8. To investigate the genetic characteristics of the Asiatic cheetah. Tissue and blood samples from captured individuals will provide the first opportunity to accurately assess the genetic status of the sub-species using fresh material.

Methods

In February, 2007, we launched efforts to capture cheetahs and other carnivores in the 885 km² Bafgh PA, Yazd Province. Bafgh PA records relatively frequent sightings of cheetahs, has relatively high densities of urial and wild goat, and all extant large carnivores for the region occur there. It also experiences seasonal influxes of herders and livestock in 80 % of the protected area, and cheetahs have been harassed and killed by people adjacent to the protected area (most recently reported in 2003; Hunter 2004, Farhadinia 2004). The capture effort described here ran from February 12 to March 30, coinciding with the end of the cold, wet winter in Iran. By the end of March, temperatures in the region are typically too high to safely capture animals.

Cheetahs in Iran are extremely shy and impossible to approach for free-darting as is possible with habituated individuals in the protected areas of southern and East Africa (eg Caro 1994). African cheetahs are often caught in cage-traps (Marker 2003) but injuries and deaths have resulted from their use; and cages are cumbersome and difficult to deploy efficiently in remote field conditions (Frank *et al.* 2003). Accordingly,

we deployed foot-snares (Frank *et al.* 2003, Balme *et al.* in press) built by us and fitted with numerous modifications to minimize the possibility of injury to cheetahs (for detail, see www.bigcats.com/bigcats_asiatic_cheetah_collared.php). As cheetahs very rarely scavenge and respond poorly to baits, we established ‘blind-sets’ by placing snares at key features in the environment where we anticipated relatively high rates of usage by cheetahs. Sites included solitary trees in valleys where cheetahs have been camera-trapped while scent-marking (and which may be analogous to the ‘play-trees’ of cheetahs in Namibia; Marker 2003) as well as along game trails and dry riverbeds (Fig. 2). We set a total of 14 snares and monitored them by fitting each with a TBT-500 trap transmitter (Telonics, Arizona), enabling us to remotely check the traps without creating additional disturbance to the site. The TBT-500 runs continuously (confirming it is functioning) and changes pulse rate when the trap is triggered. We checked each by radio-receiver at hourly intervals around the clock from two camps which were 500 m to 6 kms away from snares.

Captured carnivores were immobilized with tiletamine-zolezepam (Zoletil) or a zoletil-medetomidine cocktail delivered intramuscularly by dart gun. We fitted carnivores with GPS collars (Vec-

tronics, Germany) with a timed CR-2A drop-off unit (Telonics, Arizona) that automatically removes the collar so that re-capture of animals is unnecessary. The total weight of collars including the drop-off unit was 395 grams. Collars were programmed for four GPS acquisitions per day, retrieved periodically by uploading to a hand-held receiver via UHF radio link. Given the wide-ranging movements of cheetahs in Iran, ideally data acquisition would be achieved by satellite or GSM uploads. However, the smallest available Argos-GPS or GSM-GPS collars with comparable specifications to our collars are considerably heavier, and we consider them unsuitable for cheetahs. For all captured animals, we took standard morphological measurements and biological samples (tissue and blood).

Results and Discussion

We captured two male Asiatic cheetahs, (Figs 3 & 4) one of which we recaptured 15 days later, and one male Persian leopard (Fig. 5) in approximately 512 trap nights (Table 1); we did not capture any other carnivores. To our

Table 1. Morphological data for 3 captured cats. HT = head-tail.

Animal	Estimated age (years)	HT cm	Tail cm	Weight kg
Cheetah CM1	3-5	182.5	77	29
Cheetah CM2	3-5	N/A	N/A	32
Leopard LM1	7-10	202	87	57

knowledge, this is the first deliberate attempt to capture cheetahs using foot snares, and it proved to be a safe and efficient method. All cats were uninjured by the process and cheetahs were surprisingly calm when captured; mostly, they attempted to hide by lying flat on the ground or crawling behind vegetation as we approached on foot (cover photo). The two cheetahs were captured in the same evening at 17:00 and 00.00 respectively in snares approximately 1 km apart, and telemetry indicated they were traveling together the next morning. Both animals were adult males approximately 3-5 years old; it is unknown if Asiatic cheetah males form coalitions as in African populations, but given their age and movements, it is likely the pair comprise a coalition, perhaps brothers. We will assess this by DNA analyses currently underway. The cheetahs remained together in the location of the valley in which they were captured for two weeks before leaving the area. Their movements and those of the collared leopard are being monitored by periodically locating them from a vehicle and parasail equipped for radio-tracking.

Although, it is early days in this project, we have demonstrated that it is possible to safely capture Asiatic cheetahs despite their rarity and extremely low densities (Schaller & O'Brien 2001). We will resume the capture effort towards the end of 2007 when declining temperatures reduce the possibility of stress to animals captured in snares. Ultimately, we hope to collar a further 6 cheetahs as well 6-8 individuals of the other carnivore species in the region. This project represents one of the very few telemetry studies conducted in the country since the Iranian Revolution and is the only major research effort of its type currently underway. Accordingly, aside from its value in providing the first detailed data on cheetahs in Iran, it also represents a unique opportunity for Iranian biologists and students to acquire training and expertise in conducting applied wildlife research of this type. The project will run at least until the end of 2009.

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Fig. 5. Sepideh Kashani with anaesthetized male Persian leopard fitted with GPS collar (Photo C. Walzer).

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