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The current status of Asiatic cheetah in Iran

The current distribution of Asiatic cheetah *Acinonyx jubatus venaticus* in Iran is fragmented in three scattered subpopulations in the central arid plateau. Population size is unknown but tentatively estimated at less than 50 individuals. We review the historic and current status, population trend, and threats to cheetah survival in Iran, and present conservation actions recommended by Iranian experts. Between 2015 and 2017, 26 different individuals have been recorded in protected areas based on camera-trapping and direct observation. The northern subpopulation in Touran Biosphere Reserve BR and Miandasht Wildlife Refuge WR is the only one with evidence of reproduction. No reproduction has been observed in the southern subpopulation since 2012, suggesting that it is decreasing in size and range. No cheetah presence has been recorded in the western subpopulation since 2013. Despite the conservation efforts of the last 16 years the cheetah in Iran remains Critically Endangered. Urgent conservation interventions are needed to protect the last remaining individuals. The combined engagement and contribution of national and international partners will be critical for the success of these interventions.

The Asiatic cheetah has been extirpated from most of its historic distribution in Asia by the 1970s and is currently limited to the central arid plateau of Iran (Nowell & Jackson 1996, Hunter et al. 2007, Jowkar et al. 2008). Recently, the population size was tentatively estimated to comprise fewer than 50 individuals (Farhadinia et al. 2016), divided into three subpopulations: north-eastern Iran (northern subpopulation), central Iran (southern subpopulation), and in Kavir National Park NP (western subpopulation; Fig. 1) (Farhadinia et al. 2016).

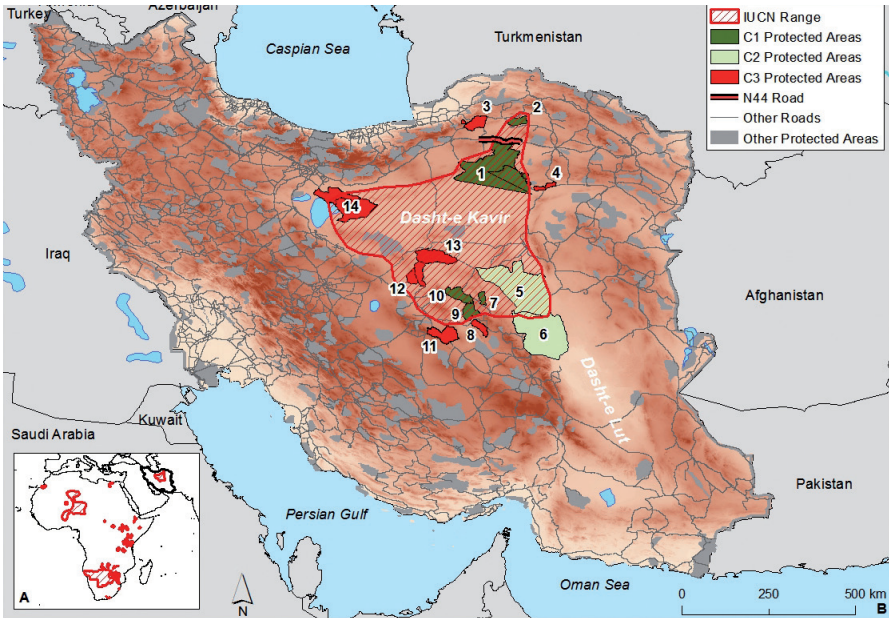

Fig. 1. A) Global distribution of cheetah. B) Current distribution of Asiatic cheetah metapopulation in Iran. Coloured protected areas PAs indicate those with cheetah observations since 2001. *Northern subpopulation:* 1) Touran BR*; 2) Miandasht WR & Zamen e Ahoo NP*; 3) Khosh Yeylagh WR; 4) Darooneh PA; *Southern subpopulation:* 5) Naybandan WR*; 6) Darband e Ravar WR*; 7) Kamki Bahabad Hunting Prohibited Area HPA; 8) Bafgh PA*; 9) Ariz HPA; 10) Dareh Anjir WR*; 11) Kalmand PA*; 12) Siah Kooh NP & PA*; and 13) Abbas Abad WR*; *Western subpopulation:* 14) Kavir NP & PA*. Areas with confirmed recent records (C1 PAs), with confirmed (5) and unconfirmed (6) records but in need of additional sampling to assess population status (C2 PAs), and with no confirmed record after 2014 (C3 PAs) are identified. PAs targeted by CACP are identified (*).

Specific conservation actions for the cheetah in Iran started in 2001 with the launch of the Conservation of Asiatic Cheetah Project CACP. Despite the many activities and conservation efforts developed since, the Asiatic cheetah has remained Critically Endangered. In this article, we review the population trends of cheetah in Iran, update the current population status, and assess threats to its survival. We present possible solutions to mitigate threats and propose priority interventions recommended to protect the remaining population.

Methods

We (1) reviewed available literature, including journal articles, CACP annual reports, research project reports, and newsletters; (2) carried out two field surveys (May and June 2017) in protected areas PAs with confirmed reports of cheetahs in the past four years (No. 1, 2, 3, 5, 7, 8, 9, 10 in Fig. 1); and (3) conducted meetings with experts of provincial Department of Environment DoE offices, directors of PAs, and game guards to understand their perception of the current status and major threats to cheetahs in PAs (Supporting Online Material SOM Table T1). We held meetings with the two Iranian NGOs most actively engaged in cheetah conservation, the Iranian Cheetah Society ICS and the Persian Wildlife Heritage Foundation PWHF, independent experts, field biologists, CACP staff, and DoE experts to identify and rank threats and urgent conservation actions (for more details see supplementary online material). Threats were identified for each subpopulation based on field assessments and experts' opinions, and were listed following the IUCN Threats Classification Scheme (Version 3.2).

Results

Past distribution and population size

The historic range of the Asiatic cheetah extended from the shores of the Mediterranean Sea and Arabian Peninsula to the northern shores of Caspian and Aral seas into Uzbekistan, Turkmenistan, Afghanistan, Pakistan, and central India in the south-east (Durant et al. 2017). The range has undergone severe decline in the last century. In the mid-1970s, the population was estimated at over 200 cheetahs distributed over 44 Iranian areas (Firouz 1999, CACP 2008). By 1980, the cheetah population in Iran had declined to 50-100 individuals distributed over six subpopulations (Asadi 1997). By 1996, the distribution was limited to the central plateau and the population size estimated as less than 50

individuals (Nowell & Jackson 1996); a grim situation, which might have lasted to present days (Farhadinia et al. 2016). However, all estimates were based on educated guesses rather than on robust counts. Although legitimate, the hypothesis of a negative trend in cheetah population size and range for the past 40 years is more based on the documented decline in prey species in Iran (Firouz 1999, Ghoddousi et al. 2017) and on the shrinking number of presence reports in areas known to have hosted cheetahs in the 1970's and up to the 1990's, despite increasing survey efforts (Farhadinia et al. 2017), rather than on a scientific monitoring.

In the IUCN Red List of Threatened Species, the cheetah was assessed as Vulnerable in 1965. In 1986 the Asian sub-species *venaticus* was listed as Endangered (Jowkar et al. 2008), and in 1996 it was up-listed to Critically Endangered (Asadi 1997, Jackson 1998).

Present conservation status: distribution, population size and trends

Since 2001, cheetahs have been recorded in 14 PAs, of which 10 have been prioritised for conservation actions by CACP (CACP 2016, Ostrowski 2017; Fig. 1). Since 2014, there have been confirmed observations (camera trap pictures, photos, dead specimens and direct observations) of cheetahs from only 7 of these PAs (Table 1, Fig. 1). 18 individuals (10 adults and 8 cubs) were observed in the northern subpopulation (Fig. 2) and 8 individuals (7 adults and possibly one grown-up cub) in the southern subpopulation. The northern subpopulation seems to be stable compared to 2014 (Farhadinia et al. 2014), although a slight decline or increase is also possible. The southern subpopulation is decreasing in range and size. No cheetah has been recorded in the western subpopulation since 2013, but this subpopulation was not surveyed after 2016.

Table 1. Summary of population size estimates of Asiatic cheetah and sampling effort since 2015 in PAs (Fig. 1). Information is given per subpopulation: northern, southern and western. The year of last cheetah observation (Last obs), the size of each PA (in km^2) (Area), the number of game guards in each PA (Ngds), the year of each survey (Year), the number of camera traps stations during the survey (Ncam) where camera trapping was used ("-" indicates direct observation or "unconfirmed" for Darband e Ravar), the duration of camera trapping (Days), the number of individuals detected (N), including M (male), F (female), C (cub) and U (unknown), the number of distinct individuals recorded from 2015-2017 after eliminating duplicates and mortalities, and adding unidentified individuals - mainly cubs - (N indiv), and the source of information (Ref), are presented.

Protected area	Last obs	Area	Ngds	Year	Ncam	Days	N	N indiv	Ref*
Northern subpopulation									
1) Touran BR	2017	14415	22	2015	80	144[1]	9 (3M, 2F, 1C, 3U)		2
				2015	-	-	3 (1F, 2C)	10 (3M, 2F, 5C)	2
				2016	34	365	7 (3M, 2F, 2C)		2
				2016	-	-	1 U		2
				2017	30	90[2]	5 (1M, 2F, 2C)		2
				2017	-	-	6 (2U, 1F, 3C)[3]		7
2) Miandasht WR & Zamen e Ahoo NP	2017	844	6	2015	31	65	5 (2M, 3F)	8 (2M, 3F, 3C)	3
				2016	31	69	2 (1M, 1F)		3
				2017	-	-	4 (1F, 3C)		6
3) Khosh Yeylagh WR	2013	1500	13	-	-	-	0	0	1
4) Darooneh PA	2012	667	3	-	-	-	0	0	1
Southern subpopulation									
5) Naybandan WR	2017	15170	6	2015	13	35	2 (2M)		3
				2016	50	50	2 (2M)	4 (2M, 1F, 1C)	3
				2017	4	60	2 (2M)		4
				2017	-	-	2 (1F + 1C)		5
6) Darband e Ravar WR	2011	13577	5	2017	-	-	0	U	4
7) Kamki Bahabad HPA	2017	650	3	2017	-	-	4 (4M)		3
8) Bafgh PA	2014	885	2	2017	-	-	0	0	1
9) Ariz HPA	2017	1311	2	2017	-	-	4 (4M)	4 (4M)	3
10) Dareh Anjir WR	2017	1753	4	2015	22	50	4 (4M)		3
				2016	26	56	4 (4M)		3
12) Siah Kooh NP & PA	2012	2050	4	2016	24	67	0	0	3
11) Kalmand PA	2011	2291	11	-	-	-	0	0	1
13) Abbas Abad WR	2010	3054	6	-	-	-	0	0	1
Western subpopulation									
14) Kavir NP & PA	2013	4422	17	-	-	-	0	0	1

*References code: 1 This study, 2 Abolghasemi & Kazari 2017, 3 Gholikhani et al. 2017, 4 Najafi & Ghadirian 2017, 5 S. Ostrowski, pers. comm., 6 H. Jowkar, pers. comm. and 7 A. Qorbanloo, DoE of Shahroud, pers. comm..

[1] In the rest of year 8 to 20 camera traps were active in the area.

[2] In the rest of year 22 camera traps were active in the area.

[3] The female and cubs were observed near Touran BR, close to the city of Shahrud.

Threats

The major threats to the northern subpopulation are disturbance by nomadic grazing (IUCN code 2.3; SOM Figure F1), roads and railroads (4.1; SOM F2), direct killing of cheetah (5.1.1) and their prey (5.1.2). Touran BR is traditionally an area where local people have permission to graze 76,000 domestic sheep and goats every year (Abangah 2017). Livestock compete with cheetah prey such as goitered gazelle *Gazella subgutturosa*, Indian gazelle *Gazella bennettii*, wild sheep *Ovis orientalis*, and wild goat *Capra aegagrus*, and shepherds and guarding dogs occasionally kill cheetahs and their prey (Farhadinia et al. 2017). Contagious diseases transmitted by livestock are an increasing threat to wild ungulate prey (Marashi et al. 2017) and indirectly to cheetahs. During the last 10 years, at least 5 cheetahs (females and cubs) were killed by vehicles on the Semnan-Mashhad highway (N44), stretching along the northern boundary of Touran BR (CACP 2016, Abolghasemi & Kazari 2017; Fig. 1).

In the southern subpopulation, threats include disturbance, increased intrusion and associated poaching linked to mining and quarrying (IUCN code 3.2), lack of protection and the small size of several PAs. In the very large Naybandan WR and Darband e Ravar WR the number of game guards is too low for an effective protection (Table 1). Other PAs (7-13 in Table 1) are too small for a species like cheetah that needs vast areas.

Climate change will likely increase the frequency and severity of extreme weather events, including droughts and prolonged periods of high temperature (IUCN code 11.2 and 11.3), and these changes are predicted to happen faster in flat, desert areas (Loarie et al. 2009).

Conservation priorities and management actions

The northern subpopulation comprises the most viable population, and should be the priority target for conservation actions.

The conservation actions presented by type of management interventions were compiled in consultation with Iranian experts. Measures highlighted with (*) were added by authors.

a) Measures to protect the remnant cheetahs:

a1) Recovery of prey population is critical for the recovery and long-term survival of cheetah population in all PAs (Sandom et al. 2017). In Iran this entails two main approaches:

a1-1) Management of cheetah prey in PAs should be prioritised by DoE managers. Effective protection and conservation should be developed mainly for gazelle populations, which are the main prey base for cheetahs across the Dasht-e Kavir through engagement of all stakeholders.

a1-2) Increasing prey populations is essential to secure the survival of the cheetah population in Touran and Miandasht, and this will require a livestock management and herder engagement strategy. Reducing livestock presence is possible by buying out grazing rights in these PAs, resulting in higher wild ungulate abundance and reduced conflicts with herders and their dogs.

a2) Safeguarding road crossings for cheetahs along a 20 km section of the N44 highway (Fig. 1) and also other identified segments of dangerous roads (Mohammadi & Kaboli 2016, Moqanaki & Chushman 2016) is critical. Both sides of the highway should be secured with fences funnelling cheetahs to embedded underpasses.

a3) Cheetah conservation should not be limited to protected areas (Durant et al. 2017). The connectivity within cheetah habitat has recently been studied (Ahmadi et al. 2017) and the proposed models should be used to secure corridors between protected areas, for example though the development of community-based conservation areas.

Fig. 2. A female with her two cubs at an artificial water trough in Touran BR (Photo PWHF-CACP-DoE-UNDP).

b) Improved understanding of the status of and threats to cheetah and increase political commitment

b1) Establish thorough wildlife population monitoring across cheetah core suitable habitats (see Ahmadi et al. 2017) through camera trapping or telemetry.

b2) Assess effective population size, population structure, and inbreeding levels through genetic studies.

b3) Perform a population viability analysis to understand if the metapopulation is still demographically and genetically viable and is able to recover.

*b4) Standardise monitoring protocols to allow comparing data collected from different sources.

*b5) Assess risk of disease transmission from livestock and guarding dogs to wild herbivores and carnivores, respectively, and identify most efficient preventing measures.

c) Mid- to long-term measures that need further data and discussion before implementation

c1) Based on the conclusions of b3, a conservation breeding programme in special facilities or in a very large (>1,000–2,000 km^2) enclosure in the cheetah habitat could be considered following a thorough feasibility study.

*c2) Develop a livestock-wildlife coexistence strategy: a payment mechanism that pays herders for healthy wildlife population. The controversial idea of expanding compensation measures - currently applying only to cheetah damages to livestock - to other large carnivores as an incentive to reduce the number of guarding dogs with livestock herds was proposed by a number of local experts, and will need to be discussed.

*c3) Recover rangeland and prey population in more temperate suitable habitats for cheetahs, such as Khosh Yeylagh WR (Nr 3 in Fig. 1), in anticipation of an increasing aridity in areas currently used by cheetahs.

Discussion

Current population trends

The evidence compiled here and in recent reports (e.g. Farhadinia et al. 2017) indicate a decline of the last population of cheetah in Asia. However, the lack of a reliable monitoring system is hampering the evaluation of population trends and the effectiveness of conservation actions (Ostrowski 2017).

Monitoring an elusive and rare species such as cheetahs in arid areas requires standardised protocols and enormous logistical and organisational efforts (Belbachir et al. 2015). It is necessary to create a central database to compile the raw data from all surveys and monitoring efforts, and to adopt robust methodology and transparency. Despite significant monitoring efforts by CACP, ICS and PWHF, a comprehensive monitoring concept and additional field research are needed to improve the population status assessment, and evaluate the effects of interventions, particularly in areas lacking formal protection, which are rarely surveyed, although they may represent additional suitable habitat for cheetahs (Ahmadi et al. 2017). Only 26 different individuals have been identified between 2015 and 2017 (Table 1), although due to high variability in quality and quantity of detection efforts this number cannot be seen as an instantaneous count, and the claim of less than 50 surviving cheetahs in Iran remains putative. Nevertheless, irrespective of these speculations on population size, the number of cheetahs in Iran is low and any further population decline may push the subspecies to extinction. However, we believe that there is still time to save the Asiatic cheetah, though the time is running out.

Final assessment and way forward

Around 60 years ago, Iran lost tiger *Panthera tigris virgata* and lion *Panthera leo persica* (Faizolahi 2016, Khosravifard & Niamir 2016). People who saw the last specimen of these species are still alive today; they were not aware of the final decline of the populations at the time and that they may have seen the last remaining individuals. For the Asiatic cheetah we have the opportunity to track the decline. Distribution maps from historical (Nowell & Jackson 1996) and present (this study) times reveal an enormous range decline. The present dire situation emphasises the urgency in mitigating threats to protect the last remaining individuals and enact interventions to support the species' recovery. Such challenges urgently require all key-players in cheetah conservation to unite and to coordinate their conservation efforts. Iran is the last hope for the Asiatic cheetah.

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Supporting Online Material SOM Figures F1 & F2 and Table T1 are available at www.catsg.org.

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Khalatbari L., Jowkar H., Yusefi G. H., Brito J. C. and Ostrowski S. 2017. The current status of Asiatic cheetah in Iran. Cat News 66, 10-13. Supporting Online Material.

Cheetah status, threats to its survival, and possible management measures for the overall population and in different protected areas were discusses with relevant experts (Step 1, SOM T1). Identified management measures were discussed with DoE provincial offices (Step 2, SOM T1). The most important actions, retrieved from step 1 and 2 consultations were proposed for discussion to participants to the Step 3 meeting, which led to add (four) actions to the list. Participants of Step 3 were then asked to score each proposed action (from 1 to 10 according to the perceived importance). Scores were summed and ranked from highest to lowest. At this stage proposed measures were re-discussed by a number of participants, several were altered or sometimes merged after hearing opposite and compliant comments. After gaining general agreement the final selection of actions was re-scored by each participant; scores were summed, the highest total pointing to the highest priority action (Step 3, SOM T1).

SOM F1. A flock of sheep with three guarding dogs and the shepherd's horse (and foal) in Khosh Yeylagh WR (Photo G. H. Yusefi).

SOM F2. An adult female cheetah dead as a result of a car collision on highway N44, May 2016. Her cub survived and was photographed by ISC several months later in Miandasht Wildlife Refuge (Photo DoE of Semnan).

SOM T1. Name and affiliation of people who were involved in different steps of identifying threats and mitigation actions, alphabetically ordered by affiliation and last name.

Step 1	
Ehsan Hakimi	CACP
Houman Jowkar	CACP
Rajab Ali Kargar	CACP
Leili Khalatbari	CIBIO/InBio ; Mohitban Society
Gholam Hosein Yusefi	CIBIO/InBio ; Mohitban Society
Arash Ghoddousi	Conservation Biogeography Lab, Geography Department, Humboldt-Universität zu Berlin, Berlin, Germany
Hosein Akbari	DoE / Director of Naein DoE / Abbas Abad WR / Isfahan
Hosein Harati	DoE / Director of Jajarm DoE / Miandasht WR / N Khorasan
Asadollah Hatami	DoE / Director of Tabas DoE / Naybandan WR / S Khorasan
Bahman Najafi	DoE / Retired director of Tabas DoE / Naybandan WR / S Khorasan
Ahmad Ajami	DoE / Retired director of Touran BR / Touran BR / Semnan
Roohollah Yousefian	DoE / Game guard / Touran BR / Semnan
Hamid Reza Sabbagh	DoE / Game guard / Khosh Yeylagh WR / Semnan
Hasan Akbari	DoE / Deputy of Natural Environment / Yazd / Yazd
Seyed Jalal Mousavi	DoE / Director of Bafgh DoE / Bafgh / Yazd
Delaram Ashayeri	Independent expert
Morteza Eslami	Iranian Cheetah Society
Leila Ghasemzadeh	Iranian Cheetah Society
Morteza Pourmirzai	Iranian Cheetah Society
Hamed Abolghasemi	Persian Wildlife Heritage Foundation
Taher Ghadirian	Persian Wildlife Heritage Foundation / Paazan, Iranian Mammal Quarterly
Mahgol Kazari	Persian Wildlife Heritage Foundation
Amir Hosein Khaleghi	Persian Wildlife Heritage Foundation
Morad Tahbaz	Persian Wildlife Heritage Foundation
Mohammad S. Farhadinia	Wildlife Conservation Research Unit, Department of Zoology, University of Oxford, Recanati-Kaplan Centre

Step 2	
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Hosein Harati	Jajarm / North Khorasan
Mohammad Reza Delghani Moghadam	Semnan / Semnan
Bahram Ali Zaheri	Semnan / Semnan
Razieh Dari Giv	Tabas / South Khorasan
Akram Esmaiil Zadeh	Tabas / South Khorasan
Asadollah Hatami	Tabas / South Khorasan
Nasir-Aldin Khashi	Tabas / South Khorasan
Bahman Moodi	Tabas / South Khorasan
Morteza Azizi	Ardakan / Yazd
Seyed Jalal Mousavi	Bafgh / Yazd

Step 2	
Hasan Akbari	Yazd / Yazd
Reza Mola-Mohammad Alian	Yazd / Yazd
Fatemeh Sadat Namayandeh	Yazd / Yazd
Moosa Shamsaii Kamsorkhi	Yazd / Yazd
Step 3 – Participants	
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Houman Jowkar	CACP
Rajab Ali Kargar	CACP
Baghe Nezami	CACP
Leili Khalatbari	CIBIO/InBio ; Mohitban Society
Gholam Hosein Yusefi	CIBIO/InBio ; Mohitban Society
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Marzieh Mousavi	DoE, Wildlife office
Delaram Ashayeri	Independent expert
Pouyan Behnoud	Independent expert
Kaveh Hobe Ali	Independent expert
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Navid Gholikhani	Iranian Cheetah Society
Morteza Pourmirzai	Iranian Cheetah Society
Ali Shams	Iranian Cheetah Society
Navid Gholikhani	Iranian Cheetah Society
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Hamed Abolghasemi	Persian Wildlife Heritage Foundation
Sepideh Kashani	Persian Wildlife Heritage Foundation
Mahgol Kazari	Persian Wildlife Heritage Foundation
Amir Hosein Khaleghi	Persian Wildlife Heritage Foundation
Ladan Salamat	Persian Wildlife Heritage Foundation
Pouria Sepahvand	Persian Wildlife Heritage Foundation
Morad Tahbaz	Persian Wildlife Heritage Foundation
Alireza Mohammadi	Tehran University
Step 3 - Facilitators	
Urs Breitenmoser	IUCN / SSC Cat Specialist Group
Stephane Ostrowski	Wildlife Conservation Society