BioOne COMPLETE

Predation of montane deserts ungulates by Asiatic Cheetah Acinonyx jubatus venaticus in Central Iran

Authors: Zamani, Navid, Karami, Mahmoud, Zamani, Wahid, Alizadeh, Afshin, Gharehaghaji, Maryam, et al.

Source: Folia Zoologica, 66(1) : 50-57

Published By: Institute of Vertebrate Biology, Czech Academy of Sciences

URL: https://doi.org/10.25225/fozo.v66.i1.a7.2017

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://bioone.org/journals/Folia-Zoologica on 28 Mar 2024
Terms of Use: https://bioone.org/terms-of-use

Folia Zool. – 66 (1): 50–57 (2017)

Predation of montane deserts ungulates by Asiatic cheetah *Acinonyx jubatus venaticus* in Central Iran

Navid ZAMANI[1]*, Mahmoud KARAMI[2], Wahid ZAMANI[3,4], Afshin ALIZADEH[2], Maryam GHAREHAGHAJI[5] and Marzieh ASADIAGHBOLAGHI[6]

[1] *Department of Environment, Faculty of Environment and Natural Resources, Behbahan Khatam Alanbia University of Technology, Khuzestan, P.O. Box 63615-151, Iran; e-mail: naviduok@gmail.com*
[2] *Department of Environment, Faculty of Natural Resources, University of Tehran, Karaj, Iran*
[3] *Department of Environmental Sciences, Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, Noor, Iran*
[4] *Laboratoire d'Ecologie Alpine, CNRS UMR 5553, Université Joseph Fourier Grenoble, B.P. 53, Cedex 9, F-38041, France*
[5] *Department of Biological Sciences, University of Illinois at Chicago, Chicago, IL, U.S.A.*
[6] *Department of Biodiversity and Ecosystem Management, Environmental Sciences Research Institute, Shahid Beheshti University, G.C., Tehran, Iran*

Received 30 July 2016; Accepted 17 November 2016

Abstract. The Asiatic cheetah *(Acinonyx jubatus venaticus)*, has disappeared in major parts of its mountainous habitats in west Asia. Asiatic cheetah is a critically endangered subspecies currently found only in central Iran. In this study, the feeding habits of Asiatic cheetah was investigated in two reserves in central Iran. Diet and prey selection of cheetah were assessed using two biomass models along with Jacob's selectivity index. We found no significant difference between biomass consumption based on each model between the reserves or between models inside each reserve. Over 90 % of species diet was composed of three medium-sized ungulates (i.e. 15-40 kg): wild sheep, wild goat and chinkara. Hares and other small mammals (less than 15 kg) made up the remainder of their diet. Asiatic cheetahs mainly preyed on wild sheep (*Ovis vignei*) which composed more than 50 % of consumed biomass. Wild sheep was identified as single staple prey, while chinkara (*Gazella bennettii*) was the most preferred prey despite its lower occurrence. Our study indicates that wild sheep, wild goat and especially chinkara are critical for persistence of Asiatic cheetah and must be particularly considered in conservation plans.

Key words: mammal, diet, selectivity, scat analysis, desert, carnivore

Introduction

Cheetahs' (*Acinonyx jubatus*) abundance and distribution have declined dramatically across their global range (Durant et al. 2008). In Africa, cheetahs sparsely occur in less than 24 % of their original distribution (Ray et al. 2005), while in Asia they have disappeared entirely from the west and south of the continent, except for Iran (Nowell & Jackson 1996, Mallon 2007).

The Asiatic cheetah *A. j. venaticus* exists within arid and semi-arid deserts and hilly terrains of Iran (Farhadinia 2004), mainly within "mosaic" areas of plains and rolling mountains intersected by numerous seasonal watercourses (Hunter et al. 2007), which provide essential cover for hunting success (Mills et al. 2004).

Unlike sub-Saharan cheetahs, the Asiatic cheetahs do not have a broad range of prey options available in west Asian deserts. Sub-Saharan cheetahs, predate opportunistically on a wide spectrum of available prey up to the size of greater kudu (*Tragelaphus strepsiceros*) and hartebeest (*Alcelaphus buselaphus*) (Caro 1994, Marker et al. 2003, Wachter et al. 2012) or even giraffe and buffalo calves. Nonetheless, through a combined tactic of high speed and ability to change direction rapidly to catch prey, cheetahs are known to have a preferred prey range of 23-56 kg with a mean mass of 27 kg (Hayward et al. 2006).

The small Asiatic cheetahs, which weigh around 30 kg (Hunter et al. 2007), co-exist with a limited range of potential prey species, mainly bovid (Weigel 1975, Ziaie 2009). Nevertheless, they are reported

* *Corresponding Author*

Downloaded From: https://bioone.org/journals/Folia-Zoologica on 28 Mar 2024
Terms of Use: https://bioone.org/terms-of-use

to exclusively prey on wild sheep (*Ovis vignei*), wild goat (*Capra aegagrus*) and gazelles (*Gazella* sp.) (Harrington 1977, Asadi 1997, Hunter et al. 2007, Farhadinia & Hemami 2010). Cheetahs are also known to prey on livestock in areas where they share their range with rural communities across their global distribution (Saleh et al. 2001, Selebatso et al. 2008, Wachter et al. 2012), particularly if their preferred prey species are depleted (Farhadinia et al. 2012).

Cheetahs are widely known to be open country predators throughout their range (Caro 1994, Sunquist & Sunquist 2002). However, research has shown that they are more adaptable to habitat diversity and prey choice than previously thought (Mills et al. 2004, Bissett & Bernard 2007). They are reported to survive even in mountainous terrain, found in Asia and north Africa (Harrington 1977, Dragesco-Joffé 1993, Wacher et al. 2005), preying on local ungulates, such as barbary sheep (*Ammotragus lervia*) (Dragesco-Joffé 1993, Wacher et al. 2005), wild sheep (Asadi 1997, Harrington 1997, Farhadina 2004, Mallon 2007) or wild goat (Hunter et al. 2007, Farhadinia & Hemami 2010). Therefore, while the species ecology, including food habits, has been intensively investigated in savannah, it is critical to obtain more ecological insight within mountainous landscapes. Moreover, the species' mountainous habitats are predominantly found in north African and west Asian parts of the species distribution where the species occurs at extremely low density and has disappeared from the majority of its range (Asadi 1997, Saleh 2001, Breitenmoser 2002, Sunquist & Sunquist 2002, Farhadinia 2004, Wacher et al. 2005). Therefore, studying Asiatic cheetah's food habits in these areas can promote appropriate conservation planning for the species.

Asiatic cheetahs are extremely shy and elusive species which use large ranges, and occur at low densities (Hunter et al. 2007, Farhadinia et al. 2013). Therefore, using indirect methods such as scat analysis can be helpful while studying their diet. There are a number of limitations that confront this method, or results derived from this technique, such as accurate identification of scats and calculating proportions of consumed mass of each prey species. Yet, despite some limitations, biomass models based on feeding trials provide the best approximation of the actual diet of carnivores (Klare et al. 2011). Marker et al. (2003) developed a linear regression biomass model for cheetah. However, in order to overcome potential bias, exponential regression models were calculated to account for consumed prey mass after correcting for the proportion of digestible to indigestible portions (Wachter et al. 2012). In order to compare the results, we use both methods to calculate dietary composition of the Asiatic cheetah.

The present study illustrates the feeding habits of Asiatic cheetah within two reserves in central Iran in absence of other large predators, i.e. Persian leopard (*Panthera pardus saxicolor*) and grey wolf (*Canis lupus*). Our objectives were to 1) determine dietary composition of Asiatic cheetahs in montane desert landscapes (2) compare prey consumption patterns between reserves and (3) determine prey selection of the species.

Material and Methods

Study area

Located in central Iran, Naybandan and Dare Anjir wildlife refuges (Fig. 1) have protected the Asiatic cheetah and its associated biota since 2001 and 2002, respectively. Both reserves are located in arid areas with rolling terrain and mountains surrounded by open plains, partially covered with sand dunes.

Dare Anjir (32°11′ to 32°37′ N and 54°49′ to 55°32′ E) covers an area of 1753 km^2 in Yazd Province. Whereas, Naybandan, one of the largest reserves in Iran, (31°47′ to 33°23′ N and 55°31′ to 57°29′ E) is located in South Khorasan Province with an area of 14225 km^2. Cheetahs are mainly found in the eastern core zone of the area, around Mount Nayband, which is the highest peak in this part of the country, where we conveyed our sampling surveys.

There is a high altitude variation in Naybandan, ranging from 690 to 3009 m above sea level. While, in Dare Anjir, altitude ranges from 850 to 2200 m above sea level. In Naybandan, the mean annual precipitation is between 70 and 110 mm and temperature is approximately 21.2 °C. In Dare Anjir, mean annual precipitation is 75 mm and temperature is 19.1 °C respectively which have resulted in extra-arid and warm arid climates (Darvishsefat 2006, Sarhangzadeh et al. 2006).

The vegetation consists of different perennial, shrub and tree species such as (*Ficus carica*), mountain almond (*Amygdalus horrid*), and turpentine tree (*Pistacia atlantica*) (Darvishsefat 2006). Most of the area has been covered with communities of wormwood (*Artemisia sieberi*) and bean caper (*Zygophyllum* sp.). Based on camera trap images, chinkara, wild sheep, wild goat, and cape hare (*Lepus capensis*) can be found in both reserves. Furthermore, Persian leopard (*Panthera pardus saxicolor*) caracal (*Caracal caracal*), wild cat (*Felis silvestris*), golden jackal

Downloaded From: https://bioone.org/journals/Folia-Zoologica on 28 Mar 2024
Terms of Use: https://bioone.org/terms-of-use

(*Canis aureus*), red fox (*Vulpes vulpes*), and striped hyena (*Hyeana hyeana*), were reported previously in both study areas (Jourabchian & Farhadinia 2008). There is no major human settlement within both areas, but camels that are owned by local people, roam freely in the reserve's rangelands.

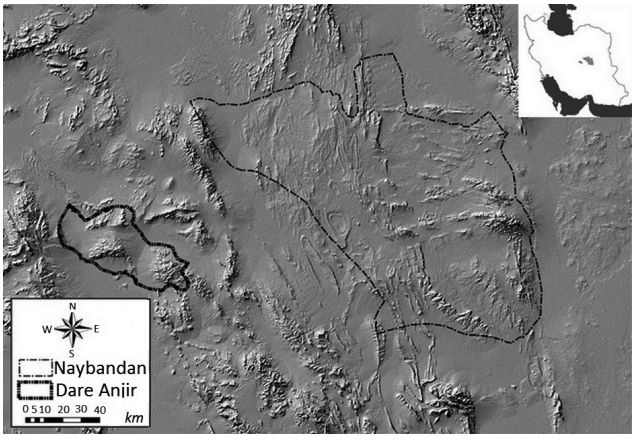


Fig. 1. Location of Dare Anjir and Naybandan in central Iran.

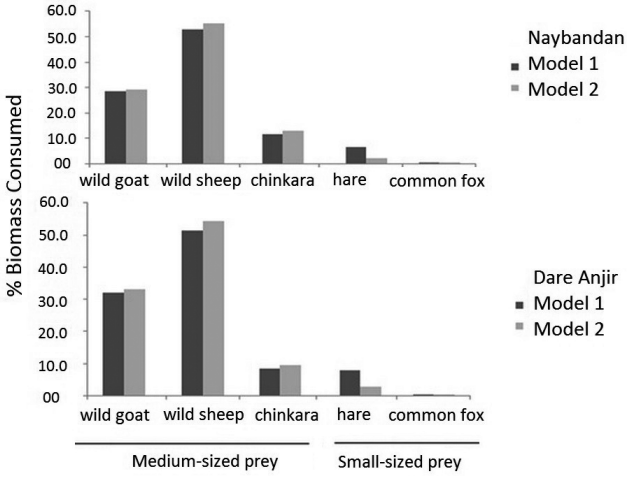


Fig. 2. Comparative assessment of the cheetah predation on mammals based on two available biomass calculation models.

Field sampling

Field surveys were carried out from October 2009 to October 2010, mainly along trails and watercourses, where cheetahs usually travel (Farhadinia 2004). Furthermore, potential marking posts, such as trees, were searched for signs of cheetahs. The records of camera traps in the both area and conducting interview with park rangers confirm that Persian leopard and grey wolf were absent during our sampling time.

Cheetah scats were recognized by their typical cat-like "segmented" appearance and large size. To avoid confusion, the efforts were corroborated by additional signs such as tracks. Hyena scats were identified due to their white appearance, which is mainly because of high bone content in their diet (Mills & Hofer 1998). The *Felidae* family feces can be identified by their compact form with well-defined segments and one of the extremities especially tapered (Chame 2003). The scat of smaller felids found in the study areas e.g. caracal and wild cat are usually less than 20 mm in diameter (Chame 2003). Therefore, we sampled the scats over 20 mm. The volume and diameter of leopard's scat is more than cheetahs and contains lots of hair strands comparing to cheetah's scat. Finally, we confirmed cheetah's scat by asking park rangers' expert opinion and excluded any suspicious scat from our analysis.

Scat samples were sealed in plastic bags and labeled with their location and date. Scats were then individually placed in tubes and washed through a fine-mesh sieve to remove surface oil and to separate the hair from other undigested organic matter (Mayes et al. 2005). To create slides for species identification, strands of hair were selected randomly from each sample, centered parallel on the slide, and mounted with cover slip using DPX mount. At least four slides were made per scat sample (n: 20 hair strand/sample). Slides were examined at 400×, using a Leica microscope. Strands of hair were then identified by comparison with a collection of mammal hair obtained from captive prey species, museum specimens and kills, after examining their length, thickness, shape, and colour. Features of medulla were compared with a reference collection that prepared using hair samples from existing prey species microscopically. Rodents were identified based on remains (i.e. skull, bone and hair).

Statistical analysis

For statistical quantification, each prey species found in one scat sample was assumed to characterize a single predatory event (Marker et al. 2003). We determined frequency of occurrence (percentage of total scats in which an item was found). However, since this tends to overestimate the importance of smaller items (Klare et al. 2011), we also converted frequency of occurrence value for each taxon to a relative estimate of biomass consumption, after correcting for scats containing remains of multiple prey species according to Karanth & Sunquist (1995), using two models. The first was a linear regression (Eq. 1) (after Marker et al. 2003) and the second, an exponential regression (Eq. 2) (after Wachter et al. 2012),

$$y = 0.0098x + 0.3425 \text{ (Equation 1)}$$

$$y = 2.358\ (1 - \exp\ (-0.075x)) \text{ (Equation 2)}$$

Downloaded From: https://bioone.org/journals/Folia-Zoologica on 28 Mar 2024
Terms of Use: https://bioone.org/terms-of-use

where y is the consumed prey mass in kg to excrete one scat and x is prey body mass in kg. The exponential model is theoretically superior because it accounts for the species that were not consumed completely (Wachter et al. 2012).

All materials identified in each fecal sample were counted and multiplied by the average weight of the consumed item. To avoid counting certain prey more than once, we only considered certain structures, particularly hair for each taxon. However, because it was impossible to recognize the number of rodents, we excluded them from this analysis. The average weight of each prey for the study area were taken either from the reference collections or the literature (chinkara: Prater 1971, wild sheep: Valdez et al. 1977).

Prey size categorization was modified after Clements et al. (2014) to include existing prey species in our study areas (Clements et al. 2014). Accordingly, medium-sized prey varied from 15 to 40 kg in weight while below 15 kg was regarded as small-sized prey such as rodents. The selectivity of cheetah predation for a specified medium-sized prey species was assessed by Ivlev's selectivity index D, which was modified by (Jacobs 1974):

$$D = (r - p)/(r + p - 2rp) \quad \text{(Equation 3)}$$

where r is the proportion of a given prey species based on percentage of biomass consumed by a cheetah, and p is the associated prey population size in the wild. Prey population was applied into the equation using mean total counts conducted in 2009 and 2010 for both reserves (Yazd DoE 2011). Jacob's selectivity index ranges from –1 (total avoidance) to +1 (restricted to that habit).

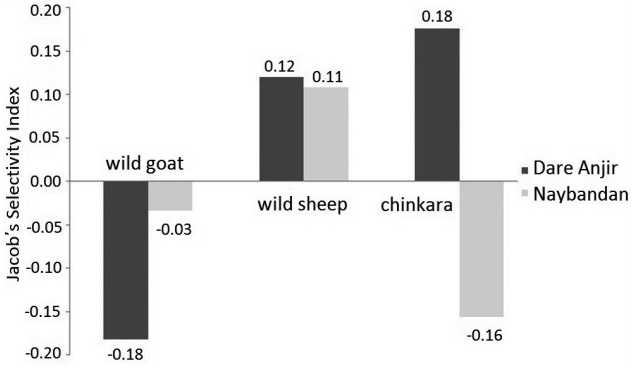


Fig. 3. Cheetah dietary preferences based on Jacob's selectivity index for three mountain preys two reserves in central Iran.

Results

During the survey period, we collected 426 cheetah scats from both areas, including 234 from Naybandan and 192 from Dare Anjir. We identified 279 food items for Naybandan and 216 food items from Dare Anjir samples, yielding to 1.19 and 1.13 food items per scat, respectively.

The frequency of occurrence (FO) of main prey species including wild sheep, wild goat and chinkara was 40.2 %, 21.1 % and 10.5 % for Naybandan and 42.2 %, 25.5 % and 8.3 % for Dare Anjir, respectively. Table 1, shows that by corrected FO, chinkara made up more of cheetah's diet in Naybandan (10.5 %) than in Dare Anjir (8.3 %). In Dare Anjir hare and rodents were found more frequently in the diet than in Naybandan. In Naybandan, the most consumed biomass were wildsheep (55.1 %), wild goat (29.3 %) and chinkara (19.9 %). Dare Anjir showed the same results for consumed biomass: wildsheep (54.2 %), wild goat (33.2 %) and chinkara (9.5 %). These results show that in Naybandan, FO is in accordance with consumed biomass contrary to Dare Anjir, where chinkara was the third main consumed biomass and hare, the third most frequent occurred prey. This difference in FO between the two reserves may be due to much smaller numbers of chinkara in Dare Anjir (53) compared to Naybandan (307). Abundance of wild sheep, wild goat, chinkara was 964, 593 and 307 for Naybandan and 374, 355, 53 for Dare Anjir according to the 2009 and 2010 records. In this study, we identified red fox, birds, plants and insect in the diet of cheetah and it is important to note that there was no sign of domestic animals in the scats in both reserves.

Overall, nine species were identified in cheetah scats in both reserves. The majority of fecal samples contained only one food item (83.35 % and 88.9 % in Naybandan and Dare Anjir, respectively). 12.8 % of Naybandan's samples and 7.4 % of scat samples in Dare Anjir had two items, respectively. Only 3.7-3.8 % of the entire samples (Naybandan and Dare Anjir, respectively) contained three food items.

In total, hare comprised 11.1 % (n = 55) of all known food items from both reserves, as the only prey item mostly found in the feces (76.4 %). It was quite rare to see two ungulate remains within the same feces.

Generally, both biomass models revealed that 91.7 to 97.3 % of the cheetahs' diet consisted of three medium-sized ungulates in both areas (Table 1). The remaining proportions of cheetahs' diet consist of smaller mammals, particularly hare which provided only 2.3 to 2.9 % of the consumed prey mass within surveyed areas based on the exponential model of Wachter equation (2012). On the other hand, when linear regression biomass model was applied, our results showed that 6.5 to 7.9 % of cheetahs' diet was based on hare (Table

Downloaded From: https://bioone.org/journals/Folia-Zoologica on 28 Mar 2024
Terms of Use: https://bioone.org/terms-of-use

Downloaded From: https://bioone.org/journals/Folia-Zoologica on 28 Mar 2024
Terms of Use: https://bioone.org/terms-of-use

Table 1. Feeding ecology analysis of Asiatic cheetah based on fecal sampling in central Iran.

	Naybandan							Dare Anjir				
						Consumed biomass (%)					Consumed biomass (%)	
Food item	Prey mean mass (kg)	Consumed mass/scat	N	FO[1] (%)	Corrected FO (%)[2]	Model 1[3]	Model 2[4]	N	FO[1] (%)	Corrected FO (%)[2]	Model 1[3]	Model 2[4]
Medium-sized food items												
wild goat	36	2.2	62	26.5	21.1	28.5	29.3	51	26.6	25.5	31.9	33.2
wild sheep	34	2.2	110	47.0	40.2	52.7	55.1	89	46.3	42.2	51.3	54.2
chinkara	23	1.9	37	15.8	10.5	11.6	12.9	19	9.9	8.3	8.5	9.5
Small-sized food items												
rodents			25	10.7				20	10.4			
hare	2.5	0.4	27	11.5	9.1	6.5	2.3	28	14.6	12.0	7.9	2.9
birds			5	2.1				2	1.0			
common fox	5	0.7	2	0.9	0.9	0.7	0.4	1	0.5	0.5	0.4	0.2
reptiles			1	0.4				2	1.0			
insects			6	2.6				2	1.0			
fruit			4	1.7				2	1.0			
Non-food items												
stone			4	1.7				9	4.7			
plant materials			4	1.7				2	1.0			
no. of food items			279					216				
no. of scats			234					192				
no. of food items/scat			1.19					1.13				

[1] FO = frequency of occurrence.
[2] Frequency of occurrence was corrected after removal of multiple preys.
[3] Biomass model 1 refers to linear regression model adopted from Marker et al. (2003).
[4] Biomass model 2 is based on exponential regresstion after correcting for digestion proportion in the biomass calculation, adopted from Wachter et al. (2012).

1), which is still a relatively small portion of the species diet. Applied models differed in terms of proportions of small mammals remaining in cheetah's diet, i.e. the linear model estimated values lower than those derived from the exponential model (Fig. 2).

Our results showed that prey consumption patterns were not quite consistent between the two reserves. Jacob's selectivity index (*D*) (Eq. 3) was positive for wild sheep in both reserves (Fig. 3), indicating cheetahs' preference for the species. On the other hand, *D* was negative for wild goat in both reserves, while chinkara showed different patterns in each reserve (Fig. 3).

Discussion

The Asiatic cheetahs within our study sites preyed primarily upon wild sheep followed by wild goat and chinkara. However, in terms of preference, chinkara was the most preferred prey species in Dare Anjir, followed by wild sheep, with wild goats being the least preferred. Despite the low density of the plain-dwelling ungulates, i.e. chinkara, this species was preferred by cheetahs in Dare Anjir. Our results are in accordance with the results related to kill examination (Farhadinia & Hemami 2010). The same preference pattern was seen in Naybandan, except for chinkara which was avoided. Exclusive predation on wild sheep by Asiatic cheetahs was in accordance to their abundance, availability and preferred weight range (Hayward et al. 2006). Gazelle species are also critical for persistence of the Asiatic cheetah, particularly chinkara, which mainly graze among hilly terrains and foot hills. Therefore, while supporting existing anti-poaching efforts within the reserves, lowland species need more attention to halt poaching of more susceptible gazelles.

Moderate occurrence of wild goat which mainly inhabit rocky cliffs and higher elevations (Ziaie 2009, Shams-Esfandabad et al. 2010) can be explained by the animals' daily behaviour, which pass through lowland terrain when moving between different habitats. Furthermore, water which is a significant limiting factor within arid landscapes, is mainly provided by artificial water-sources, all of which are located at foothills and valleys and can therefore provide a hunting ground for the cheetahs. However, it seems that other ungulate species were more opportunistic targets for the cheetahs within these areas. In areas where cheetahs share their range with leopards, it is expected that wild goat accounts for a smaller portion in cheetah's diet.

With limited availability of livestock throughout the surveyed range, it is not surprising that no remains of domestic animals were found in the analyzed feces, in contrary to some rural beliefs assuming that cheetah hunt for domestic animals. Nonetheless, attacks on camel calves have been sporadically reported from other parts of the species range (Asadi 1997, Wacher et al. 2005, Belbachir 2006) and may cause retaliatory killing by local people (Karami 1992, Saleh et al. 2001).

The two compared biomass models yielded similar results for the medium-sized prey, but different results for smaller prey. This implies that the recent exponential biomass model can result in larger correction for situations in which the predator obtains a substantial portion of its preys using smaller mammals (e.g. Marker et al. 2003), unlike our case where the cheetah's diet is predominantly medium-sized ungulates (ca. 5 % difference between two methods). This is supported by our finding where consumed prey mass decreased 2.7-2.8 fold, as predicted by Wachter et al. (2012).

Only a minor proportion of cheetahs' diet consisted of smaller mammals, i.e. rodents and hare. Even within the prey-depleted landscapes, Asiatic cheetah do not prey on small-sized species frequently (Farhadinia et al. 2012). Small preys seem not to support cheetahs' viability, particularly females with cubs (Hunter et al. 2007).

Our results are in contrast to Karami (1992), Saleh et al. (2001), and Ziaie (2009) who concluded that primary subsistence of cheetahs are on these small prey species. Our results highlight the importance of medium-sized ungulates for population viability. Considering the recent (after our study) record of wolves in both sites and the fact that they mostly prey on medium sized ungulates as opposed to small mammals, there is a potential threat that cheetahs may attack livestock in future if the number of medium sized ungulates declines. Accordingly, management practices should be geared towards protecting existing range of wild ungulates within cheetah ranges in order to ensure their long-term survival.

The present study illustrated cheetah's predation in the presumed absence of large predators. However, cheetahs share most parts of their range with leopard and wolf in Iran, both of which can affect cheetahs' feeding ecology (Caro 1994, Cooper et al. 2007) and habitat selection (Mills et al. 2004, Pettorelli et al. 2008). This highlights the importance of conducting foraging ecological studies for managing predator-prey systems, especially when critically endangered carnivores are involved. Wild ungulates possess low diversity and density in the west Asian montane desert landscapes, which can result in less resource

Downloaded From: https://bioone.org/journals/Folia-Zoologica on 28 Mar 2024
Terms of Use: https://bioone.org/terms-of-use

partitioning among existing carnivores. Therefore, it is essential to conduct similar food assessment in areas where large predators are present so as to understand the extent of competition over food resources and the effects of multiple predators on prey and on each other.

Acknowledgements

The present paper is based on Navid Zamani's Master thesis at University of Tehran. NZ is grateful to the Conservation of Asiatic Cheetah Project (CACP), Yazd Provincial Office of Department of Environment and Iranian Cheetah Society (ICS) for supporting his University dissertation. Ezequiel Fabiano, Niki Rust and two anonymous reviewers provided helpful comments on previous versions of this manuscript. Special thanks go to Alireza Jourabchian, Hasan Akbari, Seyedjalal Mousavi and Foad Fatehi for their advice and contribution to improve the survey. Finally, we are grateful to reserves' personnel, particularly Asadollah Hatamian, Ali Bakhshi, Abbas Mirkalani, Shirdel Sharafi, Ali Ajami, Mohammad Hasankhani, and Akbar Jafarpour for their companionship during field work.

Literature

Asadi H. 1997: The environmental limitations and future of the Asiatic cheetah in Iran. *Project Progress Report, IUCN/SSC Cat SG, Tehran.*

Belbachir F. 2006: Human attitudes of Sahelo-Saharan antelopes and cheetah: Algeria. *Proceedings of the seventh annual SSIG meeting, May 2006, Douz, Tunisia.*

Bissett C. & Bernard R.T.F. 2007: Habitat selection and feeding ecology of the cheetah in thicket vegetation: is the cheetah a savanna specialist? *J. Zool. Lond. 271: 310–317.*

Breitenmoser U. 2002: Feasibility study on cheetah re-introduction in Turkmenistan. *Cat News: 13–15.*

Caro T.M. 1994: Cheetahs of the Serengeti Plains. *The University of Chicago Press, Chicago.*

Chame M. 2003: Terrestrial mammal feces: a morphometric summary and description. *Mem. Inst. Oswaldo Cruz 98: 71–94.*

Clements H.S., Tambling C.J., Hayward M.W. & Kerley G.I. 2014: An objective approach to determining the weight ranges of prey preferred by and accessible to the five large African carnivores. *PLoS ONE 9: e101054.*

Cooper A.B., Pettorelli N. & Durant S.M. 2007: Large carnivore menus: factors affecting hunting decisions by cheetahs in the Serengeti. *Anim. Behav. 73: 651–659.*

Darvishsefat A.A. 2006: Atlas of protected areas of Iran. *University of Tehran Press, Tehran, Iran. (in Persian)*

Dragesco-Joffé A. 1993: La vie sauvage au Sahara. *Delachaux et Niestlé, Lausanne.*

Durant S., Marker L., Purchase N. et al. 2008: *Acinonyx jubatus*. The IUCN Red List of Threatened Species, Version 2013.1. *Downloaded on 11 October 2013. www.iucnredlist.org*

Farhadinia M.S. 2004: The last stronghold: the cheetah in Iran. *Cat News 40: 11–14.*

Farhadinia M.S., Akbari H., Musavi S. et al. 2013: Movements of Asiatic cheetah *Acinonyx jubatus venaticus* across multiple arid reserves in central Iran. *Oryx 47: 427–430.*

Farhadinia M.S. & Hemami M.R. 2010: Prey selection by critically endangered Asiatic cheetah in central Iran. *Nat. Hist. 44: 1239–1249.*

Farhadinia M.S., Hosseini F., Nezami B. et al. 2012: Feeding ecology of the Asiatic cheetah (*Acinonyx jubatus venaticus*) in low prey habitats in northeastern Iran: implications for effective conservation. *Arid. Environ. 87: 206–211.*

Harrington F.A. 1977: A guide to the mammals of Iran. *Department of the Environment, Tehran, Iran. (in Persian)*

Hayward M.W., Hofmeyr M., O'Brien J. & Kerley G.I.H. 2006: Prey preferences of the cheetah *Acinonyx jubatus*: morphological limitations or the need to capture rapidly consumable prey before kleptoparasites arrive? *J. Zool. Lond. 270: 615–627.*

Hunter L., Jowkar H., Ziaie H. et al. 2007: Conserving the Asiatic cheetah in Iran: launching the first radio-telemetry study. *Cat News 46: 8–11.*

Jacobs J. 1974: Quantitative measurement of food selection. *Oecologia 14: 413–417.*

Jourabchian A.R. & Farhadinia M.S. 2008: Final report on conservation of the Asiatic cheetah, its natural habitats and associated biota in Iran. *Project Number IRA/00/G35 (GEF/UNDP/DoE), in October 2008, Tehran, Iran. (in Persian with English summary)*

Karami M. 1992: Cheetah distribution in Khorasan Province, Iran. *Cat News 16: 4.*

Karanth K.U. & Sunquist M.E. 1995: Prey selection by tiger, leopard and dhole in tropical forests. *Trop. Ecol. 64: 439–450.*

Klare U., Kamler J.F. & Macdonald D.W. 2011: A comparison and critique of different scat-analysis methods for determining carnivore diet. *Mammal Rev. 41: 294–312.*

Mallon D.P. 2007: Cheetahs in Central Asia: a historical summary. *Cat News 46: 4–7.*

Marker L.L., Muntifering J.R., Dickman A.J. et al. 2003: Quantifying prey preferences of free-ranging Namibian cheetahs. *S. Afr. J. Wildl. Res. 33: 43–53.*

Mayes P.J., Tompson G.G. & Whiters P.C. 2005: Diet and foraging behavior of the semi-quatic *Varanus mertensi* (Reptilia: Varanideh). *J. Wildl. Res. 23: 67–74.*

Mills M.G.L., Broomhall L.S. & Toit J.T. 2004: Cheetah *Acinonyx jubatus* feeding ecology in the Kruger National Park and a comparison across African savanna habitats: is the cheetah only a successful hunter on open grassland plains? *Wildlife Biol. 10: 177–186.*

Mills G. & Hofer H. 1998: Hyaenas: status survey and conservation action plan. *IUCN/SSC Hyaena Specialist Group. IUCN, Gland, Switzerland and Cambridge, U.K.*

Nowell K. & Jackson P. 1996: Wild cats: status, survey and conservation action plan. *IUCN/Species Survival Commission Cat Specialist Group, Gland, Switzerland.*

Pettorelli N., Hilborn A., Broekhuis F. & Durant S.M. 2008: Exploring habitat use by cheetahs using ecological niche factor analysis. *J. Zool. Lond. 277: 141–148.*

Prater S.H. 1971: The book of Indian animals. *Oxford University Press, England.*

Downloaded From: https://bioone.org/journals/Folia-Zoologica on 28 Mar 2024
Terms of Use: https://bioone.org/terms-of-use

Ray J.C., Hunter L.B. & Zigouris J. 2005: Setting conservation and research priorities for larger African carnivores. *WCS Working Paper No. 24, Wildlife Conservation Society, New York.*

Saleh M.A., Helmy I. & Giegengac R. 2001: The cheetah *Acinonyx jubatus* (Schreber, 1776) in Egypt (Felidae, Acinonycinae). *Mammalia 65: 177–194.*

Sarhangzadeh J., Irannezhad M. & Mokhtari M. 2006: Naybandan Wildlife Refuge management plan. *Final Report, Department of Environment, Provincial Office of Yazd Province.*

Selebatso M., Moe S.R. & Swenson J.E. 2008: Do farmers support cheetah *(Acinonyx jubatus)* conservation in Botswana despite livestock depredation? *Oryx 42: 430–436.*

Shams-Esfandabad B., Karami M., Hemami M.R. et al. 2010: Habitat associations of wild goat in central Iran: implications for conservation. *S. Afr. J. Wild. Res. 56: 883–894.*

Sunquist M. & Sunquist F. 2002: Wild cats of the world. *University of Chicago press, Chicago.*

Valdez R., Alamia L.V., Bunch T.D. & Mowlavi M. 1977: Weights and measurements of Iranian wild sheep and wild goats. *J. Wildlife Manage. 41: 592–594.*

Wachter B.A.S., Blanc J., Melzheimer O. et al. 2012: An advanced method to assess the diet of free-ranging large carnivores based on scats. *PLoS ONE 7: e38066.*

Wacher T., De Smet K., Belbachir F. et al. 2005: Sahelo-Saharan interest group wildlife surveys. Central Ahaggar Mountains (March 2005). *ZSL Conservation report No 4., Zoological Socienty of London, London*.

Weigel I. 1975: Big felids and cheetahs. In: Grzimek B. (ed.), Grzimek's animal life encyclopedia, vol. 12. *Van Nostrand Rheinhold, London: 335–344.*

Yazd DoE 2011: Yazd annual census report. *Yazd Department of Environment, Yazd, Iran.*

Ziaie H. 2009: A field guide to mammals of Iran, 2nd ed. *Wildlife Center Publication, Tehran, Iran. (in Persian)*

Downloaded From: https://bioone.org/journals/Folia-Zoologica on 28 Mar 2024
Terms of Use: https://bioone.org/terms-of-use