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Abstract: Established in 1973, Minadasht Wildlife Refuge is the last verified cheetah habitat in Iran, which is located in northeastern country with more than 85000 hectares. The area has been one of the best ranges for the goitered gazelle before 1980s as well as the cheetah, but due to weakening of conservation actions since early 1980s, the area lost most of its gazelle population (more than 90%) and the cheetah was never seen. In winter 2002, the cheetah was reported from the area which drew the attention of the Iranian Cheetah Society (ICS) for more investigations in the area.

The Project Asiatic Cheetah in Miandasht WR was initiated by the Iranian Cheetah Society (ICS) in March 2003, aiming to study the cheetah status and ecology as well as its associated species inside the only plain habitat for the cheetahs in the country and increasing the awareness of local people about this critically endangered species. The project won a Small Grant from Rufford Maurice Laing Foundation in 2004 and received more supports from the Iranian Department of the Environment (DOE) as well as a few domestic and international sponsors. The project is still ongoing to monitor the cheetah population and possible dispersal to the surrounding areas as well as more public awareness efforts inside the local community around the area.

On the basis of investigations, it was concluded that the cheetah was never disappeared from the area during 1980s to 2000s, but they survived inside far remote parts of Miandasht, where they occasionally encountered with local people. They usually inhabit inside the hilly terrain and try to avoid flat plains where they are traditionally believed to be their original habitat. Meanwhile, they utilize their developed camouflaging ability to approach the small bands of gazelles grazing near the hills, where they are the most susceptible to the cheetah hunting.

It is estimated that a total of 6 to 10 cheetahs live throughout Minadasht. Since the area possesses less than 300 gazelles, it is logical that they need to use alternative food sources, which in respect to high abundance of hare and rodents throughout the reserve; it seems that the small size foods are now the main source of energy for the cheetahs. Moreover, occasional hunting effort on common fox, ground birds and wild boar was reported. At the same time, it was for the first time in the country that the cheetah depredation on livestock, mainly domestic sheep was approved, however, it was so rare that has created no negative attitude toward the cheetahs among the local people.

Beside ecological investigations, a remarkable proportion of efforts went to increase people awareness about the cheetahs and other species of the area. The grey wolf is the main enemy of people's ownership, but since the newly known cheetah is morphologically similar to the wolves from a distance of more than several dozens meters, therefore, the people may suppose that the animal in charge of attacking to the livestock is a cheetah. Accordingly, it was necessary to initiate a public awareness campaign in order to empower the people to identify the cheetah, wolf and striped hyena. Meanwhile, since the depredation loss was not significant, it was not necessary to think about economical compensation plans in order to prevent the killing of predators.

It is recommended to monitor the population demography of the cheetah and its associated species in order to ensure the animal's survival inside Miandasht and neighbor habitats where the cheetahs may disperse. As well, it is critical to launch an organized educational program to increase the local people's knowledge about the fauna of Miandasht and decrease the present conflicts.

Ecology and Conservation of the Asiatic Cheetah in Miandasht Wildlife Refuge, Iran



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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. ICS is based in Tehran with members from all around the country. Presently, more than 20 people are working as ICS staffs or volunteers with various skills, all interested to do something for the five large carnivores to ensure their survival.

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.iraniancheetah.org.



The idea for studying on the cheetahs came about in fall 1996 when I met Marita, a young female Iranian cheetah in Pardisan Zoo, Tehran, for the first time. She was rescued from a tragedy in the city of Bafq in which her young sisters were killed due to unawareness by local people. At that time, the cheetah was one of the least known species of Iran and almost, there was no data about it in the country, which encouraged me to abandon medical sciences after 3 years and switching to study wildlife sciences at the university. I would like to dedicate this work to that cheetah, Marita.

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1. ACKNOWLEDGEMENT

In March 2003, the present project was initiated with cooperation of Jajarm Office of Environment, especially Hossein Absalan, chief of the area whose enthusiasm and commitment to save the area's wildlife resulted in approving Miandasht to be a cheetah habitat in winter 2002 for the first time. This work was possible due to a grant from the Rufford Maurice Laing Foundation, U.K. in 2004. We would like to thank Josh Cole for the hassle-free nature of the grant disbursement, who allowed us to use it in the best way possible to conduct a serious survey on the cheetah as well as launching a public awareness campaign. We are also greatly indebted to the US Columbus Zoo, Ohio because of recognizing this project to deserve a conservation award which facilitated more researches during 2005. We would also like to thank the Iranian Department of the Environment (DoE) who provided more financial support to continue this project till 2006. Production of 2 educational materials, Miandasht brochure as well as Miandasht wall calendar was supported by Mr Karroubi from the Iranian Technical Publishing Company in 2004 and 2005, which is really appreciated.

The Iranian Cheetah Society (ICS) is also grateful to Alireza Jourabchian, the former executive director of the Conservation of the Asiatic Cheetah Project (CACP) for his scientific and operational advices during this project. Also, we thank Dr Mahmoud Karami, Abdolhossein Vahhabzadeh, Mostafa Khalili, and Dr Bahman Shams for their fruitful comments on different aspects of this project. On the other hand, many thanks go to Josh Cole and Jane Reymond from Rufford Maurice Laing Foundation for their generous support as well as Dusty Lombardi, Director of the Living Collections and Rebecca Rose, Field Conservation Coordinator in Columbus Zoo who tried their best to fund this project despite of serious obstacles to support this Iranian project as a result of political complications between two countries. We are also grateful to Dr George B. Schaller, Dr Laurie Marker and Mr Eskandar Firouz who supported the ICS as referees to win a Rufford Small Grant.

A number of the ICS's volunteers participated in implementation of this project, including Fatemeh Hosseini, Morteza Eslami, Kaveh Hatami, Rouzbeh Behrouz, Saba Sohrabinia, Alireza Mahdavi, and Reza Goljani, whose help during field surveys is not ignorable.

Finally, I feel a privilege to express our frank sympathy and respect to the game guards as local partners of this project due to their kindly cooperation in field surveys, particularly Behzad Sherafati, Mohammad Hosseinzadeh, Ghanbar Mirnezhad, Hossein Harati, Hasan Farakhani, Hasan A. Sharif, Safdar Dinari, and Anvar Mirza Ali.

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2. EXECUTIVE SUMMARY

Established in 1973, Minadasht Wildlife Refuge is the last verified cheetah habitat in Iran, which is located in northeastern country with more than 85000 hectares. The area has been one of the best ranges for the goitered gazelle before 1980s as well as the cheetah, but due to weakening of conservation actions since early 1980s, the area lost most of its gazelle population (more than 90%) and the cheetah was never seen. In winter 2002, the cheetah was reported from the area which drew the attention of the Iranian Cheetah Society (ICS) for more investigations in the area.

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3. INTRODUCTION

With an area of more than 1,648,000 square kilometers, Islamic Republic of Iran is located in Middle East, Western Asia. The country possesses a network of less than 200 reserves, including National Park, Natural Monument, Wildlife Refuge and Protected Area, serving to conserve various aspects of the Iranian rich biodiversity (Darvishsefat 2006). The Iranian Department of the Environment (DOE) is the main governmental organization in charge of biodiversity conservation in the country.



FIG.1. Location of Iran. Source: www.worldatlas.com

Once distributed from the Indian subcontinent through Afghanistan, Turkmenistan and Iran to the Arabian Peninsula and Syria, the Asiatic cheetah (*Acinonyx jubatus venaticus*) is now one of the most endangered members of the family Felidae in the world and a flagship species for conservation measures in Iran. The last physical evidence of the cheetah in India was of three shot in 1947 by the ruler of the then Korea state. Since then, the cheetah rapidly disappeared from most of its range (Nowell & Jackson, 1996). Over the past 20 years, Iran has been the last stronghold for the Asiatic cheetah, known in Iran as *Yuz*, although there have been occasional reports of cheetahs across the border in Pakistan (Farhadinia 2004). The cheetah has been listed as “Vulnerable” in 2006 IUCN Red List of Threatened Species, but the Asiatic cheetah is “Critically Endangered” and is legally hunting prohibited in the country.

According to the Iranian Cheetah Society (2007), presently a population of at least 100 individuals is estimated to range across the eastern half of the country, mainly inside 7 verified habitats around the central Kavir. Located in northeastern part of the Iranian cheetah’s range, Miandasht Wildlife Refuge is the most recently verified habitat in the country (Farhadinia & Absalan 2004).

In order to enhance our knowledge about different ecological aspects of the cheetah and its associated biota in Miandasht, the present project was developed by the Iranian Cheetah Society (ICS) and implemented between 2003 till 2006. In fact, this is the first scientific document on the ecology of the critically endangered Asiatic cheetah in Iran, which can be a baseline of information for more studies on the other cheetah populations in the country.

4. WHY MIANDASHT WILDLIFE REFUGE?

Before World War II, the cheetah population was estimated to be around 400, ranging in almost all of the steppes and desert areas of the eastern half of the country and some western terrains near the Iraqi border (Harrington, 1971), but the advent of the jeep after the war marked the beginning of a decrease of this animal, largely through slaughter of their essential prey species, the gazelle (Lay, 1967). As a result, the cheetah population declined greatly in number. In 1956, the former Iranian Game Council declared the gazelle as protected by law and the cheetah too, in 1959. The gazelle population recovered in many areas and so did the cheetah. Cheetah sightings increased in different localities, particularly inside the gazelle habitats, revealing a remarkable resurgence of its population and the efficacy of conservational measures. In the late 1970s, the cheetah population was estimated to be 200-300 for the whole of the country (Firouz, 1974a). The cheetah range appeared to include all the desert areas of the eastern half of the country which consists of vast expanses of largely unpopulated terrains (Firouz, 1974b).

In 1979, the country witnessed a revolution, which interrupted wildlife conservation for a few years. So many areas were occupied by livestock and flat plains and steppes became the field of maneuver for armed 4WD vehicles and motorbikes chasing desert species, such as gazelles and also the cheetah. Gazelles declined in many areas, so the cheetahs had to move toward the foothills and mountainous habitats to avoid human persecution. On the other hand, because of the remarkable reduction in gazelle numbers, the cheetahs had to look for new food sources, wild sheep *Ovis orientalis* and wild goat *Capra aegagrus*, which in their mountain habitat, had not suffered the same pressures as the gazelles. The cheetah disappeared from many of its former ranges and was limited to some remote areas with a reliable prey population and relative safety.

Since late 1990s, efforts to save the cheetahs was started which resulted in approving several habitats for the cheetahs in Iran. The present cheetah range is significantly limited to desert rolling mountains and their surrounded foothills where they meet the flat plains. It has been a serious controversial issue among the wildlife experts about the most necessary action to ensure the long-term survival of the cheetah in Iran: Whether we need to save these mountainous habitats where the cheetahs presently live on wild sheep and wild goat? Or it is highly critical to save the flat plains and the gazelle populations which are supposed to be the original habitat and food prey of the Iranian cheetahs?

As described before, Miandasht Wildlife Refuge is the only plain habitat of the cheetahs in the country where there is no representative of family Bovidae, other than goitered gazelle. Accordingly, it seems that the area can play an important role to explore the cheetah's ecology inside flat plains, where it has been supposed to be their original home, rather than mountainous habitats. We hope that findings of this survey could help us to answer the above question.

5. GOAL AND OBJECTIVES

The project Asiatic cheetah's goal in Miandasht Wildlife Refuge was to ensure the cheetah survival in the area by preparing a conservation plan.

Accordingly, a series of objectives had been set as the following:

1. Exploration the cheetah's ecology, especially habitat selection and food habits;
2. Estimation of the cheetah's population parameters;
3. Investigation on cheetah and other large carnivores interaction;
4. Assessment of the human-predator interaction;
5. Finding practical approaches for more effective conservation of the area;
6. Increasing the awareness of local people.

6. PROJECT SITE

6.1. General Features

Located near the city of Jajarm (N 36 45' to 37 05' & E 56 25' to 56 57') in North Khorasan Province, northeastern Iran, this 84435 hectares area was designated wildlife refuge in November 1973 by the Iranian Department of the Environment (DoE). The area is composed of vast expanses of flat plains with rolling hilly terrains which have divided the area into two northern and southern halves. Hilly terrains inside the reserve form a core zone covered dominantly with scrubs, and some light hilly-mountains form the southern borders. A seasonal salty river, namely Jajarm Kalshur limits the northern boundary, providing an appropriate refuge for wildlife, particularly wild boar *Sus scrofa*, goitered gazelle *Gazella subgutturosa* and the cheetah.

It is highly important to emphasize that Miandasht is unique among the Iranian reserves, because more than 90% of the area has a slope less than 10% forming flat plains, while slopes more than 30% are rare. The altitude range of Miandasht is 900-1340 meters, mainly less than 1000 meters. The mean annual temperature and precipitation of 14 degree centigrade and 150 millimeters, respectively have resulted in a arid climate in the region.

The reserve consists of desert and kavir ecosystems with xerophyte and halophyte species, mainly from families *Leguminosae*, *Salsolaceae*, *Chenopodiaceae*, and *Graminae* (Salehi 1994). Miandasht is dominantly covered with wormwood *Artemisia sieberi*, feather grass *Stipa spp.*, and saltwort *Salsola spp.* with saxaul trees *Haloxylon*, scattered on sand plains as well as tamarisk *Tamarix* along the dried watercourses. Meanwhile, invasive plant species such as *Peganum spp.* and *Sophora alopecuroides* are covering the area from the southern degraded pastures toward north. Physiographic features of Miandasht WR can be seen more clearly on the following landform maps:

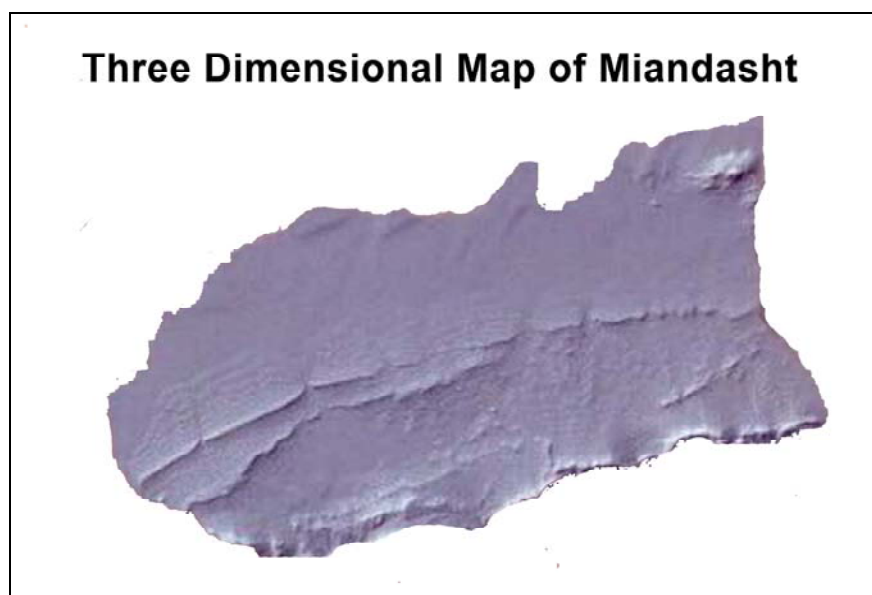


FIG.2. 3 dimensional map of Miandasht

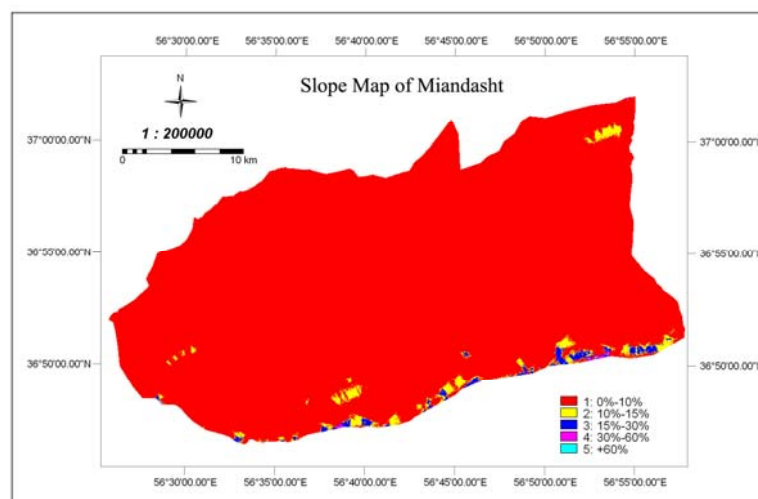
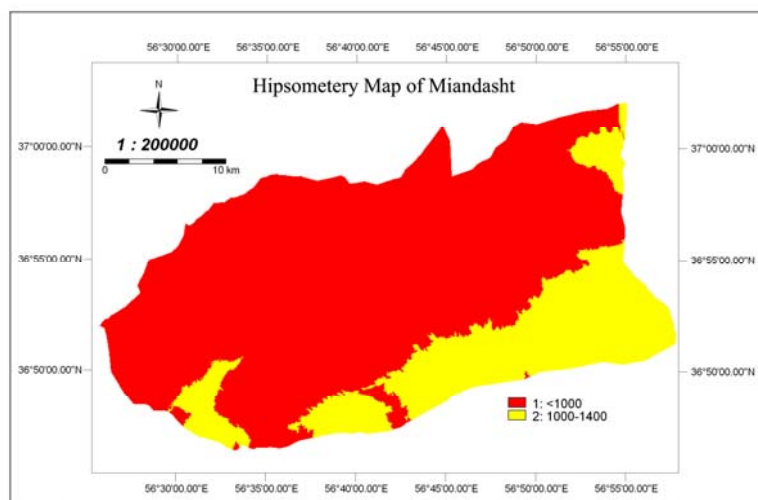
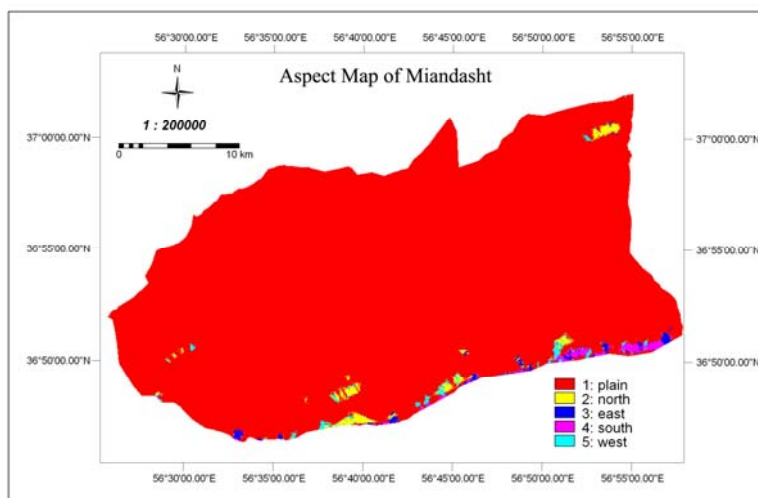


FIG.3. Landform maps of Miandasht

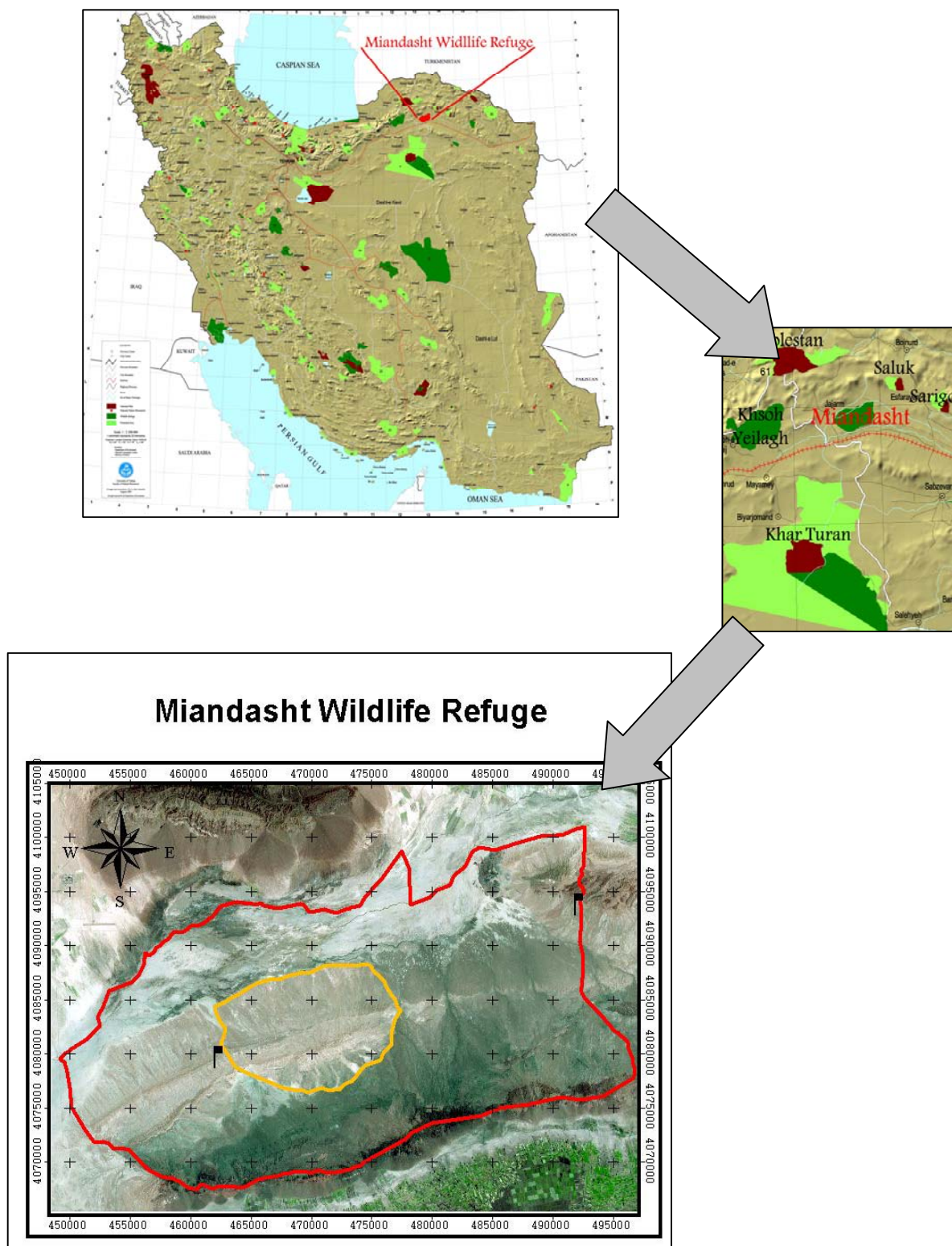


FIG.4. Miandasht position among the Iranian reserves, neighbor reserves and the area's map and satellite image

Miandasht is surrounded by a network of well-known Iranian reserves, namely Golestan NP, the most famous and oldest Iranian reserve in north, Khar Turan NP and Khosh Yeylagh WR, where once was considered to be the best cheetah habitat in the Asia (Joslin 1984, Hajji 1986) in south and west and Saluk and Sarigol NPs in east. Thus, Miandasht was expected to enhance the conservational role of above mentioned network, particularly for the cheetah due to its high density of goitered gazelle.

Due to weakening conservation measures after the 1979 revolution, the area was occupied by more than 50000 head of livestock belonging to local villages. Moreover, the area was invaded by local poachers, who chased the gazelles on powerful motorbikes. Livestock pressure, doubled by drought, led to degradation of the range and most of the herders sold their stock and went to work on farms.

At present, Miandasht Wildlife Refuge faces a variety of major problems. Poachers have had a great impact on the gazelle population, but as a result of law enforcement in recent years, Miandasht has become relatively safe, so that there is an invaluable opportunity for the gazelles to recover. On the other hand, decreased number of livestock to 15000 heads is still a main problem which has reduced the high quality rangelands for the gazelles. Moreover, presence of several livestock herd dogs (not guard dogs) in companion of each flock as well as distribution of the flocks throughout the southern half of the area interrupts its security. The core zone, approved in July 2004, was a great step towards conserving Miandasht. Fortunately, the Iranian Department of the Environment plans to upgrade the area's conservation status from Wildlife Refuge to National Park.

6.2. Wildlife of Miandasht

Due to vast and flat plains forming most of the area, Miandasht Wildlife Refuge is a unique reserve among the Iranian protected areas. The area now holds a few hundreds of goitered gazelle as the only bovid, which once was estimated to be around 3600 in 1970s (Bayat 1984). Recently reached to the area, wild boar *Sus scrofa*, is the latest guest of Miandasht, which has dispersed from northeastern mountains into the area in early 2000s.

Due to high density and diversity of rodents (11 species) as well as cape hare *Lepus capensis*, small carnivores are abundant inside Minadasht, such as:

- Common Fox (*Vulpes vulpes*) has the highest density among the area's carnivores and can be seen easily during daylight.
- Jackal (*Canis aureus*) is more abundant in the northwest Miandasht close to the city of Jajarm.
- Wild Cat (Steppe Cat) (*Felis ornata*) is the most abundant felid.
- Sand Cat (*Felis margarita*) was seen in spring 2007 for the first time.
- Caracal (*Caracal caracal*) is the least known, in September 2004 seen for the first time, then approved by camera traps
- No reliable report from family Mustelidae is available.

The cheetah is the most charismatic species inside the area, coexisting with two other large carnivores, namely grey wolf *Canis lupus* and striped hyena *Hyeana hyeana*.

Miandasht possesses a high diversity among its avifauna and less than 50 species were identified, including only 10 species from order Falconiformes. Houbara bustard (*Chlamydotis undulata*) and black-bellied sandgrouse (*Pteroles orientalis*) are common species in the area and possibly a food source for carnivores. More than 10 species of reptiles have been identified during this survey, as well.

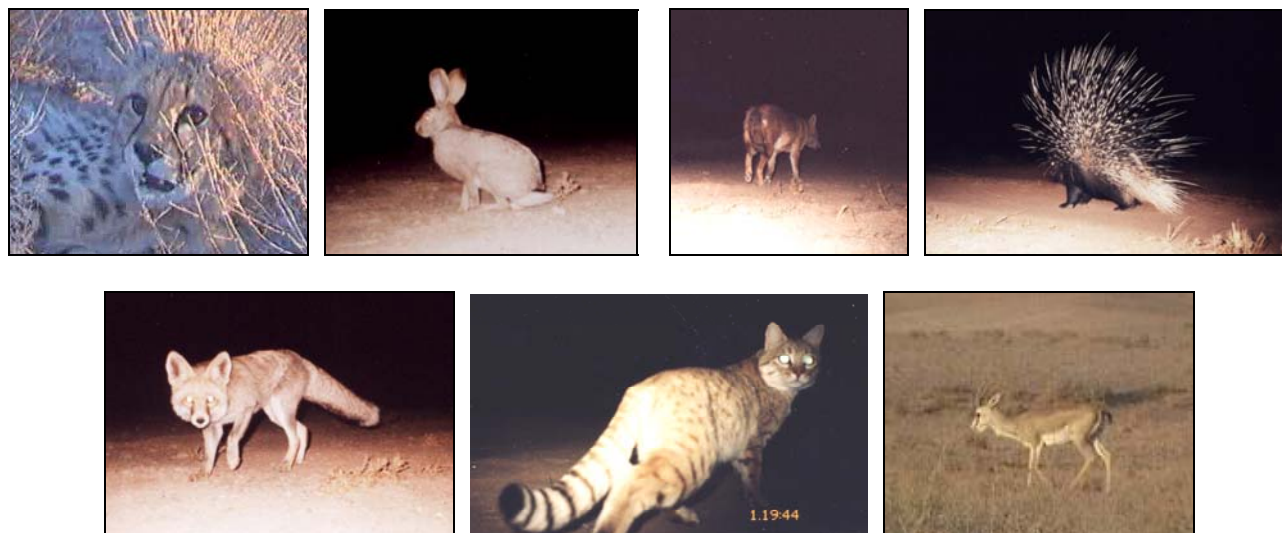


FIG.5. Some of Miandasht mammals

7. METHODS

Despite of long conservational background since early 1970s, no remarkable scientific survey has been done in Miandasht WR. The preliminary distribution map of the species was initially prepared based on inquiries of verified direct observations of the cheetah in different parts of the area as the basic step to designate survey routes (Karanth & Nichols 2002). Inquiries about the cheetahs were also made with local people, mainly game guards and shepherds of the study area who visit frequently most of the area. Cheetah observation by local people was only accepted after proper confirmation, mainly through proper assessing of the observer's ability to describe the animal's morphology. Behavior of the animal, as described by the observer, sometimes helped to reveal the identity of the species seen. Due to presence of other sympatric large carnivores in the area, including the striped hyena and grey wolf, which seem to be remarkably similar to the cheetahs in the wild from a distance of more than several dozen meters, it is highly important to verify the local people's observations.

Miandasht is a plain-hilly area and we selected three different routes in order to cover various habitats of the area. The main parameters to choose the routes were covering various habitat types, covering different rangelands for gazelles and livestock, passing near waterholes, and accessibility. All the routes were patrolled twice a month since winter 2004 to winter 2005 on motorcycle to observe different species and to find the animals' signs. The motorcycle was often ridden by a driver with a back observer.

In order to find more about the cheetah and other carnivore habitats in the area, we determined 10 different tracking points distributed throughout the area. Tracking points possess appropriate soil to leave the tracks for a few days, usually near waterholes, main watercourses or tamarisks where are commonly visited by the cheetahs. The cheetah tracks in different parts of the area were measured exactly on the maximum length and width in order to obtain a perception about the cheetah's size and possibly identifying different individuals.

We used two methods to study on food habits of the cheetah in the area, namely scat analysis and kill monitoring. Mills (1992) noted that scat analysis is useful for a basic description of a carnivore's diet, particularly where other types of observation are impossible. Cheetah males may defecate on prominent objects, whereas females tend to defecate randomly. Males tend to take larger prey more frequently than do females, so a male-biased fecal sample is expected (Mills 1992).

Due to presence of other large carnivores in the area, we needed to be conservative to record the kills and scats as the cheetah's. The positive signs of cheetah origin of the scats were characteristic compact form with well defined segments and one of the extremities especially tapered described by Chame (2003). If the scat was white full of small bone particles or garbage, it was related to the striped hyena (Eslami & Mahdavi 2007) and if a thick scat with diameter larger than 3 cm (Waeber & Fritts 1979) on the bushes without a complete segmented cat-like shape was found, we collected the sample as the wolf (Farhadinia *et al* 2006).

Samples were sealed in plastic bags and labeled for path location and date. According to Ramakrishnan *et al* (1999), the hair of prey is relatively undamaged in carnivore scat and can thus be used to identify the prey species eaten. Rodents were identifiable based on remains, such as skull, bone and hair (Stuart & Stuart 1993) and plant materials could be easily recognized. A day's search rarely led to the recovery of more than one scat sample, indicating that scat samples were the results of independent predation events. Samples were collected regularly throughout the study period. All samples were inspected for presence of hairs, bones, nails, and other remains. Hairs were identified using a reference collection compiled by Sepasi & Falahatkar (2006) under microscope. While searching the trails and tracking posts for the cheetah's scats, it was necessary to search remote areas far from the trails for kills, especially the gazelle.

Apart from scat collection, presence of cheetahs during the entire study was recorded by direct sightings, both by researchers and local residents, and presence of cheetah tracks and kills.

The geographical coordinates of cheetah's direct or indirect sightings were determined by Garmin Etrex GPS and then plotted on the Landsat 7 satellite image of the area by means of ESRI ArcView GIS 3.2a software to describe the habitat selection of the species. Unfortunately, the landscape map of Miandasht was not available for more analysis on this critical aspect of the cheetah's ecology.

As the first step to study on the cheetahs population, their spatial distribution was recognized based on verified direct and indirect observations made by local people/game guards. Then, in order to obtain a basic perception about the cheetah population size in each area, the camera trapping technique was used. In this technique, 'marked' animal allow unambiguous identification of the individual (Karanth & Nichols 2002) and since the spot patterns of the cheetahs are unique and remain constant through their life (Caro and Durant 1991), individuals can be recognized from photographs and followed through time (Kelly 2001).

An appropriate sampling design is critical before using this technique to catch a reliable, scientific estimation of the cheetah's abundance for each area. Capture-Recapture sampling is recommended to be a robust, well-developed tool that provides a sound theoretical basis, good software and formal ways of accommodating and testing biological assumptions underlying camera trap photo captures of tigers (as a marked species) and even allows us to test the fit of the alternative estimation models to our own data which are practically used by Trolle and Kery (2003) for ocelots and O'Brien *et al* for Sumatran tigers (2003). However, due to low numbers of cameras applied in the area and lack of an appropriate spatial configuration of the cameras, we were not able to meet the basic assumptions needed to use these methods. Accordingly, we utilized Minimum Number Alive (MNA) method which is described by Krebs (1999) and found it a simple solution to analyze the images.

MNA is an enumeration method with a common complaint- it suffers from a negative bias. However, in a few cases enumeration methods are needed and can be justified on the principle that a negatively biased estimate of population size is better than no estimate. The fact that most animals do not satisfy the randomness-of-capture assumption of mark-recapture methods is often used to justify the use of enumeration as an alternative estimation procedure (Krebs 1999).

Thus, the camera trapping data was used to prepare a basic estimation of the population based on spotted patterns comparison described by Chelysheva (2004). Meanwhile, it was tried that around the camera trapping intervals, observation of the species plus its track became verified in order to obtain a more realistic perception about the population inside the area.

After preparation of the cheetah's distribution map, a total of 11 appropriate points were defined to set camera traps. Since Miandasht is a complete plain habitat, it was critical to conduct a tracking phase before utilizing a few camera traps to obtain the best results, as it is indicated by Sanderson (2004) that prior to placing camera photo traps, inspect the area selected for monitoring for at least 30 days to identify all locations that show preferential usage by medium and large mammals. Local knowledge from the game guards played the main role to find the locations for the cameras. However, field surveys by the researcher team gave the best locations to set the cameras in order to increase the chance of capturing a cheetah.

According to Krebs (1999), in cases with endangered species, the numbers of animals in the population are so low that recaptures are so rare. Images were used to estimate the minimum abundance of the species through Minimum Number Alive method and the data gathered through direct and indirect observations while the camera trapping period were used in order to obtain a more realistic perception about the cheetah population in Miandasht.

Based on 7 months tracking the cheetah and other species, we used a number of Wildlife Pro camera traps (CamTrakker Co.Ltd ©, USA, 2004) in 11 different camera points, totally more than 400 camera nights. However, due to some problems to set the cameras, including unavailability of most of the area in rainy months, lack of reliable vehicle in most of visits, lack of safety in some places and low number of cameras, we were not able to follow the Capture-Recapture method. Accordingly, we tried our best to

implement the first of four steps of wildlife population survey described by Karanth and Nichols (2002), namely Absence/Presence survey of the cheetah and its relevant species via tracking, direct observation, camera trapping, and interviewing with local people.

Investigation on prey species was done simultaneously, particularly ungulates, rodents and ground birds. Determination of the gazelle's population size is done 1 or 2 (fall and spring) times a year by the Department of the Environment (DoE) based on direct observation census. Sherman live traps and spotlight were utilized to identify the rodent species as well as catching a rough estimation of encounter rate, especially for Dipodidae. Ground birds were surveyed throughout the area, especially Houbara bustard (*Chlamydotis undulata*) and black-bellied sandgrouse (*Pteroles orientalis*), which are considered to be migrant species.

Socio-economical study was an important part of this survey, particularly to assess predator depredation on livestock. Due to high conflict with governmental game guards because of lack of grazing permission in most cases, presence of game guards made them run away. Accordingly, a motorcycle was bought to visit them inside their pastures for a questionnaire survey. A questionnaire was developed and addressed to a total of 37 herders of the area, which represented around 80% of all herders. The questionnaire requested information concerning livestock holding patterns, types and numbers of livestock lost to the predators and their economic value, and herders' suggestions for reducing predation losses (Oli 1995). Also, the frequency of cheetah sighting on their pastures was asked (Saberwal *et al* 1994). The data were entered to Microsoft Excel 2003 for descriptive analysis.

After assessment of the human-cheetah interaction, a public awareness campaign was launched just to sensitize local people about the cheetah and its importance and how to identify it from other large carnivores. A number of brochures as well as wall calendar with the area's wildlife images were published and disseminated among the people.

8. CHEETAH

8.1. Background

Located inside the cheetah range in the country, Miandasht Wildlife Refuge has been considered as one of the best habitats for the cheetah in the country since establishment in 1975, as Eskandar Firouz (*pers.comm.*), the head of the Iranian Department of the Environment in 1970s describes the area as a fulfilling target for dispersal from surrounding cheetah habitats including Khosh Yeylagh, Khar Turan and Golestan. According to local people, the cheetah was once abundant in the area and there are various reports on observing and even poaching this animal. The most important factors which had made Miandasht a suitable habitat for this creature are as the following:

1. A plain habitat with hilly terrains distributed throughout the area and cut with long and deep watercourses which provide an appropriate habitat for different aspects of the cheetahs' life, including reproduction, hunting, avoiding danger, movement and dispersal.

2. A good population of the goitered gazelle *Gazella subgutturosa* (FIG.7) exists in scrublands of the area. According to Farahmand (2001), the goitered gazelle prefers plain habitats with slope range of between 0 to 30 percent. Hemami (1994) regards *Artemisia siberi* beside representatives from families *Salsolaceae*, *Chenopodiaceae* and *Graminae* as suitable foods for the gazelles which are abundant in Miandasht. Bordering with extensive agricultural lands in north and south, Miandasht can meet the gazelles' preference to refer to farmlands, based on Alamesh (1993). Moreover, presence of hilly terrains and light topographic conditions provide the gazelle herds a suitable habitat with reliable escaping terrains from predators and poachers. Accordingly, it is clear that Miandasht has been a suitable for the goitered gazelles as the main large prey for the cheetahs.

As a key site inside the cheetah range in north of the central Kavir, Miandasht is only a few dozens kilometers northeastern of Khar Turan and Khosh Yeylagh. The last official report from the latter reserve dates back to 1983, but Khar Turan still holds one of the largest populations of the species in the country (Farhadinia 2004). Holding a few hundreds gazelles, Golestan NP in north was once considered as a cheetah habitat (Kiabi *et al* 1993) with the last official report in 1986 (Jourabchian, *pers. comm.*). In fact, Miandasht Wildlife Refuge is a key and important site to connect the populations in Semnan and Khorasan provinces, northeastern Iran.

1. Kavir National Park
2. Arask Hunting Prohibited Area
3. Khar Turan National Park
4. Khosh Yeylagh Wildlife Refuge
5. Miandasht Wildlife Refuge
6. Golestan and Behkadeh Reserves



FIG.7. Goitered gazelle, the main wild ungulate in Miandasht

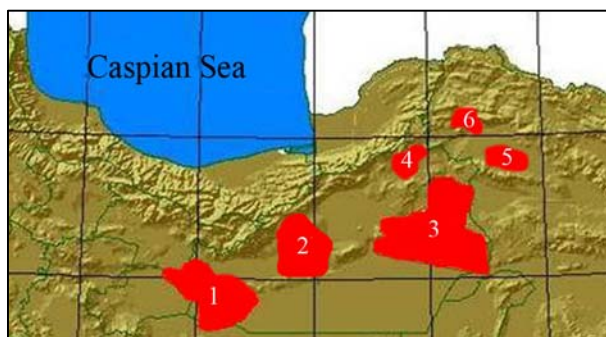


FIG.7. Cheetah habitats composing the northern population in Iran

There is no report on the cheetah history in Miandasht, but the area has been a famous habitat for both the goitered gazelle and cheetah in the country (Jamshid 1975). There are a few occasional documents in Jajarm Office of the Environment on observation the cheetahs or finding some signs in 1980s and 1990s, but none of them are reliable. Thus, the cheetah had an unclear background in the area, particularly during 1980s and 1990s when there is no official report about the cheetahs in Miandasht after the 1979 revolution. Meanwhile, two scenarios about the cheetah status in 1980s and 1990s can be considered:

1. According to the Iranian Department of the Environment, as interrupting the wildlife conservation after the 1979 revolution, slaughtering of the gazelles and occupying the area by livestock, the cheetah became extinct in Miandasht. But, due to strengthening conservation measures in recent years in the nearest cheetah habitat as Khar Turan NP, the cheetahs were able to disperse into Miandasht. At the same time, due to enforced conservation actions by the Iranian DoE, the cheetahs found the area a suitable habitat and have established a resident population.

2. On the basis of occasional reports by local hunters and herders, the second point of view says that the cheetahs never became extinct in Miandasht, but they survived in small number. As a result of empowering conservational measures since early 2000s, the cheetahs' observability increased.

According to the surveys and interviews with local people, during the past 2 decades the animal has been sometimes seen and at least 10 cheetahs have been killed during this period. However, there is no photo, skin or skull from this animal to approve this opinion, but we think that the second idea is more probable and mountainous/hilly parts of the eastern Miandasht to Chehel Dokhtaran (some 30 kms outside the area's boundaries) have been the cheetah's stronghold during the above-mentioned period (FIG.8).



FIG.8. Eastern mountainous stronghold of the cheetah in Miandasht

Due to locating outside of the area and its topographic circumstances, this stronghold is rarely visited by game guards. On the other hand, presence of small bands of the goitered gazelle in the eastern plains could provide the cheetahs a small source of food, but not reliable. There are two villages around this stronghold which the people have been mostly busy with their herding and farming activities, not hunting. It seems that due to enhanced protective efforts since early 2000s, the cheetahs were allowed to come more inside the area which can provide them higher density of gazelles. On the other hand, it has always been probable that as increasing the cheetah population in Khar Turan NP in south, the cheetahs could disperse into the intermediate habitats, then to Miandasht.

The first recent report on the cheetah in Miandasht dates back to December 2002 when a mother in companion of her 2 young cubs seen while eating a young male gazelle. Since then, the cheetah is seen by the game guards, shepherds and local people on average once a month which is a relatively high rate among the Iranian cheetah habitats.



FIG.9. Caster of plaster of the first cheetah observation in Miandasht which approved the cheetah existence officially (December 2002)

8.2. Habitat

Most of data about habitat selection of the Iranian cheetahs come from the African studies (e.g. Schaller 1972, Eaton 1970, Caro 1994) where the cheetahs mainly occur inside the flat plains to feed on gazelles. According to most of the literatures on the cheetahs in Iran, the species habitat has been considered as desert plains and low hills that have gazelle (Firouz 1974b, Dareshuri & Harrington 1976, Etemad 1985, Ziaie 1996), meanwhile, Jourabchian (1999) noted that the present cheetahs in the country live on wild sheep and wild goat inside hilly and mountainous habitats. Accordingly, Farhadinia (2004) declared a hypothesis that due to interruption of wildlife conservation after the 1979 revolution, the more susceptible plain dwelling species, including the gazelles were slaughtered and the cheetahs had to switch their habitat from plains to hilly and mountainous terrains in order to find more safety and to feed on ungulates living in these habitats, including wild sheep and wild goat which were able to save themselves against the heavy poaching pressure in early 1980.

This hypothesis is one of the most controversial issues among the Iranian wildlife experts and managers, which has a significant impact on protective measures and rehabilitant efforts across historical ranges to save the integrity of the cheetah's range in eastern country. Unfortunately, our knowledge about the cheetah is quite limited to just a few years ago and there is no data on the cheetah in times when the cheetahs had access to different ungulates in large number without any human persecution to live.

The present cheetah population occurs in 7 verified habitats (Iranian Cheetah Society 2006) which most of them have low populations of gazelles, but higher numbers of wild sheep and wild goat inside the mountainous habitats. However, Miandasht WR is a unique area, because unlike other six cheetah habitats in the country, it is mainly composed of vast expanses of plains with scattered hilly terrains which have made it an appropriate habitat for the cheetahs and the gazelles (Farhadinia & Absalan 2004). Accordingly, it seems that Miandasht WR is an appropriate natural lab to enhance our knowledge about the cheetah's ecology, particularly food habits and habitat selection, because of its high similarity to the cheetah habitats before 1970s.

Due to topographic conditions and prey species, Miandasht WR is the most similar Iranian habitat to the Africans where the cheetahs are in close interaction with antelopes in plains; therefore the result of several decades studies on various aspects of the cheetah's ecology and biology in Africa is the most applicable to Miandasht cheetah population among the Iranian cheetah habitats.

On the basis of locating the cheetahs (directly and indirectly) in 69 points between February 2003 to September 2006, 68% of the cheetah points have been recorded among the hilly plains or in distance of less than 500 meters from the topographic conditions, including dried watercourses (more than 1 meter deep) or hilly terrains. At the same time, most of the remaining 32% were in proximity of dense vegetation, particularly tamarisk trees as well as small watercourses, which can provide them necessary cover. In total, it was very uncommon to find the cheetah's evidence in flat plains without any watercourses, hilly terrains, or tamarisk cover. According to Farhadinia (2006), out of 81 direct observations of goitered gazelle during a course of 1 year in Miandasht Wildlife Refuge, 64% were made in hilly plains, while less than 12% belonged to flat plains. Also, 24% of the gazelles were sighted on plains covered with small trees. Jamshid (1975) also noted that the gazelles used to stay near hilly terrains in Miandasht. Hence, it seems that spending around the hilly terrains bring the cheetahs chance of more encounters with the gazelles. Approving of the central hilly terrains with more than 16000 hectares as core zone was considered to be an important step to save the cheetahs; however, there has been no official report before 2000s (Salehi 1974).

Our data suggest that the cheetahs in Miandasht used to occur mainly around and among hilly terrains and rarely can be seen in vast plains, even those areas where the gazelles occur in higher abundance. It seems that they can find shelter in hot sun and rain, good sight over surrounding plains for preys and also,

increasing the survival chance of their newborn cubs against sympatric carnivores, striped hyena and wolf who can be potential dangers.

Woodland savannas, with a greater availability of cover than open plains, might inhibit cheetahs from attaining high speeds, but may confer other advantages not provided by grassland habitats. Cover is considered advantageous to cheetahs for taking prey (Caro 1994), because it enables them to get closer to the quarry before the chase, thereby reducing chase distance and improving hunting success (Eaton 1970, Caro 1994).

As it can be seen on figure 12, most of the cheetah sightings have been recorded near or along the drainages, proposing that the animals usually walk along dry watercourses with a few dozens centimeters to more than 3 meters depth to change their location and to reach to other parts of their habitat. Meanwhile, moving under ground routes gives them the advantage of approaching their preferable prey species, the goitered gazelle without any disturbance, within a few dozens meters where they have a good chance to catch them. On the other hand, we never found any sign of wolf, a robust, usually group living carnivore as a possible rival along the watercourse, but mostly along the roads. Thus, the cheetahs probably avoid any encounter with the wolves and also the human.

Surprisingly, Doshakh and Satelmish, two vast plains with slight hilly terrains and watercourses, have been considered to be important habitats in the area, but we recorded the cheetah less than 3 times inside each one, possibly due to difficulty in approaching the gazelle herds in flat plains despite of their relatively higher density. Accordingly, it seems that the cheetahs are mainly dependent to the habitats with higher prey “catchability” rather than high abundance. Hopcraft *et al* (2005) noted that the Serengeti lions select areas where prey are easier to catch, rather than areas where prey densities are highest. Prey tend to avoid dangerous areas. In Serengeti National Park, Caro and Collins (1987) found that territorial males usually select territories centered on areas that provided cover but did not have particularly high rainfall or prey abundance. The position of territories suggests the importance of cover or some resource associated with it. This is supported in that those areas which contained very many gazelles, but very few kopjes or hardly any trees, were not found to be territories. Caro (1994) noted that beside the prey density, cover type is a significant parameter to define a suitable habitat for the cheetahs. Presence of denser and taller plant cover and topographic conditions enable them to reach to their prey without being seen by this group living species. Therefore, the cheetahs benefit significantly higher hunting success rate, particularly among the females who hunt usually alone in areas with taller plants and topographic conditions.

Among 69 cheetah observation points, 88% (n=61) were inside a radius of less than 5 km from water sources, while more than 62% (n=43) were no far than 1 kilometer from water, which most of the points outside of 1 kilometer radius were in wet months. The maximum distance from a water source was around 9.5 km in November, for a patrolling young cheetah, but most of the observations were made just a few kilometers from waterholes in warm months. More occurrences of the cheetahs near waterholes (FIG.10) can be logically related to higher density of their favorite prey species (Dragesco-Joffe 1993), which the more distance from water sources, the lower density of the gazelles (Farahmand 2001).

It seems that the water can not be a limiting factor to determine the cheetah’s territory/home ranges in Miandasht, because the area is not so vast. Females need water during the first months after bearing their cubs to provide their newborn cubs enough water (Laurenson 1992) which in this period of time, they spend more time drinking water and make efforts to increase their hunting success (Laurenson 1995). The other cheetahs can even supply their water via drinking their prey blood or urine (Caro 1994). According



FIG.10. Cheetah track at a waterhole

to Frame (1984), the cheetahs in Serengeti rarely drink water, normally once per 4 days and he encountered some individuals without drinking even up to 10 days. Thus, the water has apparently no remarkable direct impact on the cheetahs, but it is a critical abiotic factor which determines the distribution and productivity of the cheetah's large prey, the goitered gazelle.

In sum, it seems that the Iranian cheetahs inside their last typical plain habitat in the country still prefer to live among/near hilly terrains and avoid flat plains which were commonly believed to be their main habitat (Etemad 1985, Ziaie 1996), just as corridors to switch their location and to reach to the other parts of their habitat. On the other hand, rarely seen by the herders and game guards whose activities are mainly concentrated on plain regions during the past decades, it is necessary to review the traditional belief that the cheetahs are mainly a plain living species with serious doubt.



FIG.11. A typical view of the cheetah's main habitat in Miandasht WR: From the left hills, it is easy to find and approach via the watercourse to the gazelles grazing on the right plains.

8.3. Distribution & Dispersal

Based on the cheetah records on the satellite image, the cheetahs range between northeastern and central hilly terrains and utilize dry watercourse to move (along the blue lines of drainage network). As shown on FIG.12, cheetah sighting points are near or along watercourses and they usually travel through them to change their position between central hilly terrains and northeastern rocky mountains. On the other hand, the cheetahs are encountered near patrolling roads (brown lines) by people, particularly game guards.

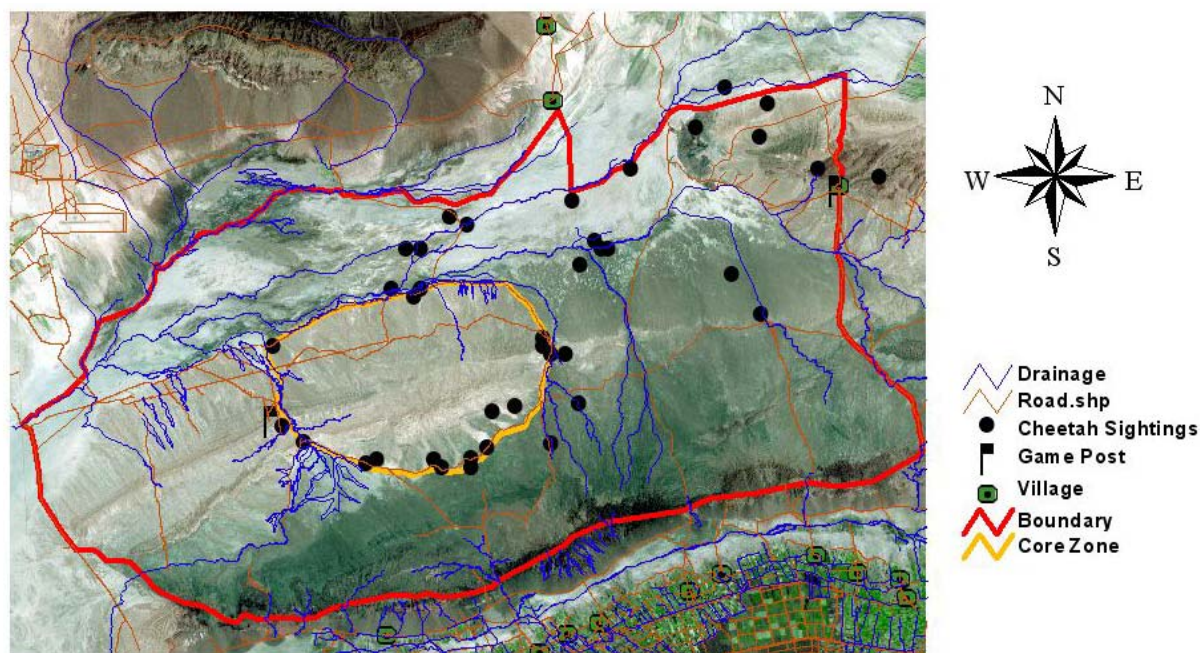


FIG.12.Cheetah observation points in Miandasht WR: Most of the points are along or near watercourse (blue lines) and the animals are encountered with the game guards during their daily patrolling routes (brown dotted lines)

In Miandasht WR, the cheetahs use to spend around the central hilly terrains which form the area's core zone and use the watercourses to approach their preys. As well, they occur around the northwestern mountains, called Sorkhcheshmeh and Anjerli. The maximum distance recorded to patrol by the cheetahs is around 20 km in less than 3 days by a mother and her adolescents in February 2003.

It seems that the central hilly terrains (core zone with yellow border) provide the cheetahs a safe habitat due to less access of poachers, less-developed network of patrolling routes and thus fewer visits by the game guards and ultimately, no permission for the livestock to graze throughout the year. At the same time, surrounding by vast plains with *Graminae* and *Artemisia* (gazelle main food items), the cheetahs have always access to the gazelle, particularly in warm months, when the gazelles need to refer regularly to the limited number of waterholes at the hill-plain borderland.

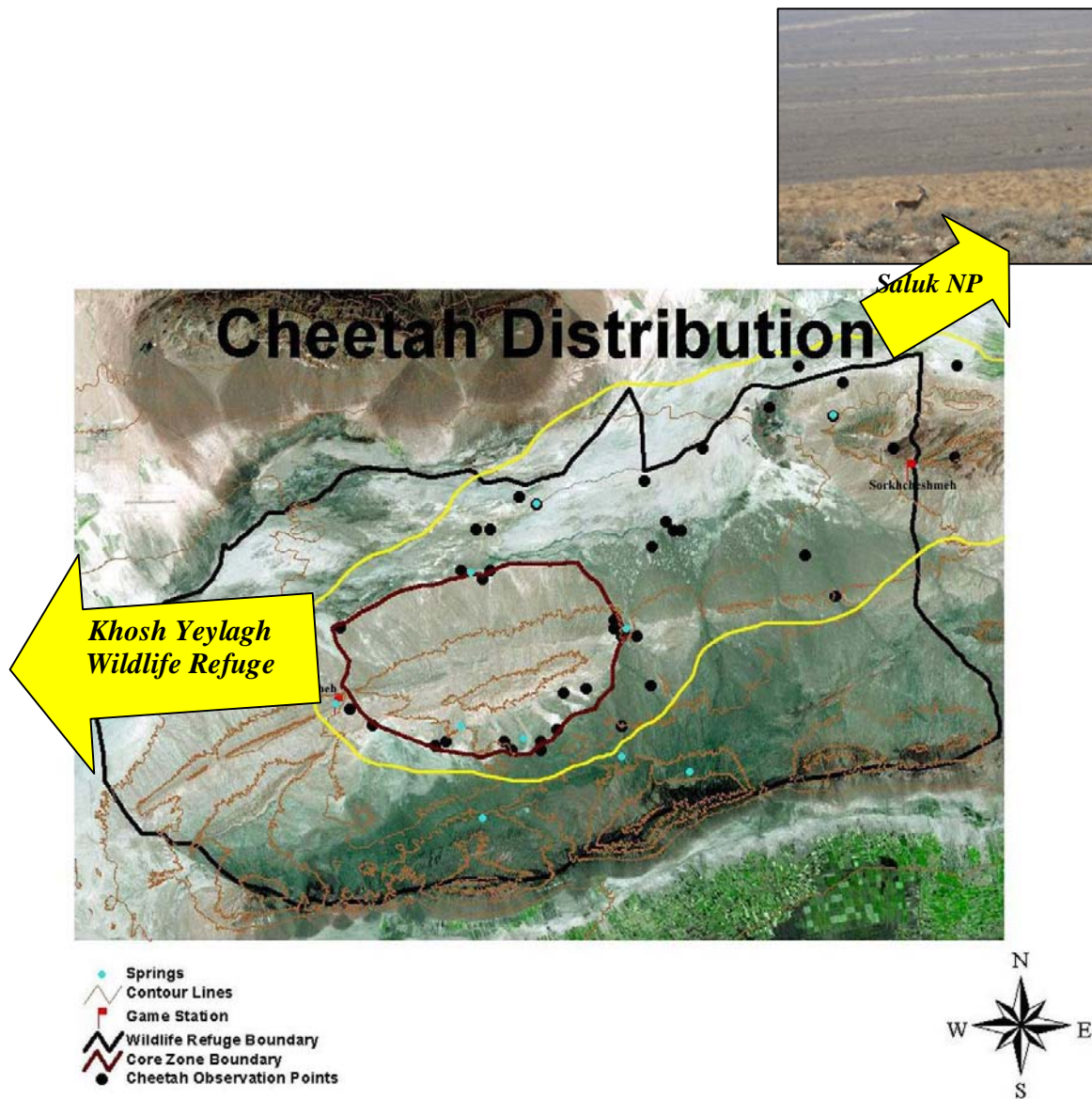


FIG.13. Cheetah distribution and dispersal: Yellow arrows show the direction and intensity of dispersal.

Located some 70 kilometers westward of Miandasht, Khosh Yeylagh Wildlife Refuge was once considered to be the best habitat for the cheetahs in the country (Joslin 1984, Hajji 1986). However, it is more than 25 years that no cheetah has been reported from Khosh Yeylagh WR (Farhadinia 2004). Regarding the intermediate habitats between Miandasht and Khosh Yeylagh without any main human settlements, main highways, and abundance of hare and rodents, it is believed that the cheetahs' first option to disperse from Miandasht is Khosh Yeylagh, which is verified due to several reported observations by local people inside intermediate habitats (Hosseini Absalan *pers.comm.*).



FIG.14. Cheetah in Khosh Yeylagh, 1976

On the other hand, located some 40 kms northeastward, Saluk National Park holds one of the highest densities of goitered gazelle in the country which is reported to be more than 3 per square kilometer (North Khorasan

Provincial Office of the Department of the Environment 2007) plus wild sheep and wild goat. But, the cheetah has never been reported from the park during past and present. Abundance of farmlands between 2 areas as well as flatness of Saluk plains without any watercourse to provide a suitable habitat for the cheetahs seem to be the main causes that this creature never occurred there and the eastward dispersal route is not considered with high importance.



FIG.14. Intermediate habitats between Miandasht and Saluk: The photo looks from Miandasht through intermediate farmlands at far mountains and plains of Saluk NP.

8.4. Food Habits

Food habits of carnivores are central to the ecological niche they occupy, play an important role in explaining their social systems, behavior, and factors affecting population density, and may also have important implications in the life histories of their prey. They are, therefore, important considerations when formulating species and ecosystem management strategies (Mills 1992).

Little is known about feeding ecology of the Iranian cheetahs, while it has been one of the most challenging quarries against wildlife experts and managers in Iran and can play a significant role in developing management plans for conservation of the species. On the other hand, the majority of studies of free-living cheetahs have centered on their feeding (Caro 1994) and due to relative similarity between Miandasht and African savanna-woodland habitats, we made a serious literature review about the cheetah food habits in Africa.

Cheetahs are diurnal and hunt during the day. Various strategies are employed including stalking, approaching prey in full view and flushing hidden prey from long vegetation (Caro 1994), all utilizing the cheetah's exceptionally high running speed. In all studies on the cheetahs in Africa, young prey animals are taken in preference to adults (Caro 1994) and Schaller (1972) calculated hunting success with 54% of adult gazelle hunts and 100% of neonate fawn hunts being successful.

The cheetahs are famous to kill gazelles as their main prey in Iran (Lay 1967, Firouz 1975b, Etemad 1985, Hajji 1986, Ziaie 1996) and other west Asian countries (Novikov 1962, Harrison 1968, Roberts 1997), however, other species are included in the cheetah's diet as well, such as small mammals and wild sheep (Goodwin and Holloway 1974, Hajji 1986, Ziaie 1996, 1998, Jourabchian 1999) and even wild goat (Jourabchian 1999, Farhadinia 2004). In Turkmenistan, the Asiatic cheetah is reported to primarily take goitered gazelle, The disappearance of the cheetah from this area is strongly correlated with the decline of this gazelle (Heptner and Sludski 1972). Dragesco-Joffe (1993) reported that dorcas gazelle is the favorite prey of the desert cheetahs in Niger. Diet preferences of cheetahs in different areas reflect differences in prey species and their abundance (Caro 1994), with preferred food of cheetahs varies with location, although most preferred species are medium-sized herbivores (Caro 1994, Mills *et al* 2004) weigh less than 40 kg (Schaller 1972).

Farhadinia (2004) noted that during 1979 revolution, which interrupted wildlife conservation for a few years, so many areas were occupied by livestock and the flat plains and steppes became the field of maneuver for armed 4WD vehicles and motorbikes chasing desert species, such as goitered gazelle *Gazella subgutturosa*, Jebeer gazelle *Gazella bennettii*, and also the cheetah. Gazelles declined in many areas, so the cheetahs had to move toward the foothills and mountainous habitats to avoid human persecution. On the other hand, because of the remarkable reduction in gazelle numbers, the cheetahs had to look for a new food source, wild sheep *Ovis orientalis* and wild goat *Capra aegagrus*, which, in their mountain habitat, had not suffered the same pressures as the gazelles.

It is not clear if the cheetah relied mainly on gazelles previously or they supplied part of their food needs based on mountainous herbivores. Unlike so many Iranian reserves, Mindasht WR only holds a population of goitered gazelle *Gazella subgutturosa*, because there is no rolling mountainous habitat to be home of wild sheep *Ovis orientalis* and wild goat *Capra aegagrus*. Therefore, Minadasht is the only remained heritage of the previous age of the Iranian wildlife, because it helps us to imagine the previous circumstances in which the cheetahs lived in plains and fed on gazelles, but now they have left the plains for mountainous wild sheep and wild goat in other habitats (Farhadinia 2004). As a natural lab, Miandasht can teach some useful management implications which can enhance our knowledge about the status and ecology of the cheetah a few decades ago and how to save this creature from extinction.



FIG.15. Goitered gazelles graze in small groups in Miandasht

Minadasht is a dynamic ecosystem and predators' kills and scats are rarely found, so it is difficult to evaluate the cheetah's diet based on scat analysis, mainly due to decomposing by insects and rodents. Unlike the leopard, most of investigations on the cheetah's food habits in Africa have been conducted based on direct observation, probably because the cheetah scat sample illustrates the risk of inadequate sampling (Mills 1992). Also, it was difficult to distinguish between the cheetah's and other large predator's scats. Fortunately, there is no leopard in Miandasht who possesses the most similar scat to the cheetah. The positive signs of cheetah origin of the scats were characteristic compact form with well defined segments and one of the extremities especially tapered described by Chame (2003). Moreover, we removed scats with maximum diameter less than 15 mm in order to avoid any confusion between the cheetah's and small cats (Farhadinia and Mahdavi 2007). The average maximum diameter of the scats were calculated 21.1 mm (SD=1.4, n=9), usually found on the grasses/scrubs or under tamarisks.



FIG.16. Cheetah scats on grass/scrubs

Cheetah scats were found usually around waterholes, among tamarisks or inside the watercourses which they usually use to travel. We could relate only 9 out of several dozens found scats to the cheetah based on the above parameters which were analyzed as the following:

| Number | Main Food Item | Scat Abundance |
|--------|--------------------------------------------|----------------|
| 1 | Goitered gazelle | 2 |
| 2 | Livestock | 2 |
| 3 | Small mammals* agama, snake and insects | 5 |
| | Total | 9 |

* Including rodents and hare.

FIG.17. Results of cheetah scat analysis

Meanwhile, plant materials were found in 2 scat samples. Due to low number of scats found inside the area, we also tried to utilize kill monitoring as an alternative method to study on the cheetah food habits. However, between 2003 and 2006, no more than 6 gazelle remains were found inside the area (2 by herders) which in just 2 cases, the cheetah was seen on the carrion. It seems that a main cause is high abundance of scavengers (e.g. striped hyena, golden jackal and common fox) which eradicate any remains from the cheetahs. Meanwhile, due to low level of available food source, cheetahs consume most of the killed gazelle, which possesses slender skeleton. In one case, a family of a female in companion of her 2 adolescents were observed eating a young male gazelle, only part of the skull as well as its backbone were left. In Etosha National Park, Phillips (1993) found that cheetahs consume all bones, except the skull, of prey weighing <10 kg, and consume a substantial proportion of the rib cage and vertebral column of 30-50 kg prey.

In Africa, cheetahs do not normally remain with a kill once they are fully fed, nor return to it for a second meal; taking of carrion is very rare (Ewer 1973), probably due to abundance of other large predators (Caro 1994). Although, Pienaar (1969) reports that this has been known to occur and even cheetah scavenging has been recorded, too (Caro 1994).

Claims of cheetahs killing young camel, sheep, and goat are rife among the shepherds inside the species habitat throughout the country; however, there was no evidence to approve it (B. Najafi, Jourabchian, and A. Karimi, *pers.comm.*). Two cheetah scats (FIG.18) as well as a few reports of livestock attack which was verified by us are considered to be the first reliable evidences of cheetah depredation on livestock in the country.



FIG.18. Cheetah scat full of domestic sheep hair

During the survey, a total of 5 censuses were carried out inside the area by North Khorasan Provincial Office of the Department of the Environment. They did not follow any scientific protocol, just the traditional enumeration method was used, which seems to be the probable cause of high variance between

the censuses. However, we have relied on the results of November 2004 with highest confidence for more analysis, because it was conducted during peak of the cheetah project under the project team supervision (FIG.19).

| Date | Number Counted | Remarks |
|-----------|----------------|---------------------------------------------------------------|
| Nov 2003 | 173 | Because of rainy weather, the census was not done completely. |
| Nov 2004 | 284 | Male: 88, Female: 168, Subadult: 4, Unknown: 22 |
| July 2005 | 158 | |
| Nov 2006 | 57 | |
| June 2007 | 273 | |

FIG.19. Gazelle censuses during the project (source: North Khorasan Department of the Environment)

With respect to the gazelles living in Miandasht and habitat type, it is normally expected that the gazelles provide the cheetah's food base; however, we think that the reality seems to be different to some extent. Here, there are six facts that lead us to find alternative food sources, which do play a remarkable role in the cheetah's diet in Miandasht.

1. *It is more than 1 decade that Miandasht gazelle population has never exceeded 350 animals, so a density of maximum 0.4 per km². At present, it seems that the gazelle density is between 0.2 and 0.4/ km².*
2. *Based on pictures and locating the direct reliable observations in the area, a population of 6 to 10 cheetahs is estimated for Miandasht.*
3. *Between 2002 and 2005, only 6 gazelle kills have been found in Minadasht which just 2 kills have been with the cheetah.*
4. *Gazelle hairs were found just in 2 scats out of 9 cheetah scats during the survey period.*
5. *Various gazelle herds were monitored throughout the survey with constant herd size, no observable change!*
6. *Among 65 reliable cheetah observations since Feb 2003, 5 (7%) encounters were on gazelle kill and/or while stalking toward the gazelles, all in late fall or winter when gazelles are more susceptible and active during daytime hours.*

Based on the surveys in Serengeti National Park, Tanzania, the cheetahs consume a food meal each 1.25 to 1.5 day (30 to 36 hours) (Caro 1994). Schaller (1972) found that a mother in companion of her 2 adolescents kills almost one gazelle per a day, so 341 for a whole year. In Nairobi National Park, McLaughlin (1970) concluded that a cheetah catch a gazelle every 2 or 3 days, resulting around 150 prey throughout a year.

Schaller (1968) estimated that a sub-Saharan cheetah kills 10 kg per day which ca. 3-4 kg of food per day is really required to maintain cheetahs in excellent health (Phillips 1993). Since Saharan cheetahs have two third of the sub-Saharan cheetahs' weight, Saleh *et al* (2001) resulted 7 daily killing for the cheetah in Saharan cheetahs with 3 kg consuming. Based on linear measurements, it seems that the Iranian cheetahs do not differ significantly from their sub-Saharan cousins, so it is logical to consider that they need around 3-4 kg meat per a day to eat, totally 3650 kg a year.

Based on gazelle census in November 2004, sex ratio was estimated to be around 34:66 for the goitered gazelle in Miandasht. Karami and Shams (2003) calculated mean body weight for the goitered gazelle in Sohreyn Protected Area as 24.4 kg for female (n=89) and 33.7 kg for male (n=121). Accordingly, a cheetah needs annually 108 to 150 goitered gazelles in Miandasht WR to survive.

Desert habitats naturally have a low productivity which can not support a high density for the gazelles and other ungulates. Therefore, a cheetah needs hundreds of square kilometers of desert habitats in order to be able to catch enough food sources, but Miandasht is only 850 square kilometers. If the cheetah consumes a variety of preys in one habitat, so a smaller home range can meet its needs (Saleh *et al* 2001). Thus, the cheetahs in Miandasht have to rely on a diverse food menu in order to be able to survive in this area.

In conclusion, it seems that the cheetahs prefer to feed on gazelles, but it is a hard job for them because of low density of gazelles and probably high accessibility of small foods.

Sunquist & Sunquist (2002) noted that a hungry cheetah has two major ways of finding a meal. Watching from a rest site, the cat may see a potential hunting opportunity. When this happens, the cheetah usually waits for the animal to get close enough, then launches into a chase. Cheetahs also find prey by walking slowly through the grassland looking. In Miandasht, cheetah hunting behavior on gazelles was seen 5 times during a period of 3 years. In all cases, they were in groups stalking to get close within a few dozens meters of the gazelle herds through the dried watercourses, which provide them enough cover to approach (Caro 1994). The number of gazelles never exceeded 10 animals per a target herd. Also, a few times they were seen searching for small mammals (e.g. hare) among the plant cover. In Serengeti, Cooper *et al* (2007) found that the decision of a cheetah to hunt or not was influenced by the abundance of their main prey, the reproductive status of the cheetah and the presence of competitors and predators, but not by the hunger level of the cheetah. Given that the decision to hunt is taken, prey choice is then driven by the time of year, the sex of the predator, the abundance of prey and the presence of competitors.

Interestingly, all cases of observed hunting efforts as well as the majority of gazelle kills (five out of six found throughout the area) were in late fall and winter, when most of the plains are occupied by livestock, so the gazelle habitats are compassed between the grazing flat plains and on the other hand, central hilly terrains or northern tamarisk plains in where, they have not enough field of view to identify any cheetah from far distance. Accordingly, it seems that the livestock grazing season is the most susceptible period for the gazelles and fortunately, the best time for the cheetahs to catch higher amount of food in cold winters when most of the rodent species spend their hibernation.



FIG.20. Carnivores' scats, including the cheetah's are decomposed rapidly, so difficult to find after a while

There are a few more alternatives for the cheetahs as food source:

8.4.1. Wild Boar (*Sus scrofa*)

Based on inquiries with farmers (n=8) and game guards (n=4), no wild boar lived in Miandasht before 2000, but the animals have been dispersed to Miandasht from northeast. Most of the people believe that the main cause was drought which made the boars find new habitats. Resting among northern tamarisk jungles in Miandasht during the daytime, they do damage to agriculture crops, including melon, cotton and pistachio in night, then come back to the area.

Miandasht WR is the only joint habitat of the cheetah and the boar in the country and local people believe that the cheetah kills the boars, but it was not approved during the survey (Farhadinia and Absalan 2004). However, it seems that particularly young boars (in spring and early summer) can be occasionally taken by the cheetahs. The boars give birth in early March in Miandasht and regarding the cheetah's bearing time during the following weeks, it is likely that with respect to distribution of the gazelles throughout the area in order to give birth and consequently, low accessibility to them for the cheetahs, they need to look for alternative preys which small boars are potentially a possible food.



FIG.21. Wild boar scared by the camera trap flash

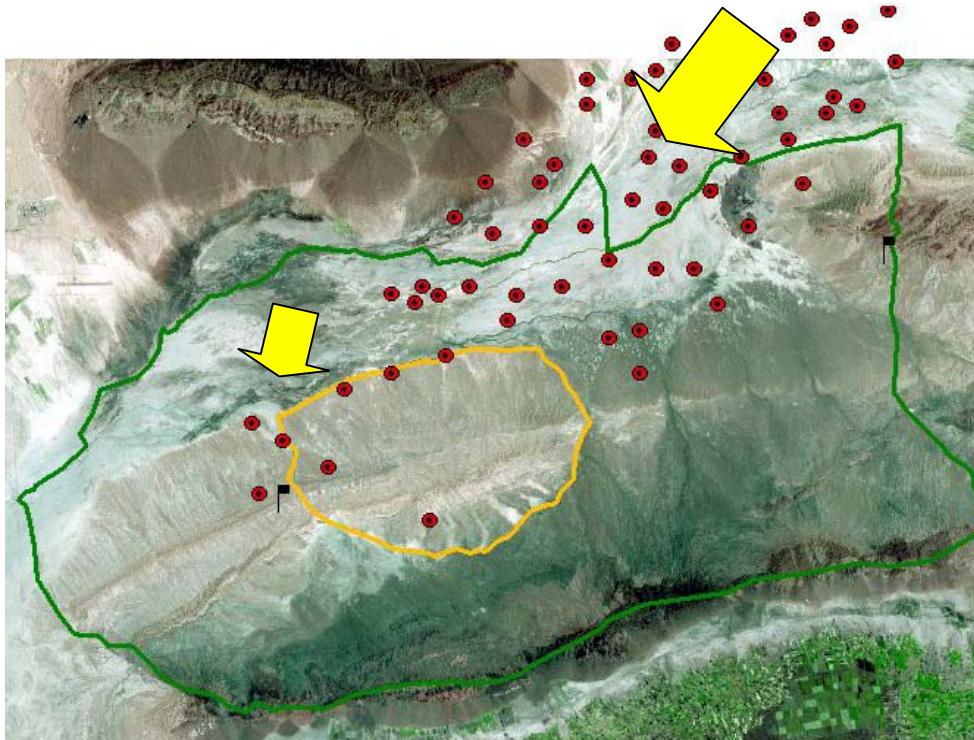


FIG.22. Boar distribution in Miandasht (Arrows show direction and intensity of dispersal)



FIG.23. Cheetah and boar tracks at the same place and almost same time

8.4.2. Small Carnivores

Beside antelope species, small carnivores have been recorded to be used by the cheetahs in Africa. Graham (1966) and Caro (1994) have noted about the cheetah hunting on jackal and Mills (1984) on fox. In Egypt, Saleh et al (2001) believe that small carnivores are part of the cheetah's diet. The Saharan cheetahs in Niger have been reported to kill jackal, Houbara bustard, hedgehog and even young striped hyena (Dragesco-Joffe 1993). Caro (1994) has observed that the cheetahs in Serengeti even attacked to caracal and mongoose. A local game guard in Kavir NP, Iran has seen a cheetah chasing a jackal in mid 1990s (Mohammadi, *pers.comm.*).

Based on direct observation and camera traps results, the common fox is the most abundant carnivore species in Miandasht and surprisingly, 3 times have been observed by game guards to be eaten by the cheetahs in the area. Once, the animal's liver was seen to be consumed by the cheetah and the rest of the body was left (FIG.24).



FIG.24. Common fox eaten by the cheetahs



FIG.25. Three abundant small carnivores in Miandasht: common fox, golden jackal, and steppe cat (left to right)

The jackal has the highest density around villages and human settlements, so the animal occurs in low density particularly in inner parts of the area. The highest possible overlap between 2 species ranges is in northwestern parts of Miandasht, where is part of the cheetah's distribution and the jackal's patrolling area. However, we could not approve any hunting approach between 2 species in Miandasht.

Based on camera trapping results, steppe cat is the most abundant felid in the area with high coexistence with the cheetahs. Camera traps were successful to capture these small cats exactly at the cheetah successful camera points which may enhance the possibility of the cheetah hunting on this felid.

8.4.3. Rodents

Miandasht WR has one the highest densities of rodents among the Iranian reserves helping the cheetahs to provide part of their food needs based on them and rodent's remains in the cheetah's scats approve this. However, small preys are underrepresented because the information on the cheetah diet is partially based on carcass remains (Caro 1994). It seems that due to desertification which has been accelerated by overgrazing, sand soil is extending from south to north and becoming the dominant soil type in Miandasht, enabling various small rodents to select a suitable burrowing habitat.

Using Sherman rodent live traps as well as spotlight technique in different seasons, 11 species of rodents have been identified in Miandasht, mostly weighting less than 100 grams, except the Great Gerbil.

1. Grey hamster (*Cricetulus migratorius*)
2. Common vole (*Microtus arvalis*)
3. Common rat (*Rattus norvegicus*)
4. Black rat (*Rattus rattus*)
5. Great gerbil (*Rhombomys opimus*)
6. Mid-day gerbil (*Meriones meridianus*)
7. Libyan jird (*Meriones libycus*)
8. Small five-toed jerboa (*Allactaga elater*)
9. Blanford's jerboa (*Jaculus blanfordi*)
10. Euphrates jerboa (*Allactaga euphratica*)
11. Little earth hare (*Alactagulus pumilio*)- still in doubt?



FIG.26. Three main rodents in Miandasht

Given the nocturnal life of most of the rodent species and nighttime activities of the cheetahs based on camera trap photos and direct observations, particularly in warm months, it seems that the cheetah can gain a proportion of its food needs by rodents. Based on nighttime line transects in different parts of the area and animals' weight, a cheetah needs to search a route of at least 3 to 4 kilometers per night to catch enough amount of rodents, between 30 to 40 animals.

8.4.4. Hare (*Lepus capensis*)

Ranging from 1.5 to 4 kilograms in weight (Dareshuri & Harrington 1976), hares are numerous in Miandasht, too which can provide a reliable source of food for the cheetah and other carnivores. The hare has a higher density near and inside the central hilly terrains comparing with surrounding plains where posses high density of various kinds of rodents. The cheetahs used to occur around the hilly terrains which may indicate that the hares play a remarkable role in their diet.

The cheetahs' hunting efforts on hare has been successful on 88% cases in Serengeti, but only 27 % on the main ungulate food prey, as Thomson's gazelle. In fact, the cheetah has the highest hunting success rate for the hare (Caro 1990). Over 2 third of the year, Miandasht is host of a high density population of raptors, particularly long-legged buzzard *Buteo rufinus* (Hosseini 2005), which mainly feed on rodents, lizards, and hare, too. It seems that due to avoid the raptors, the hares live near and among hilly terrains with scrubs comparing to grassland plains and hide inside the watercourses, between rocks or under the scrubs. The hares rest hidden during daytime and are most active in darkness, especially in hot summers. Regarding the animal's high productivity, it seems that the hare is an appropriate source of food for the cheetahs in Miandasht. The hare remain was found just once under a tamarisk killed by a carnivore, not definitely a cheetah. It seems that regarding the hare's slender skeleton, the animals is almost completely consumed by the cheetah and so, we were not able to find any kill, as mentioned by Phillips (1993), too.



FIG.27. Hare killed by an unknown predator, it was very rare to find the remains of small animals consumed by predator.

8.4.5. Birds

As a desert habitat, Miandasht WR holds high density and diversity of avifauna, particularly Iranian native species. Both ground dwelling black-bellied sandgrouse (*Pterocoles orientalis*) and Houbara bustard (*Chlamydotis undulate*) occur and breed in high numbers, particularly in northern half of the area as well as see-see partridge throughout hilly areas. These species distribution range are overlapped with the cheetah’s range, particularly since late fall till mid summer which can support the cheetah preying on these three main birds.

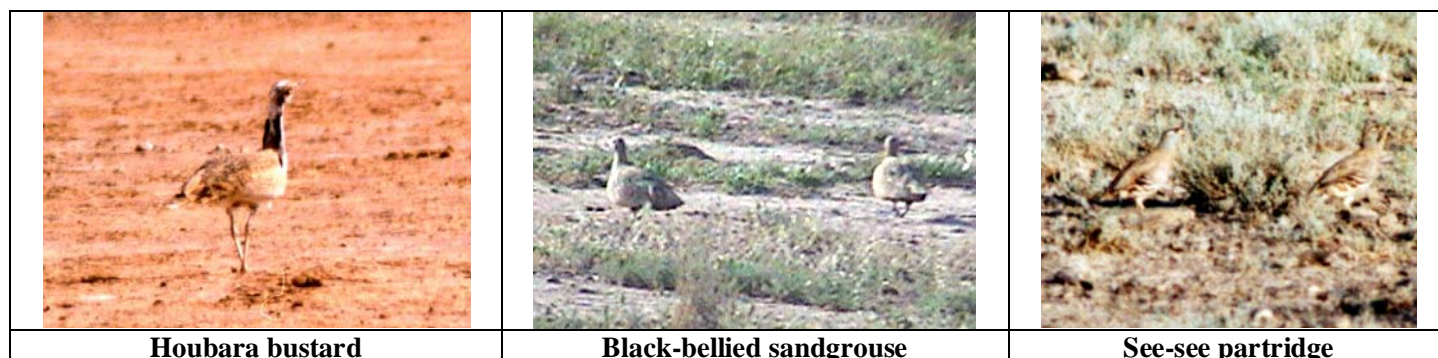


FIG.28. Three abundant ground birds in Miandasht

In Serengeti, cheetah hunting on bustard has been observed (Caro 1994) and a cheetah has been recorded to attack a bittern in Egypt (Saleh *et al* 2001). A local physician has seen a cheetah with a see-see partridge inside its mouth in east of Miandasht and the area’s game guards have witnesses a young cheetah killed a pigeon (*Columbia livia*) (Lashkari, *pers.comm.*).

In sum, with respect to low density of the gazelle (less than 300) and the estimated population of the cheetah (at least 6) in Miandasht, it seems that the cheetahs kill 1 or 2 gazelle per week depending on the season and other environmental conditions and obtain the rest of their food mainly from hare and rodents. According to cheetah photos and direct observations, the cheetahs seem to be in good physical conditions without any obvious sign of undernourishment. Accordingly, this survey indicate that the cheetahs in Miandasht live on the basis of rodents and hares, however, more data is needed to test this hypothesis. Regarding the range of body weight in hares, 1 or 2 kills per day can provide enough meat for the cheetah, but we are not sure if the energy spent to catch a hare can be totally obtained by consuming itself! At the same time, the cheetahs are active during nighttime, so different species of rodents, particularly Dipodidae family are accessible to catch.

Regarding the balance between spent energy to catch a kill and returned energy as a logical cost-benefit, it is always believed that small foods are not reliable to meet large predators’ needs and thus, rodents and hares seem to be “biscuit” not food for the cheetahs. However, we think that we need to change our point of view based on 3 years data, because not only surviving, but the cheetahs are breeding based on these small “biscuits” in Miandasht Wildlife Refuge.

8.5. Population Status

Population status of wildlife species, particularly large carnivores is a controversial issue among the experts in Iran. Fortunately, cheetahs have complex coat patterns usually with no particular distinctive feature; determining a non-match can take long, especially if photos are poor (Kelly 2001). We utilized results of camera trapping surveys to obtain a basic number of the cheetah population inside the area; however, regarding the vast range of the cheetahs and their small numbers doubled with low number of camera traps available, we considered the camera traps results as the minimum number and tried to find a more realistic estimate through the results of field tracking as well as verified direct observation.

It is highly recommended to put 2 cameras at the same place to work simultaneously and capture both sides of the naturally marked animals (Karanth & Nichols 2002). However, due to constraints in the number of cameras, the above recommendation was not usually applied and we lost some images because of having just 1 side of the cheetahs. Also, putting 1 camera per point increased the chance of capturing more individuals, of course just from 1 side.

Regarding the techniques for low density carnivores, we emphasize on the efficacy of continuous field tracking to obtain more data beside the camera trapping results. Also, applicable for large carnivores, we suggest to measure the linear parameters of the target species pugmark (in millimeter) in order to prepare a more reliable database about each area's population composed of images related to their pugmark size. Meanwhile, given the high variability of pugmark size in different conditions, it is expected to find a linear parameter with least variability which we suggest Maximum Forelimb Width may be useful (it is necessary to work more) for the cheetah. On the other hand, if we assume that each population is closed during each camera trapping session, then mapping and comparing the direct observations by local people and game guards just before to after the end of the camera trapping session seems to be useful. Of course, in case of the Iranian cheetah, it is really necessary to verify the local people's observations by qualified experts in order to prevent any confusion with other large carnivores inside the cheetah habitat, including wolf, striped hyena and even caracal.

After more than 2 decades without any official cheetah reports in Miandasht, a family of 1 female in companion of her 2 yearlings was seen in January 2002. At the same time, another large adult was encountered a few times in eastern borders (probably more than 1 adult, but at least 1 more adult, so 4 animals in early 2004). During 2003 and 2004, 3 different cheetahs have been taken by camera traps. Based on images and direct observations, 6 to 10 cheetahs are estimated to exist across the area, extending their range eastward and westward.

We also found out that camera trapping in reserves where there is a reliable backbone of knowledge on the cheetah available (as a result of field surveys or game guards' patrols) can not help so much and this kind of survey was more applicable in capturing more images which is crucial to Minimum Number Alive (MNA) (Krebs 1999). For instance, in Miandasht WR where is the last verified habitat for the cheetahs in the country, there was no data on the cheetah since its establishment in 1975 (Farhadinia & Absalan 2004), however, the camera trapping efforts during 400 camera nights using a few camera traps on the basis of several months field tracking resulted 3 different individuals. On the other hand, in Kavir NP where has been one of the well-known cheetah habitats in the country with good base of prey species, as a result of more than 3000 camera nights, just one individual was captured. In case of Bafgh PA in central Iran, as a result of 1350 trap nights using around 30 camera units, 14 images were taken which 13 were of just 1 adult female in 10 different places. Since the cameras were placed on trails recommended by the game guards who have local knowledge and highest experience, it may indicate that they have not a holistic view of their local population and are aware of just a proportion of their population range.



Sex: Male (?)
Age: at least 4
Date: September 2004
Time: 1900
Location: Ferez Windmill
By: Camera Trap

Sex: Unknown
Age: 7-8 months
Date: November 2004
Time: 2200
Location: Tamarisk Doshakh
By: Camera Trap



Sex: Female
Age: Around 20 months
Date: October 2003
Time: 1600
Location: Ghasemali, Core Zone
By: Hossein Absalan

Sex: Female
Age: Adult
Date: May 2003
Time: 0830
Location: Eastern Area
By: Conservation of the Asiatic Cheetah Project

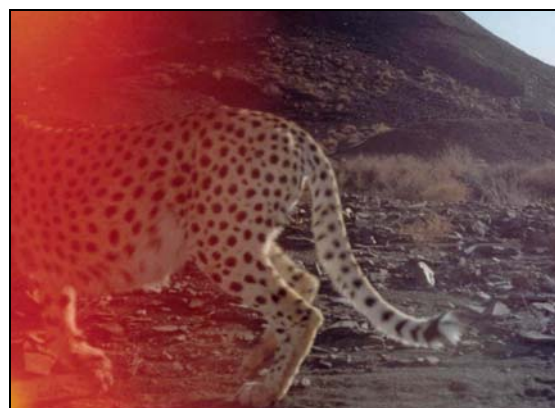


FIG.29. Present cheetah photos in Miandasht Wildlife Refuge.

8.6. Reproduction

Cheetah reproduction is one of the least known aspects of the animal's biology in Iran. It is generally supposed that mid winter is peak of cheetah mating season in Iran (Dareshuri & Harrington 1976, Ziaie 1996, Farhadinia 1999), meaning coinciding the breeding season with birth flushes of prey ungulates species, though the species is not known to be seasonal in its African range (Laurenson *et al* 1992, Caro 1994, Hunter *et al* 2007). Recent observation of cheetah cubs inside different habitats suggest that the Iranian cheetahs may do not have a distinct mating season throughout the country (Farhadinia & Hatami 2007). On 21 November 2004, a young cub was captured by a camera trap (FIG.30), which seems to be 6 to 8 months old (Laurenson, *pers.comm.*). In early April 2003, four cheetah cubs with closed eyes were found inside a den among the rocks in southern Khar Turan National Park. Accordingly, it seems that the cheetahs in Miandasht probably give birth mainly in April.



FIG.30. A young cheetah captured by camera traps during a sandy wind

The Iranian cheetahs give birth to 1 to 4 cubs in each litter size with average between 2 to 2.5 per a litter (Farhadinia 1999); however, it is not rare to see a mother in companion of 3 or 4 cubs in other cheetah habitats in the country. Based on indirect and direct observations, the cheetahs have usually 1 or 2 cubs in companion in Miandasht which is significantly lower than the average for other cheetah habitats in the country. Apparently, the cheetahs in Miandasht have been successful to establish a resident population, but it seems that due to scarcity of the gazelle as a reliable food item to meet their energetic demands, their breeding success has been affected and the cheetahs have a lower level of reproduction in the area which may result in a constant population size and lower dispersal to the surrounding reserves.

The cheetah in companion of small cub (younger than 4 months) has never seen in Miandasht, indicating that they possibly prefer to breed among northern tamarisk jungles cut by deep dried watercourses, where have the highest safety without any human and livestock disturbance as well as good camouflage. Also, they can find suitable den site in watercourses walls to bear and raise their cubs, which is very difficult to find in other parts of this plain area. According to Durant (1998), the cheetahs may survive better in wooded areas rather than open plains, where they are more susceptible to predators.



FIG.31. A mother in companion of her young cub, possibly around 6 months in September 2004 (left image) and tamarisk covered areas are supposed to be key breeding habitats for the cheetahs in Miandasht (right image)

Very uncommon among the Iranian cheetah habitats, a total of 6 observations were made of alone cubs, aging between 6 and 12 months old, but without mother in Miandasht since 2002 to 2006.

In mammals, lactation is the most energetically costly component of reproduction (Caro 1994). In Serengeti, female cheetahs meet the energetic demands of lactation primarily by increasing their food intake by almost doubling it, as they switch to larger prey and have greater success hunting it (Laurenson 1995b). In general, mothers with young cubs that were still lactating put more effort into hunting than mothers with older cubs (Caro 1994). Those females with cubs in the lair or with newly emerged cubs spent a greater proportion of the day hunting and travel more than did lone females and chose to hunt an increasing proportion of prey larger than hares and neonate fawns (Laurenson 1995b).

Accordingly, a basic hypothesis can be generated as due to low density of the gazelles, catching a goitered gazelle as a large size prey to increase the food intake as well as to feed the cubs is not an easy job for females; thus, they have to travel long distances and spend more away from their cubs which is the possible cause of sighting young cubs without mother. On the other hand, lack of reliable food sources, particularly the gazelle, can even make it difficult for females to rear their young cubs to independence age which is around 18.2 months (Laurenson *et al* 1992), so they even abandon their cubs during the first months. According to Caro (1994), some carnivores desert their dens when prey is scarce and prey availability apparently affects cub abandonment (Laurenson 1995b). Encounter with several months old cubs may indicate they were successful to live on small mammals which are so abundant and can meet their needs considerably for the first year.

As a result of investigation on a family of one female in companion of her 2 adolescents during fall and winter 2003-2004, after 8 January 2004, when the family was seen, they were never sighted together again, indicating that the young cheetahs might leave the mother. With assumption of cub birth peak in April, it means that they reached to independence at 18-19 months. Before 8 January, they were seen regularly across an area of more than 15 square kilometers for more than 70 days.

8.7. Activity Pattern

It is generally believed that the cheetahs in Iran are predominantly diurnal, mainly during early morning and late afternoon (Etemad 1985, Ziaie 1996) and even hunt in full moon nights (Ziaie 1996). Schaller (1972) noted that cheetahs spend most of the day resting. They hunt by sight, mainly during the day, especially between 0700 and 1000 and between 1600 and 1900. However, they have been seen hunting at nights in the Serengeti (Schaller 1972), but there is a general lack of information on their nighttime activities (Sunquist & Sunquist 2002). Dragesco-Joffe (1993) reported that cheetahs living in the Saharan mountains often hunt at night, when temperatures are cooler. Family groups generally spend the night resting in open grassy areas and are usually found in the same place in the morning where they were last seen in the evening (Caro 1994), whereas males and juvenile groups sometimes continue to move during the night (Sunquist & Sunquist 2002).

Since January 2003 to March 2006, time of a total of 43 direct observations by game guards, local people and project team were recorded. The cheetahs were mainly seen during afternoon (31%), probably in search for preys which are at their most active period; meanwhile, in 7 times (16%) they were encountered during nighttime (between 2000 and 0600), usually resting but not actively hunting. Regarding relatively high dependency of the cheetahs to small mammals in Miandasht WR in comparison to other Iranian habitats as well as flatness of the area which make the cheetahs more visible to human, it seems that part of the cheetah's activities in this plain area take place in nighttime hours.

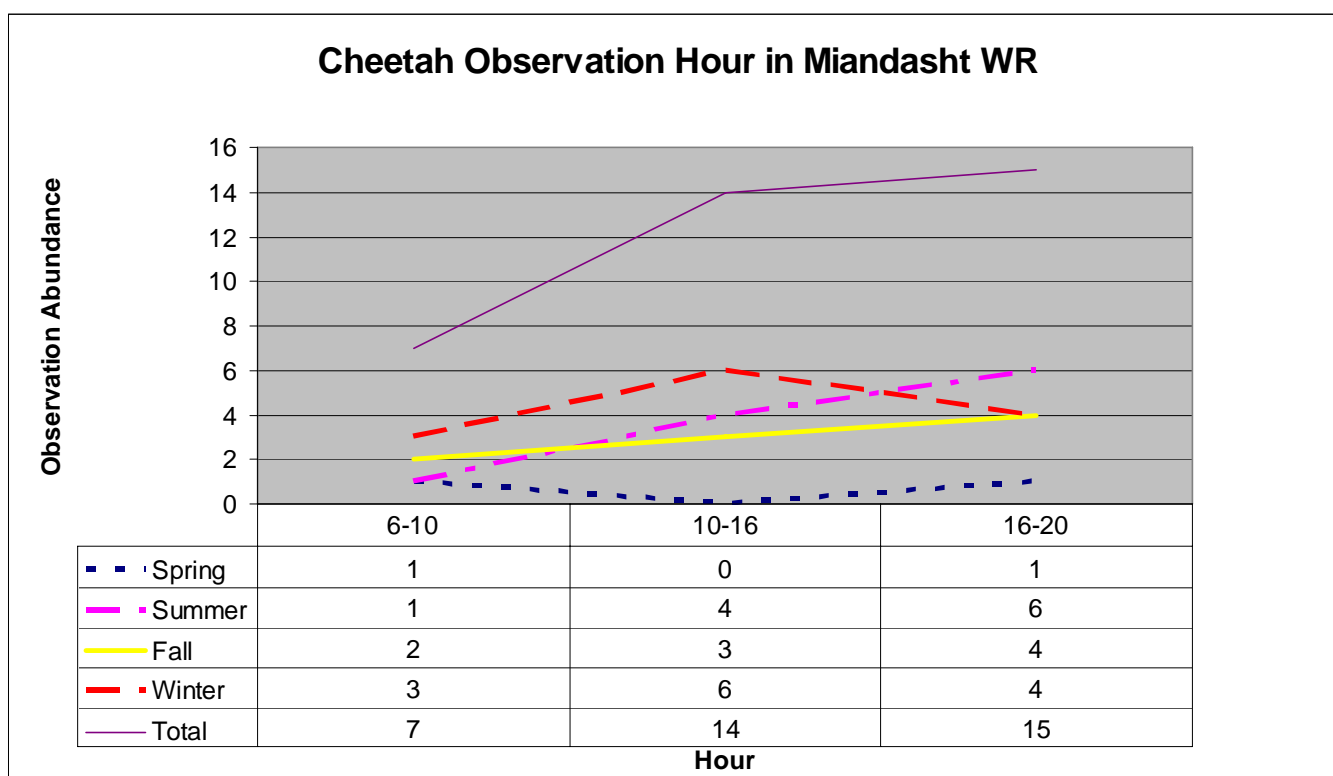


FIG.32. Cheetah observation hours in Miandasht

On the other hand, based on 40 direct observations during 3 years (2003 to 2005), the cheetahs are most active in daytime in fall and least observable in spring in Miandasht WR.

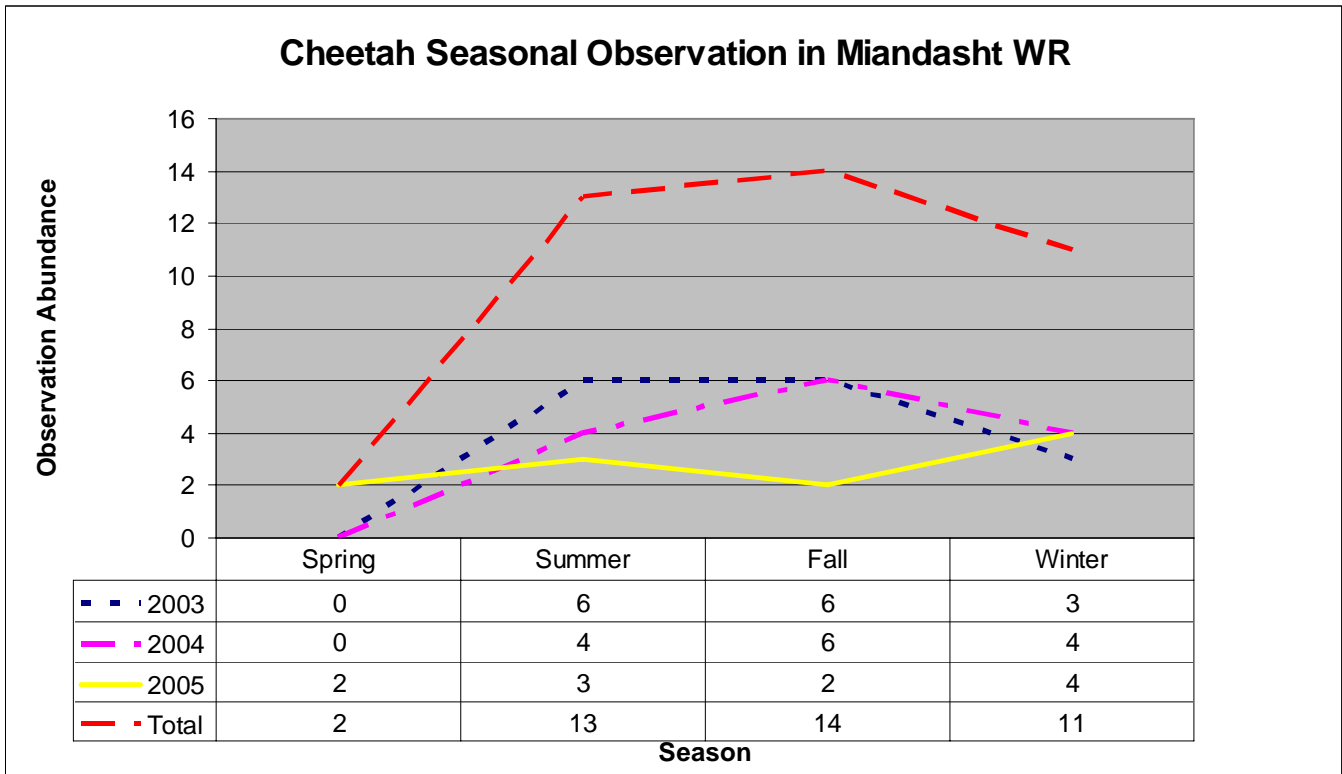


FIG.33. Cheetah seasonal observation in Miandasht WR

Direct observations of the gazelles during a course of one year suggest a seasonal pattern of group size change (FIG.34), with large assemblies during the colder months and small groups during the rest of the year, as noted by Wacher (2004), too. These data probably underestimate the proportion of single gazelles and very small groups, but the seasonal pattern of group size change observed in this data seems to correlate with simultaneous changes in cheetah observation.

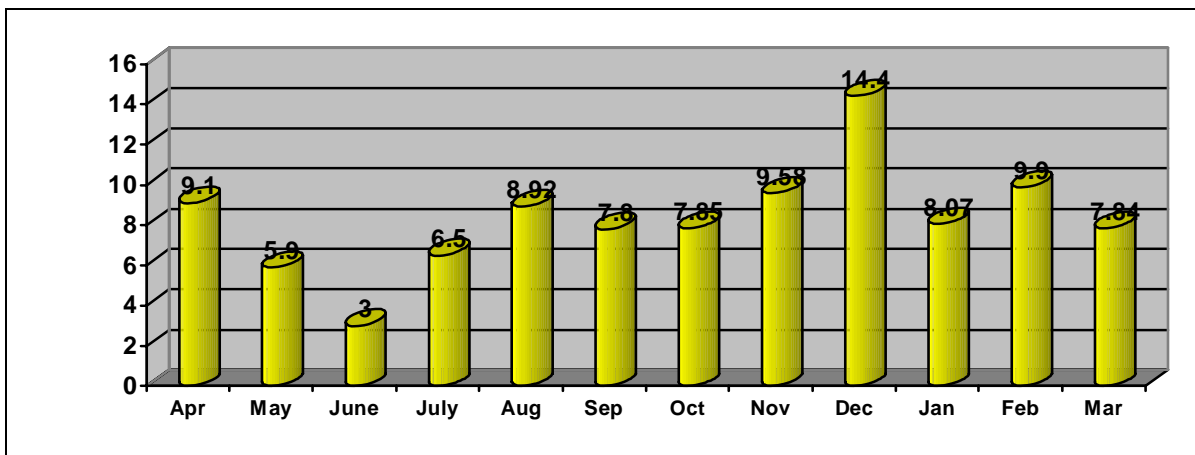


FIG.34. Gazelle average group size in Miandasht WR

The gazelles used to leave their herds and distribute throughout their habitats just before bearing their fawns (Hemami 1994), around mid May to find safe sites to give birth their newborn fawns, resulting the

smallest group size in spring. Also, fresh grasses of family Graminae cover most of the area with highest level of protein and water (Sinclair & Caughley 1994), which provide the gazelles enough food and water and attract them to most of the plain habitats. So, they do not need to concentrate around waterholes.

On the other hand, as discussed above, it seems that the cheetahs give birth mainly in early spring (March to early April), so they leave for remote places to find the best place for their newborn cubs to provide them shelter which is usually in cracks of rocks or among dense vegetation cover (Frame 1984, Marker *et al* 1996), because it is expected that the cheetahs be the most cautious to save their cubs' lives (Laurenson 1995a). Also, female cheetahs need to follow the ungulate's movement to increase their accessibility for food (Durant *et al* 1988). As mentioned before, no cub (less than 4 months) has been seen in Miandasht so far (alone or in companion of mother), thus it seems that they select dense tamarisk covered areas around the northern main watercourse, namely Kalshur, where are not easy to access. At the same time, the new naturally introduced wild boars inhabit among tamarisk covered northern watercourses and give birth in early March which can be a potential food source for the cheetahs. As a result, the cheetahs spend their least visible period in spring.

As temperature increases toward the end of spring, newborn fawns emerge from their refuge and gazelles form small groups concentrated around limited waterholes to meet their higher water need. Their activity time is limited to early morning and late afternoon when are slightly cooler. Out of a total of 40 direct observation in summer 2004, 75% (n=30) were made between 0500 to 0930 and 1700 to 2100 (Farhadinia 2006).

At the same time, cheetahs have the same pattern following their main large prey, so they are mostly active around waterholes which are regularly visited by the game guards. On the other hand, they spend a considerable percentage of nighttime in search for nocturnal rodents (mainly jerboas and gerbils) and hares which still holds the rate of cheetah observation relatively low. Meanwhile, as Graminae dry out, the gazelles refer to the surrounding farmlands to feed on fresh green plants and thus they are most susceptible to the motorbike-rider poachers who can find the gazelles in the area's margins. Accordingly, the game guards need to protect them in their nighttime patrolling around the area, so fewer encounters between the cheetahs and observers occur.

In fall, the temperature decreases and the gazelles are more active during daytime hours, not merely a few hours in early morning and late afternoon like summer and, so the cheetahs. As approaching to the gazelles rutting season in late fall (late November and early December), the mean group size and observation frequency of the only large bovid in the area reaches to its peak in December. Thus, cheetahs are more active and a proportion of the cheetah's hunting sightings have been made in late fall when is the best time to see the goitered gazelle in Miandasht in different hours.

During winter, most of the area's plains are occupied by livestock herds from surrounding villages. Therefore, the game guards should regularly visit pastures to match size of herds with their official permission as well as to prevent entering the core zone. Moreover, due to lack of safety because of various herds and their companion dogs, the cheetahs are more cautious and avoid their rangelands. Also, the gazelles should break their concentrated herds immediately after the rutting season and distribute among unoccupied areas. They mainly rely on their vision sense to identify any danger, but most of the plains are occupied by livestock for three months and they have the least access to their suitable open plain habitat. So, their habitat is contradicted between the open plain and hilly terrain where compose the core zone and actually the critical hotspot for the cheetahs. So, they spend the most susceptible period against the cheetahs in winter which are now near their home and most of hunting efforts on gazelles and gazelle carrions have been encountered in this season. Due to less activity of rodents in cold months, the cheetahs mainly need to feed on gazelles.

It seems that regarding the higher cheetah observation in late fall and early winter, their mating season is on its peak in December. Toward the end of winter, the cheetah observation increases again, but not by game guards, but by herders who need to accompany their herds to longer distances to find enough food during longer days of late winter. The cheetahs are more active in the winter's final warmer days and so, more visible. Based on field surveys, due to least activities by the rodents, more accessibility of the gazelles which are now near the cheetah's main habitat and their food needs in cold winter, the cheetahs mostly feed on the gazelles which are susceptible due to lack of enough vision around their ranging sites surrounded by foothills.

In sum, it seems that cheetahs feeding habits is a remarkable determinant in their seasonal activity pattern in Miandasht Wildlife Refuge. As discussed before, the gazelle population is lower than their minimum needs; however, it seems that they follow them throughout the year to kill opportunistically. At the same time, small animals which are most active in nighttime in spring and summer, are alternative food sources for the cheetahs and make them to be active after the sunset.

8.8. Cheetah Mortality

As mentioned before, it was more than 2 decades that no cheetah was officially reported from Miandasht, until 2002 when the animal was approved. Meanwhile, it was highly important to find and verify cheetah reports (sighting/poaching) belonging to silent decades of 1980s and 1990s in order to explore the cheetah background in the area. As a result, around 10 cheetahs were approved to be killed by local people during the mentioned course, revealing that the cheetah never became extinct in Miandasht which was always considered with doubt by experts (Hajji 1986, Karami 1992, Salehi 1994, Asadi 1998). Also, the area's cheetah population has been probably able to be feed from surrounding populations, e.g. Khar Turan NP (Ajami *pers.comm.*) or Golestan NP (Ziaie *pers.comm.*), but it is not correct to consider Miandasht cheetah population as the result of dispersal from neighbor habitats.

In conclusion, the cheetah has been always present in Miandasht; but, due to lack of serious efforts and attention to observe the cheetah, nobody knew and reported it. On the other hand, the area was not safe for the cheetahs because of poor conservation measure, therefore, the animal was not observed easily. This fact is applicable to a number of other areas in the country, where have been historical habitats for the cheetahs and are supposed to hold small number, but yet to be approved.

| | Date | Number | Location | Poacher |
|---|-------------|--------------------|----------------------|-----------------------------------------------|
| 1 | 1970s | 1 | Sorkhcheshme | Akram Sherafati |
| 2 | 1970s | 1 | Sankhast | Mortazavi |
| 3 | 1970s | 1 | Eastern Miandasht | Suffocated by a local people |
| 4 | 1980s | 1 | Anjerli | Reported by Behzad Sherafati |
| 5 | Feb 1981 | 2 (female and cub) | Cheheldokhtaran road | A local teacher killed them in a car incident |
| 6 | 1990s | 2 | Anjerli | Found dead in a coral |
| 7 | Mid 1990s | 1 | Ghalecheh | Reza Najjarzadeh |
| 8 | 2005 | 1 | Doshakh | Killed by a shepherd, then put in a well |
| | Total | 10 | | |

FIG.35. Cases of cheetah poaching approved in Miandasht

9. OTHER LARGE CARNIVORES

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 the cheetahs are Persian leopard, striped hyenas and grey wolves; meanwhile, Hunter *et al* (2007) consider caracals and golden jackals as threats to the cheetah survival, too. However, nothing is known of their inter-relationships.

As well as the Asiatic cheetah, Miandasht is home to two more large carnivores, including the striped hyena *Hyeana hyeana* and grey wolf *Canis lupus*, which may influence the cheetah's life in the area, particularly through inter-specific competition. Also, the Persian leopard *Panthera pardus saxicolor* is reported to exist in northern mountains outside of the area's boundary, however; in respect to absence of the species in the area, no attention was paid toward this species during this project.

9.1 Striped Hyena *Hyeana hyeana*

The striped hyena is not scarce in Miandasht WR and was studied as a possible rival species to the cheetahs. It seems that they are dependent to hilly/mountainous terrains to select their habitat. Two hyena dens were found in the area, both among northern hilly terrains on watercourse walls (height 0.5 and width 1 meter) composed of several chambers. Gazelle horn, donkey bones, hedgehog remains and plastic materials were found in dens and scats.



FIG.36. Striped hyena (left photo) and its fresh track (right photo)

The hyenas sometimes occur in southern farmlands for crops, but no livestock depredation was reported from 38 interviewed herders. In Miandasht, they usually move through trails and dried watercourses where often have slight slope with soft soil. The maximum walked distance measured for a hyena in Miandasht was 5-6 km in one summer night, through a flat road with sand-dominant soil.

During the camera trapping survey in the area, 2 different hyenas were captured at waterholes which the first hyena bitted the camera, then took it to some 100 meters away. Moreover, in order to catch a good perception about the hyena's population status in the area, their tracks were measured. In smaller hyenas, hindpaw/forepaw proportion is larger than adult large-size animals, meaning that the larger the hyena, the more variation between its forepaw and hindpaw sizes (n=9).

Hyenas are mostly concentrated in eastern half margins, available both to human settlements and predators. They usually visit villages for garbage and carrions and sometimes are killed in road accidents (FIG.37). The joint distribution map of the hyena and the cheetah (FIG.38) shows a high overlap, meaning that the hyenas apparently follow the cheetahs to consume their food remains which is the main cause of infrequent finding of the cheetah kills, particularly gazelle carrions. Meanwhile, it seems that there is no competition between the cheetahs and the hyenas in Miandasht.



FIG.37.Striped hyena killed in road incident

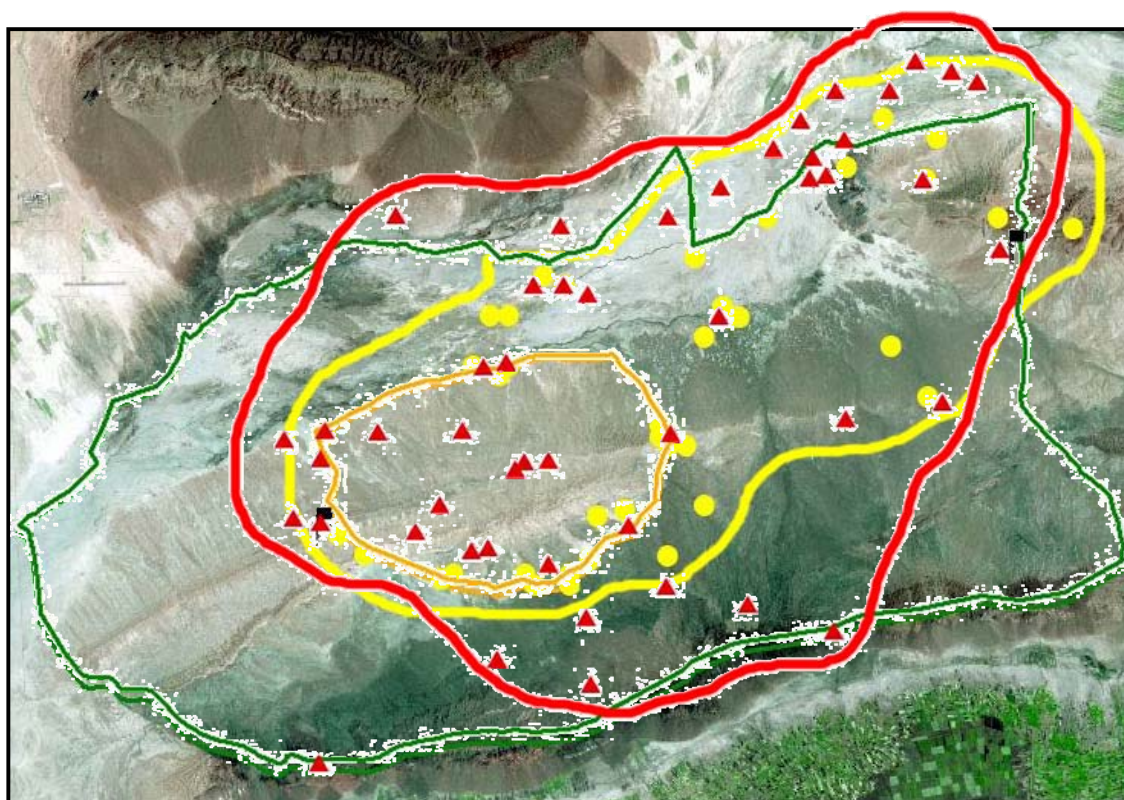


FIG.38. Cheetah and hyena distribution in Miandasht WR: Yellow circles are cheetah sightings and red triangles belong to hyenas.

Based on direct observation and tracking in various seasons, direct observation of the hyenas increases in cooler seasons, but the least direct observation occur in summer. In cooler months they are most active during daytime, but in warmer months their activities are mainly concentrated in darkness hours. The maximum number of adolescents per female for the hyenas in Miandasht was recorded as 2, but they are often seen solitary and 3 has been the largest group, a female with her cubs.



FIG.39.Striped hyena, August 0500 AM at a waterhole, seemingly an old hyena

9.2. Grey Wolf *Canis lupus*



FIG.40. Grey wolf (left photo) and its fresh track (right photo)

Wolves in Miandasht WR significantly select marginal habitats where they can easily find livestock and garbage in the surrounding villages and shelter inside the area boundary. In summer, they can rarely be seen in inner parts of the area, probably to avoid high temperature. However, they can be seen more often inside the area in cooler seasons. Annually, more than 15000 heads of livestock (mainly sheep) occupy their traditional rangelands from early December till late March for at least 100 days. During the mentioned grazing period, wolves are seen more frequently, both due to more occurrence in proximity of people as well as more daytime activity.

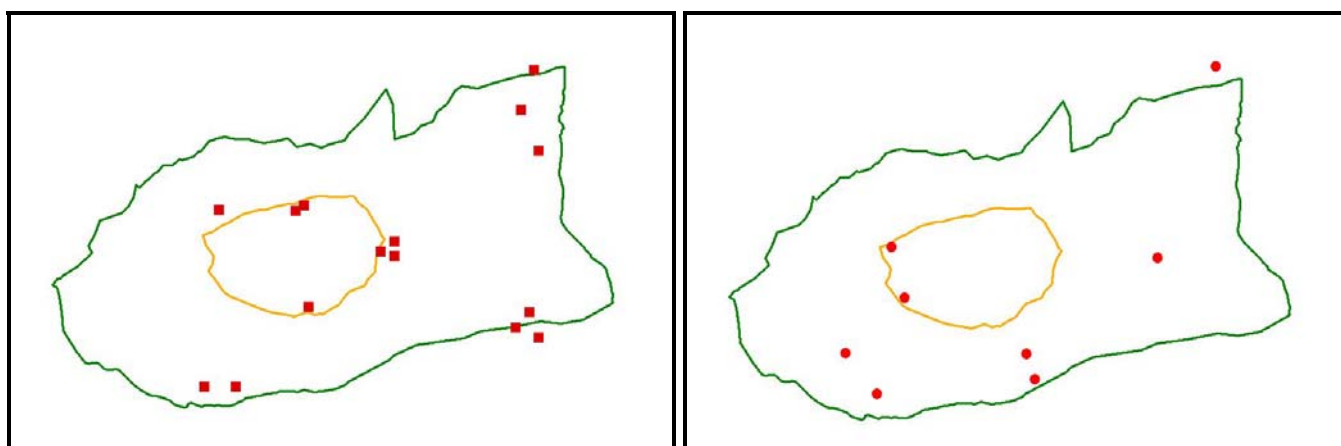


FIG.41. Wolves recorded points in Miandasht WR: Left map for fall and winter and right map indicates spring and summer.

We found livestock remains and rodents inside the scat samples of wolves in Miandasht. However, strangely they have never seen to chase or kill the gazelles. During the survey period, wolves were seen to chase and kill the gazelles in nearby Saluk National Park (60 kms eastward) with a higher density of gazelles than Miandasht. Therefore, it seems that scarcity of the gazelles, particularly in grazing season and abundance of livestock are the main causes that the wolves kill livestock more frequently.

Based on 37 times wolf encounters, a total of 120 animals were seen:

- Mean Pack Size: 3.2 (SD= 2.5)
- Max Pack Size: 17
- Min Pack Size: 1

As shown on FIG.42, wolves form larger packs in cooler than warmer seasons. Also, more wolves are seen in fall and winter which is due to spending more inside Miandasht in search for livestock. Apparently, livestock movements have the highest impact on the wolves' movements.

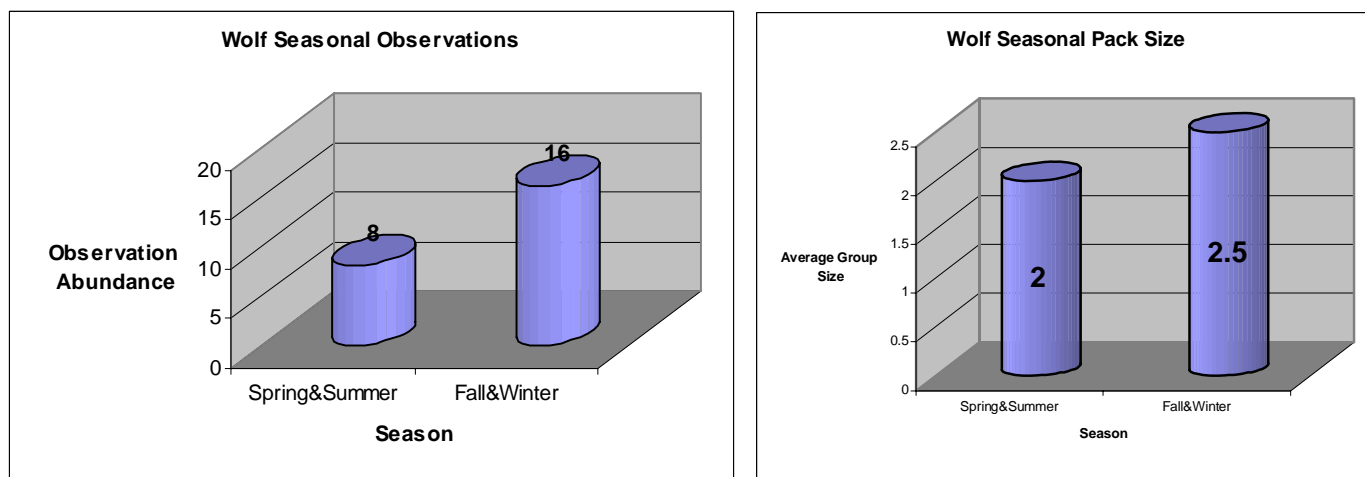


FIG.42. Wolf seasonal observations (left) and seasonal pack size (right)



FIG.43. October 2004, 1052 Am, apparently the wolf not in healthy conditions.

The joint distribution map of the wolf and the cheetah (FIG.44) shows that wolves have a broader range than the cheetahs, mostly near human settlements. In respect to wolves mean pack size in the area and their more occurrence in marginal habitats, it seems that the animal is not a threat for the cheetahs in Miandasht.

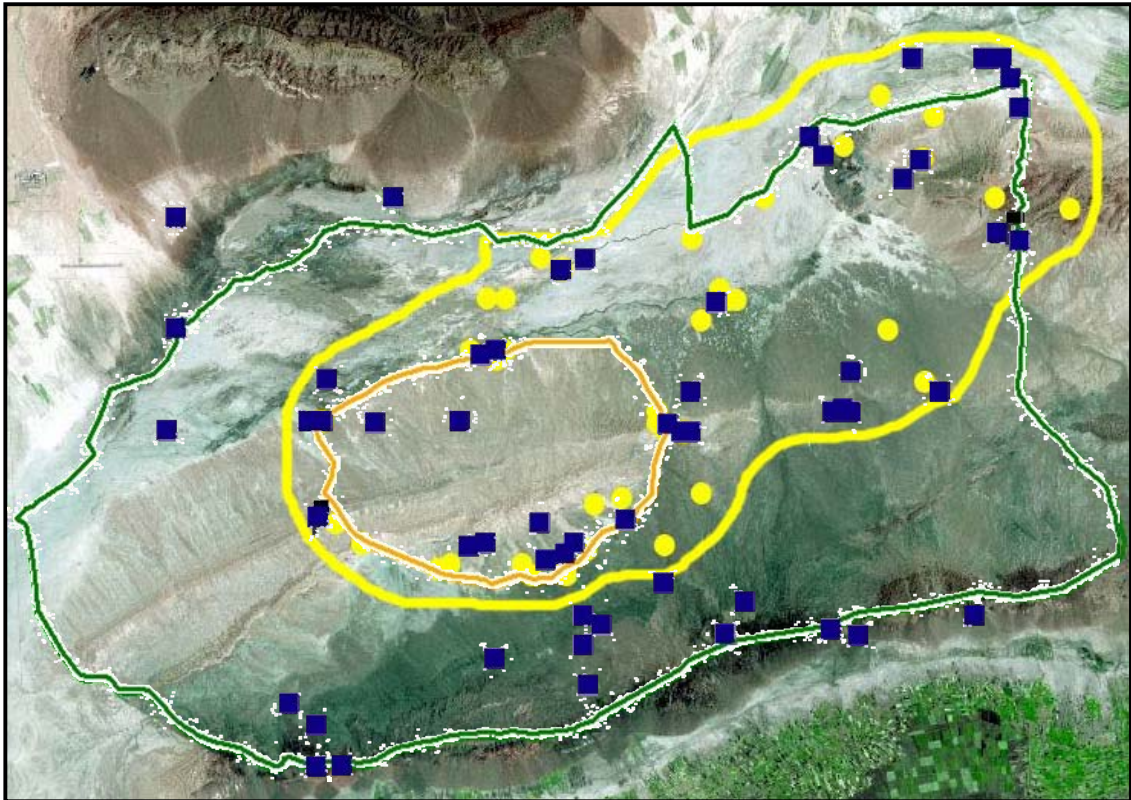


FIG.44. Cheetah and wolf distribution in Miandasht WR: Yellow circles are cheetah sightings and blue squares belong to the hyenas.

10. HUMAN-WILDLIFE INTERACTION

10.1. Local Communities

As the main city around the area in west, Jajarm & Garmeh have a population of more than 20000. The southern border of the area is limited to a number of villages located along Jovein well-known farmlands, where is one of the main agricultural poles of the country. A few small human settlements are scattered in north and east of the area, which are mainly depopulated due to high migration of people to the cities to find a job (FIG.47). Meanwhile, a total of 15000 heads of livestock, mainly sheep graze from end of November to end of March belonging to more than 50 herders, mainly from the southern villages. The herders are not nomad; they rely mainly on the area's pastures for winter and for the rest of year, they need to find plant food for their livestock around the villages as well as the remains of agricultural crops. In winter grazing season, they are allowed to occupy more than half of the area. By the end of March, herds of livestock should leave the area in order to prevent early grazing in spring. The local herders graze their livestock from late May to the end of November on remains of crops in farmlands, however; there is an interval of 2 months in spring when they have no access to an alternative pasture for their herds, hence, enter the area's pastures illegally in nighttime darkness and get out before sunrise. As a result, remarkable conflict between the people and the game guards occur in spring. On the other hand, due to high abundance of gazelles in past decades and availability of powerful trail motorbikes, hunting of the gazelles has not been rare, even as a job for a few people.



FIG.45. Sorkhcheshme, the nearest village to Miandasht WR

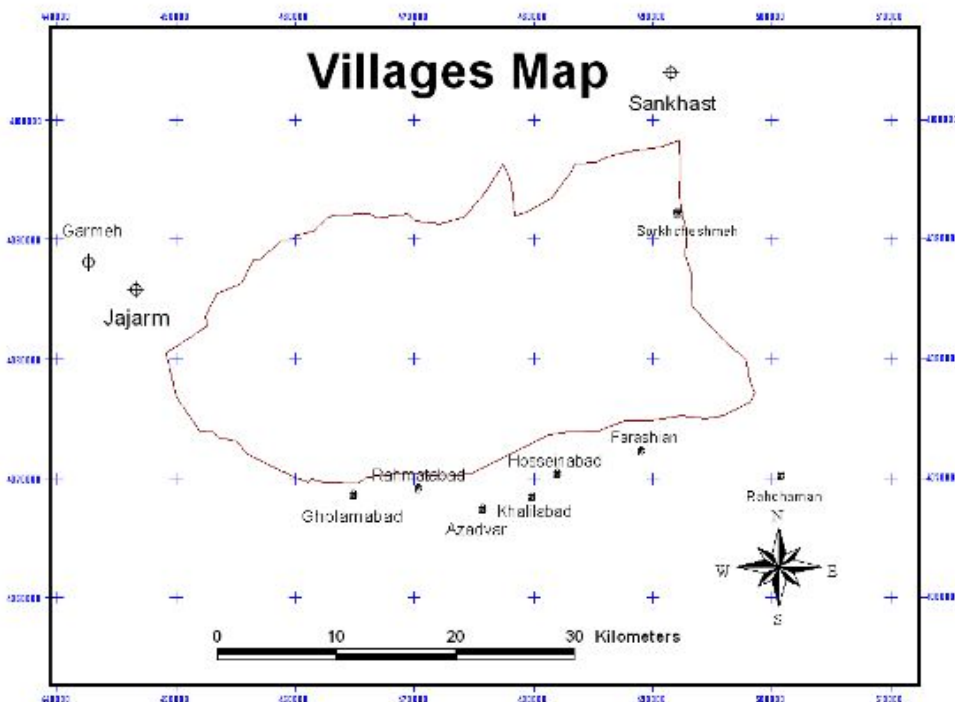


FIG.46. Map of villages around Miandasht WR

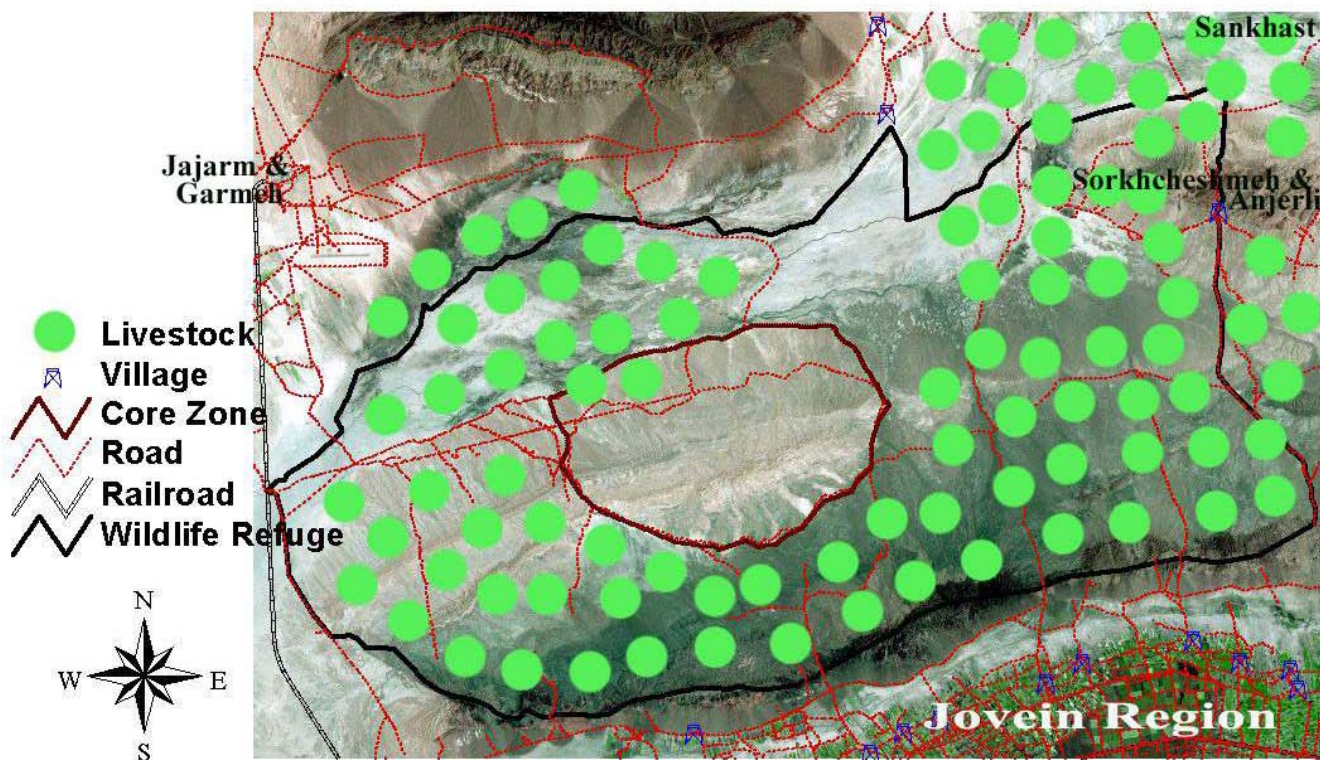


FIG.47. Socio-economic map of Miandasht WR

10.2. Predator-Human Conflict Assessment

The loss of livestock to wild predators is an important livelihood concern among Miandasht pastoralists. In the present study, we assessed the intensity of livestock depredation by large carnivores, including cheetah, grey wolf and striped hyena during winter 2004-2005.

As mentioned before, annually, more than 15000 heads of livestock (mainly sheep) occupy their traditional pastures from late November till late March for at least 100 days. The herders spent the daytime in companion of their herds in the field while return to their corals before the sunset. A total of around 50 pastoralists visited the pastures of Miandasht during the above-mentioned period which 37 of them were interviewed.

Because of conflict between the game guards and local people, mainly due to controlling actions against poaching and overgrazing, companion of game guards might affect the answer of participants, particularly on the issues of lethal preventive measures against the predators as well as size of their livestock herd. Accordingly, in order to avoid any bias, a motorbike was bought from one of the nearby villages to use during the survey without presence of the guards. After designing a 2 pages questionnaire with less than 20 questions, a total of 37 herders were interviewed in the field and/or in their corals.

Miandasht herders are almost from 10 villages and cities around the reserve while, just 1 owner originates from a far city, outside of the area's geographical borders. Most of owners were more than 50 years old and it seems that with respect to migration of younger generation as human forces to the main cities, livestock are going to be sold in near future.

Each herd consisted of on average 227 animals (SD=129, n=37), mainly sheep and between 0 to 4 herd dogs (mean=2.4, SD=1.1, n=37) accompanied the herds.

The herders were asked about the depredation by 3 large carnivores, cheetah, wolf and striped hyena and all the participants considered the wolf as the enemy number one to their livestock.

During winter 2004-2005, 24 attacks on livestock took place totally by the wolves, in which they were successful in 17 cases (71%) to catch a sheep/goat. Only 41% of participants had wolf attack experience during grazing season of winter 2004-2005. It is necessary to emphasize that herds of livestock are inside the area's pastures just during winter and spend the rest of year around the villages, which are not highly susceptible to predator's depredation.

It was estimated that 1.7 animal (SD=1.7) was the average loss to wolves among suffered herds or less than 0.9 per participants. Max loss per an attack was 8 and losses had a mode of 1 per an attack. The main victims of the wolves were sheep which with respect to their dominant abundance, it is logical. Most of wolf attacks took place between 0800 and 1400, often inside pasture.

We asked the economic value of each livestock from the herders, resulting 73.5 USD per a domestic sheep and 48.1 USD per a domestic goat. Therefore, all the participated herders combined incurred an estimated annual monetary loss of approximately 2200 USD amounting to approximately 60 USD per each interviewed herd or 140 USD per suffered herds!!! There were only 2 cases of cheetah depredation on livestock dating back to previous years.

We found two cases of depredation caused by cheetahs, each one just by a solitary cheetah who killed a one or two animals while the rest of herd relaxed in a few dozens meters away. We even found a verified report which the animals walked across the herd without any attack on sheep.



FIG.48. Interviewing with herders

Asking about their attitude toward wolves and other predators, 41% of participants believed that the wolf must be eradicated, another 41% considered their loss as the wolf's food (considering religious believes), others no idea. Also, most of them regarded the cheetah as non-dangerous creature without any threat to the human being or its properties. 84% of them knew the cheetah and could completely identify it against other predators.

In conclusion, it is obvious that the wolf is the main threat to the local people's properties, followed by the cheetah, but no record of the hyena's depredation on livestock. Meanwhile, it seems that there is no negative attitude among local people toward the cheetah as a threat to the livestock. According to the above analysis, the average loss is lower than the average value of a domestic sheep and it is thought that wolf depredation on domestic animals is not quite high that result in significant monetary losses.



FIG.49. Protective actions to save the domestic animals against predators

10.3. Problem & Solution Definition

Ultimately, we found no evidence of direct conflict between the cheetah and herders in Miandasht and people do not consider the species as a threat to their ownership. However, the grey wolf was a major problem for them and large carnivores are morphologically similar when encountering from a distance in the wild. Accordingly, it was supposed that the cheetah would be sacrificed due to the people's confusion.

Wolf depredation on livestock is not high, but with respect to the similarity between the wolf and the cheetah beside the cheetah reputation in recent years, it may be thought that the herders consider the famous cheetah as the guilty in charge of losing their animals. The shepherds often do not see the attacker predator, but as counting their animals they realized that they have lost one or a few.

Hence, it was necessary to eradicate unawareness among the local people through educating them about differences between the cheetah and other large carnivores. Moreover, it was critical to educate the people that the animal do not regularly attack on livestock and is not a threat to the human being as encountering, through enabling them to identify different large carnivores in the field, hoping prevention of occurrence of any disaster for the cheetahs. Therefore, a series of educational materials were published and disseminated among local people, including a brochure as well as 2005 wall calendar (FIG.51). Meanwhile, local and national mass media helped to inform people about the cheetahs of Miandasht. The Iranian Broadcasting produced a movie about the wildlife of Miandasht in spring 2004 with cooperation of the Iranian Cheetah Society (ICS) which had a significant role o increase the awareness of local people.

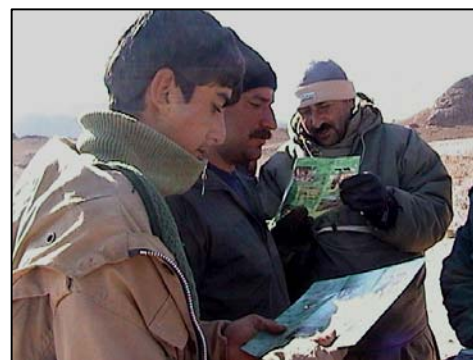


FIG.50. Dissemination of brochures among local people

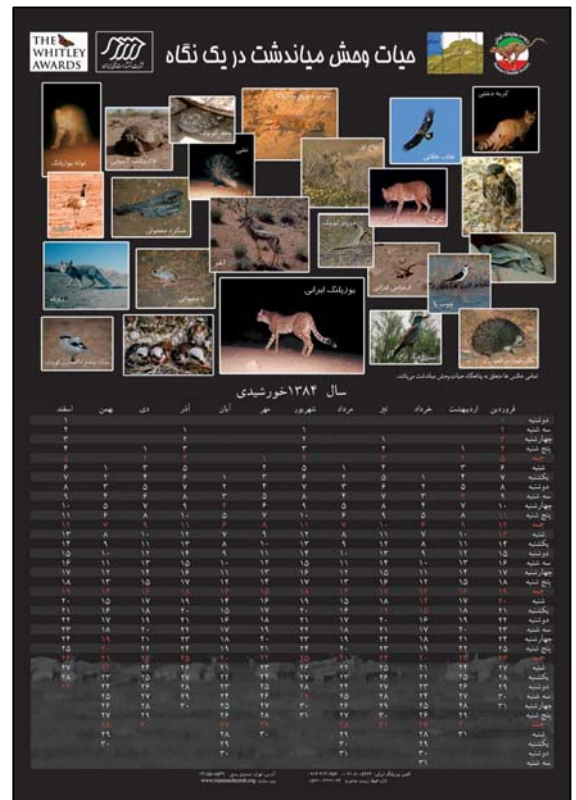
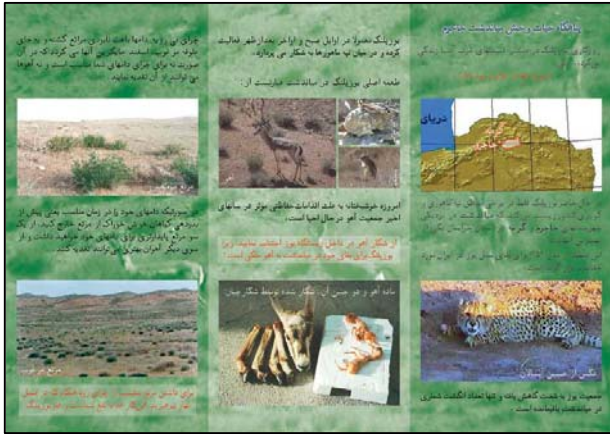


FIG.51. Educational materials, including brochure and wall calendar



FIG.52. Awareness increasing activities among local herders, villagers, hunters and government officers

In conclusion, it seems that sometime the best action is to do nothing, however; it is critical to have a correct problem analysis before making any decision. We usually look at issues the way we would like, while it is necessary to understand the perception and attitude of the people who coexist inside the ecosystem.

11. LAW ENFORCEMENT

Miandasht WR possesses two game posts, namely Ghaleche (meaning small castle) and Sorkh Cheshmeh (meaning red spring). The headquarter of the area is located in nearby city of Jajarm with 1 person usually present to facilitate the communication between the patrolling teams and following the bureaucratic affairs with miners, herders, hunters, local authorities, etc. There are less than 10 game guards working throughout the area on 5 YAMAHA DT 125 and 175 plus 1 4WD TOYOTA Hilux, always 2 people present inside each post, normally armored.



FIG.53. Some of Miandasht game guards (left) and the game guard make the camels leave the area (right)

After enforced management on guard activities since 2002, the area witnessed a growing trend in sighting of its charismatic species, particularly cheetah and gazelle. We compared the frequency of the gazelle observations for 2003 and 2004 as an indicator of more security inside the area due to more guards' patrols.

As it can be seen on FIG.54, there is a remarkable growth in the number of gazelle sightings from 2003 to 2004. However, it is not related to a remarkable growth rate in population size of gazelles just during a course of two years, but it is believed that due to higher level of security, the gazelles tolerate the human to a closer distance. In other words, they are now more observable to the observers which may result in more successful hunting by the cheetahs, too.

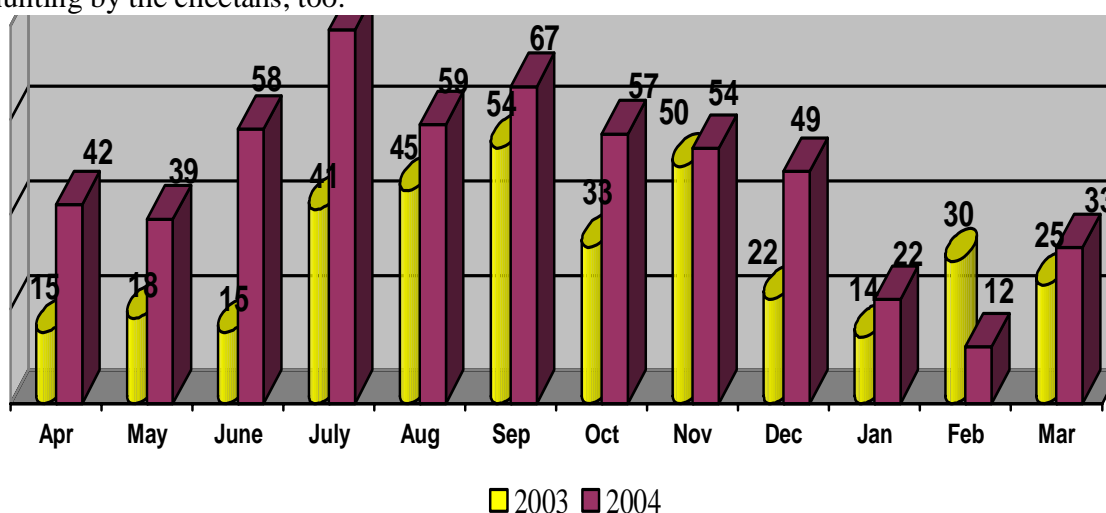


FIG.54. Gazelle observation frequency in Miandasht WR

Also, there is an increase on the number of cheetah observations (FIG.55) as a result of law enforcement measures during 2002 to 2004 which is an indicator of more observability of the cheetahs due to higher security and more seriousness of the game guards to patrol and save the areas.

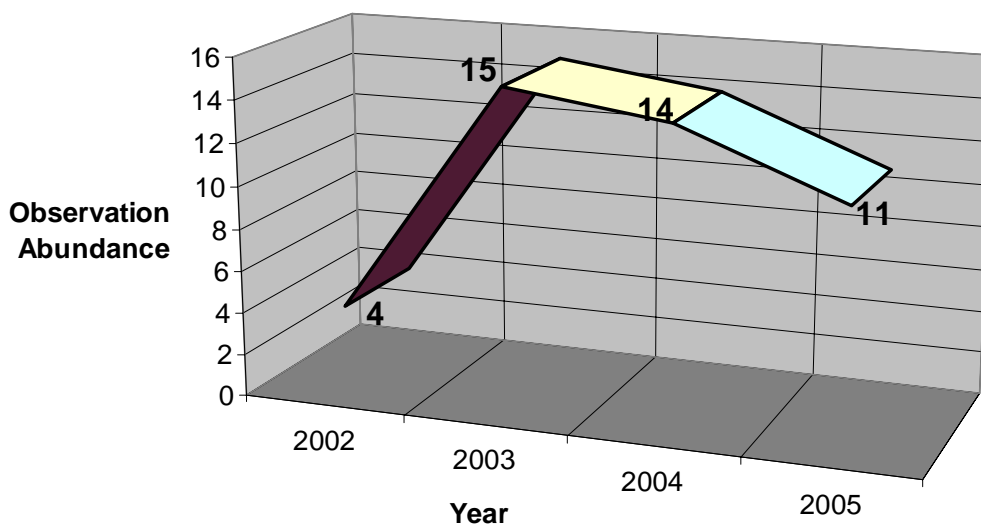


FIG.55. Annual cheetah observation abundance in Miandasht WR

In 2005, the area's management was switched to a less experienced and motivated chief which resulted in weakening of conservation efforts and lower security inside the area. As a remarkable outcome, it seems that medium and large size species are appropriate and reliable indicators to evaluate the efficacy of conservation actions inside a reserve during a short period of time.

12. LOOKING AHEAD WITH OPTIMISM: GOOD START, MORE YET TO BE DONE

It can often be heard, particularly from foundations: how to assess if a conservation plan is successful and whether is it worth further application? May be, that action needs to be changed or replaced by other, more urgent, one?

These questions are very natural, but their answers do not come easy. The point is that conservation is a long-term endeavour aimed at creation of deep changes in the society and its results are not always immediate and tangible. Sometimes, many years must pass before local people start understanding the value of conservation and implementing concrete actions. The wisdom of a necessity to preserve biodiversity as a bequest for future generations comes with years and we, people who are committed to conserve our home country's splendid nature, must present its meaning to locals in the most down-to-earth manner by spreading words and doing practical work.

In this project, we have made the first and vital steps to promote wildlife conservation actions by the new generation of wildlife conservationists in the country via providing technical assistance and organizing educational campaign in Miandasht Wildlife Refuge. Now we are asking ourselves: was it successful or not, what did it bring and what implications does it have for future activities?

We consider the project Asiatic cheetah in Miandasht WR was successful because:

- * The first scientific research on biology and ecology, particularly food habits of the cheetah was conducted in the country which provided a reliable base of knowledge to develop conservation actions;

- * It allowed us to plant the seeds of trust, inspiration, new knowledge and conservation awareness among hundreds of rural people, herders, authorities, colleagues and others which, as we hope, will eventually grow into the big tree of workable conservation.

- * The first real predator-livestock interaction assessment was done in the country which can help to think about predator depredation as a national serious problem with scientific perspective;

- * The national and international wildlife organizations are now expected to be satisfied about the Iranian young conservationists' skills and experiences;

- * 4 bachelor university projects were implemented on cheetah, goitered gazelle, rodents and birds of Miandasht by 4 students;

- * 3 more wildlife NGOs have been formed based on Miandasht project pattern to work on other species and habitats in the country;

- * Finally, the Iranian Cheetah Society (ICS) won the National Environment Award in 2005 as the first wildlife NGO in the country who made serious attempts to ensure the cheetah's survival in the wild.

13. RECOMMENDATIONS

On the basis of results of this project, the following actions are recommended:

1. Monitoring of the cheetah population using camera trapping technique during July to November in order to assess protective actions in the area;
2. Monitoring of the gazelle population as the main ungulate prey for the cheetahs in the area, preferably 2 times a year: once in November when they are highly observable in rutting season and another time in July when the newborn fawns are capable to accompany their mother;
3. Investigation in Khosh Yeylagh Wildlife Refuge as the nearest possible destination for the cheetahs' dispersal from Miandasht;
4. Increasing the number of game guards in the area to control poaching and over grazing as main problems;
5. Building a new game post at the portal of the northern village of Borde-Boland in order to decrease poaching in spring and summer;
6. Building a new game post at the southern passage of Hossein Abad as the major portal of herders during spring and poachers from Joveyn villages throughout the year;
7. Enhancing the core zone to a national park in order to ensure the long-term survival of the cheetah;
8. Public awareness activities should be continued, particularly among the southern villages where are origin of herds as well as a majority of poaches.

14. FUTURE PLANS

The present project which has been initiated in winter 2003, is one the most comprehensive researches on the species in the country which has been connected to the educational activities.

Therefore, it seems that a plan is essential to monitor the population demography of the cheetah and its associated species in order to ensure the animal's survival inside Miandasht and neighbor habitats where the cheetahs may disperse.

As well, the area's wildlife suffers from poaching seriously, particularly the gazelle which is the main large prey of the cheetah in Miandasht. Moreover, the cheetahs are sometimes victims of unaware local people who kill the animals as threats to their livestock. Therefore, it is critical to launch an organized educational program to increase the local people's knowledge about the fauna of Miandasht and decrease the present conflicts. In fact, it is believed that a complementary public awareness campaign can ensure the cheetah's long-term survival in Miandasht Wildlife Refuge.

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