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ASPECTS OF THE ECOLOGY OF THE CHEETAH (*Acinonyx jubatus*) ON NORTH CENTRAL NAMIBIAN FARMLANDS

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Abstract
Namibia has the largest remaining population of free-ranging cheetahs in the world (approximately 2,500), 90% of which are found on commercial livestock and game farms. The management of predators on private land is a complex, difficult issue especially when an endangered species is involved. The primary problem is conflict with livestock farming, to which there are solutions other than traditional lethal predator control. To be compatible with the survival of wildlife, new methods of farm management, wildlife management and predator control urgently need to be incorporated into land management.

Since 1991, the Cheetah Conservation Fund (CCF), a Namibian based research and educational foundation, has been conducting integrated and multi-disciplinary research to provide base-line knowledge on the biology and ecology of the cheetah to help to conserve the species. An over-view of CCF's methods and research findings will be discussed.

INTRODUCTION

Habitat loss and fragmentation, a declining prey base, competition with large predators and livestock interests are taking a heavy toll on wild cheetah (*Acinonyx jubatus*) populations throughout the world. Today there are fewer than 15,000 cheetah remaining in Africa and less than 200 in Iran, the last of the Asian cheetahs (Marker, 1998). The majority of cheetah populations are found in small, isolated groups outside of protected game reserves where they are often in conflict with human interests and livestock, and most populations continue to decline (Caro 1992, Nowel & Jackson 1996, Marker 1998).

The minimum viable population size for the cheetah is unknown. The cheetah's survival depends on the total ecological system, including farmland management, prey species management, and habitat stability. Does the cheetah have the ability to adapt to a changing ecological system brought about principally by conversion of preferred habitat to farmland? This is the critical question in estimating the population's survivability. Namibia is critical as the largest remaining refuge for wild cheetah. Approximately 2,500 or 20% of the world's population is found in this country (Nowel & Jackson

1996). However, this could easily change as 90% of these cheetah are found outside protected reserves on commercial livestock farmlands (Marker-Kraus *et al.* 1996).

Over the past century, the Namibian farmland ecosystem has changed. Most significant was the development of permanent water on the farmlands that changed the migration patterns of game species and much of the game became resident on farmlands. At the same time, early farmers destroyed the larger dangerous predators (ie. lions and hyenas) that allowed an increase in cheetah numbers on the Namibian farmland (Marker-Kraus *et al.* 1996). As a result, Namibian farmers have historically practised preventative management - eliminating the cheetah indiscriminately, independent of livestock loss, by either shooting on sight or after live-catching them in traps (Marker-Kraus & Kraus 1996). Average removals of cheetah per year between 1978 and 1985 were 827 and from 1986 to 1995, 297 (Nowell 1996). During the 1980's the population was believed to have declined by half from 6,000 animals to less than 3,000 (Morsbach 1997).

Namibia's cheetah are listed on Appendix I of the Convention of International Trade in Endangered Species (CITES) (CITES 1984). In 1992 Namibia was given a CITES quota of 150 animals for the export of live animals to recognised captive breeding facilities and as trophy hunted animals as an incentive to encourage farmers to stop indiscriminately removing cheetahs from the wild (CITES 1992). Along with this, efforts have been underway in Namibia by several government departments and non-government organisations (NGO's) to influence the farming community to manage the farmland ecosystem to support a healthy cheetah population.

Our organisation, Cheetah Conservation Fund (CCF), was founded in 1990. Our mission, to secure habitats for the long-term survival of cheetah and their ecosystems through multi-disciplined and integrated programmes of conservation, research and education.' Our international base is in Namibia where we focus on working with livestock farming communities developing ways to reduce predator conflict and devising a conservation plan that secures habitat for a viable population of wild cheetah while accommodating farmers' land use needs.

Early work by CCF included a personal interview survey to assess how the habitat has affected the biodiversity by investigating the history of the cheetah in Namibia. The survey was conducted between 1991 and 1993 in each district of the country where the cheetah still exists, including commercial and communal farmlands (Marker-Kraus *et al.* 1996). Information collected included: 1) important components within the farmland ecosystem that are necessary to sustain healthy cheetah populations; 2) key environmental problems leading to the cheetah and farmer conflict on these lands; 3) current livestock and game management practice; and 4) farmer's attitudes towards conservation and predators.

Information gained from this research identified background in the following areas: 1) base-line data identifying cheetah distribution patterns, including past harvest data; 2) vegetation and over-all conditions of the land; 3) availability of prey; 4) numbers of livestock on farms; 5) current livestock and wildlife management practices; and 6) farmer's interactions with cheetah and other wildlife (Marker-Kraus *et al.* 1996). This preliminary research demonstrated that this information is valuable for developing a management plan for cheetahs in Namibia, and identified possible management solutions for reducing predator conflict.

Of the 241 farmers surveyed, over 95% stated that they had no knowledge of the risks to the cheetah's existence and the role Namibians played in the specie's long-term survivial (Marker-Kraus *et al.* 1996). When questioned as to how the cheetah could survive on Namibian commercial farms, 60% of the farmers responded that they needed: 1) greater awareness of the cheetah's behaviors on the farmlands; and 2) better livestock and wildlife management practices that reduced predator conflict (Marker-Kraus *et. al.*, 1996). These key answers by farmers have guided CCF's conservation research and educational programmes to assist in maintaining the Namibian farmland ecosystem as a viable habitat for cheetah. Since 1993, bi-annual questionnaires have been sent to farmers and have provided on-going information about livestock loss and various aspects of cheetah ecology on their farmlands.

CCF's RESEARCH

The primary objectives of CCF's research are to: 1) investigate the ecology of cheetah including density, feeding, group size, home range requirements and migratory behaviors; 2) monitor the overall health, reproduction and genetic makeup of this cheetah population; and 3) develop strategies to improve the status of cheetahs through changing farmers attitudes, including sound livestock and wildlife management practices to reduce conflict with the species; specifically through the use of non-lethal predator control methods.

Ecological Research

The majority (90%) of Namibia's cheetahs are found throughout the north-central commercial cattle farmlands covering an area of 275,000 km^2. CCF's primary research area of 15,000 km^2 is in the Waterberg Plateau area and includes commercial livestock farmland, a Conservancy area within the commercial farmland, several fenced game-farms, a national park - the Waterberg Plateau Park, and communal land. This area is considered prime cheetah habitat. The land use in the area is primarily cattle and wildlife farming.

To better understand the ecology of cheetah in Namibia including density, group size, and population demographics, farmers have worked in cooperation with CCF. When possible, farmers allow cheetahs to be tagged and released on their farms and in some cases cats are radio-collared (See Table 1). From this opportunistic capture of cheetahs since 1992, an extensive database has been developed on over 376 individual cheetahs, 29 leopard and 3 caracal. Table one presents the total number of cheetahs, leopards and caracal CCF has handled, tagged and released and radio-collared.

Table 1. Animals handled, released, collared and transferred by CCF 1992-1999

	No. handled	No. released	No. radio-collared	No. transferred
Cheetah	376	137	44	28
Leopard	29	14	11	0
Caracal	3	3	3	0

Number of individuals per species that CCF has handled, released, radio-collared and transferred out of Namibia into the wild in other countries between 1992 and 1999.

CCF is investigating habitat requirements and migratory behaviours of the cheetah through the use of radio-telemetry. Since 1993, 44-farmland cheetah have been radio-collared in the Waterberg Plateau area. Minimal knowledge exists on cheetah behaviour in Namibia, and how livestock/game management practices relate to these movements. Work is currently in progress to analyse intra and inter species interactions, as 11 leopards and 3 caracal have also been radio-collared in over-lapping cheetah ranges (see Table 1).

Live-trapped cheetahs are sedated and equipped with a radio transmitter that operates in the 148 MHz band. Cheetahs are tracked weekly from a fixed-wing airplane utilising a dual antenna procedure common to aerial tracking. Positions of radio-collared cheetahs are determined by a portable Global Positioning System (GPS) receiver. Radio-telemetry is a powerful tool and important to CCF's overall management programs to show farmers the actual movements of cheetah through their lands. It illustrates where cheetah are in relation to their calving herds, indicates camps in farms where cheetah are attracted and shows the duration of time spent in an area.

Table 2 presents the average over-all home ranges of the 8 females and 20 males tracked through 1997. Our radio tracking data shows that female cheetah over-all have larger home ranges than males (see Table 2). Females exhibit an over-all home range of1591 km^2 where male's average over-all home range is 1122km^2. Currently, we are analysing the last 2 years of data along with answering questions relating to cheetah seasonal activity peaks, seasonal activity centers, and site fidelity. The radio-telemetry data has also provided invaluable information on life history requirements of cheetah.

Table 2. Average home range of CCF's radio-collared cheetahs (1993-1997).

	No. Animals	Average Home Range
Males	20	1123
Females	8	1591

The number and average home range of male and female cheetahs in CCF's research between 1993 and 1997.

Bio-medical Research

A potentially critical factor for the long-term persistence of the cheetah is its lack of genetic variation relative to other felids. The genetic structure of the cheetah has received considerable attention over the past several years (O'Brien *et al.* 1983, 1985, 1987, Menotti & O'Brien 1993), Merola 1994, May 1995). It has been suggested that this could make the species more susceptible to ecological and environmental changes (O'Brien *et al.* 1983, 1985, 1987, Menotti & O'Brien 1993). This has been interpreted in the context of two potential risks, including the expression of recessive deleterious alleles, and increased vulnerability to viral and parasitic epizootics that can affect genetically uniform populations (O'Brien *et al.* 1985, Evermann *et al.* 1988, Heeney *et al.* 1990, Brown *et al.* 1993, Munson 1993a). Given the lack of genetic diversity, monitoring the overall health of this cheetah population is a component of understanding and promoting long-term viability (Munson *et al.* 1997.)

Over the past several years, the impact of infectious diseases on endangered species has become well known (Burrows *et al.* 1992, Munson 1993a, Roelke *et al.* 1993, Roelke-Parker *et al.* 1996. As such, it is vitally important to recognize those infectious agents that comprise the normal flora of cheetahs and to discern those capable of being opportunistic pathogens. Cheetahs are known to be very susceptible to several feline diseases, increasing their vulnerability due to their lack of heterogeneity in the population (O'Brien *et al.* 1985, Evermann *et al.* 1988, Muson 1993a, b).

Since Namibian cheetahs reside on the farmlands and may potentially come into contact with domestic pets harboring infectious disease, putting in place a disease-monitoring programme has been an important component of CCF's research. Once the infections of cheetahs have been recognised, then it is possible to determine the relative risk of intraspecies transmission as well as interspecies transmission.

To analyse the possible genetic consequences of small population size within the Namibian cheetah population and to monitor over-all health and viral diseases that are a risk to cheetah survival, blood samples are collected on opportunistically live-trapped, anesthised cheetahs. After collection, the samples are analysed by various collaborative laboratories for a complete medical profile, blood counts, and serology screening.

Table 3 presents results of virus antibody analysis through 1997 (Munson *et al.* 1997). Sera is surveyed for antibodies against the following viruses, feline enteric coronavirus also known as feline infectious peritonitis (FIP), feline panleukopenia virus (FPLV) (also known as cat flu), feline herpes virus (FHV) feline calic virus (FCV), feline leukemia virus (FeLV), feline immunodeficiency virus (FIV) and canine distemper virus (CDV). Tests to measure serum antibodies for each virus are conducted using established methods. FIP antibodies are determined by indirect immunofluorescence test and FeLV antibodies by an ELISA test at the Washington Animal Disease Diagnostic Laboratory in Pullman, WA, USA. (Heeney *et al.* 1990), FIV antibodies are measured by Western blot at the National Cancer Institute, Fredrick MD, USA (Brown *et al.*, 1993), serum neutralising antibodies are measured against

Table 3. No. cheetahs tested by CCF showing antibodies (Munson et al. 1997)

	Wild (%)	Total No.	Captive (%)	Total No.
FIP	17 (32)	53	53 (40)	124
FPLV	17 (59)	55	28 (42)	66
FIV	0	27	0	95
FeLV	0	43	4	95
FHV	8 (15)	55	9 (11)	81
FCV	8 (29)	28	19 (28)	67
CDV	4(8) "suspicious"	51	23(18) 6+, 17"suspicious	129

The number of cheetahs tested by CCF for antibodies for viruses at various laboratories between 1991-1997 as reported by Munson et al. 1997.

the Ondersterpoort strain of CDV at the New York State Veterinary Diagnostic Laboratory, Ithaca, NY, USA (Roelke-Parker *et al.* 1996), and FPL, FHV1, and FCV antibodies are measured by immunofluorescent antibody tests at Laboratory of Veterinary Tropical Diseases, MEDUNSA, RSA and the New York State Veterinary Diagnostic Laboratory, Ithaca, NY, USA).

Genetic analysis uses processed and frozen plasma, white and red blood cells, and an aseptically prepared skin biopsy. Samples are currently being analysed at the National Cancer Institute, Frederick, MD, USA, by extracting DNA and employing microsatellites to determine the amount of genetic variation within the Namibian population (Menotti-Raymond & O'Brien 1995, Driscoll 1998).

The collection of biological samples has aided in the development of an extensive database on free-ranging Namibian cheetah and is supplying information on the cheetah's health throughout different regions of the country. Knowledge gained from these on-going studies will provide Namibia and the international community with more data on the overall health of and the amount of genetic variation within the Namibian population and will assist in the long-term management of the species.

Non-Lethal Predator Control

CCF has been investigating specific strategies to improve the status of the cheetah through the use of non-lethal predator control and livestock management techniques. These techniques will assist farmers in predator control, thus reducing conflicts and removals of cheetah. The use of Livestock Guarding Dogs is an ancient method of non-lethal predator control that is showing the potential of protecting farmer's livelihood while also conserving predator species in Namibia.

The use of livestock guarding dogs is a long-standing tradition that has proven its effectiveness in many parts of the world (Sims & Dawydiak 1990). To assess the potential and effectiveness of using Livestock Guarding Dogs on Namibian farms, in 1994 CCF began a pilot programme. The Anatolian Shepherd was chosen for use in Namibia with smallstock (goats and sheep). These selectively bred dogs, used for over 6,000 years for guarding livestock with little humans guidance, come from the harsh and arid Anatolian Plateau region of Turkey, an environment similar to Namibia's. The Anatolian Shepherd is a large breed with excellent eyesight, sharp hearing, thinking independently, and a strong dedication to their herd.

Guarding dogs bond with livestock instead of humans, assuming the role of protector, not moving flocks like herding dogs. If danger is near, a loud bark informs the flock and warns the predator of the guardian's presence. If the intruder approaches, the dog places itself between the herd and the intruder. Due to its size, and aggressive bark, most predators avoid the flock and look for alternative prey. If not, the dogs are aggressive protectors and seldom lose to a predator.

In 1994, CCF imported a small number of unrelated Anatolian Shepherds to begin its Livestock Guarding Dog programme. In 1995 CCF began a breeding programme in order to provide dogs for farmers interested in participating in the programme. Table 4 presents the numbers of dogs imported, births,

Table 4. No. Imports, births and deaths in CCF's Livestock Guarding Dog Programme							
	1994	1995	1996	1997	1998	1999	Total
Imports	10	0	1	0	0	0	11
Births	11	18	12	16	42	26	125
Deaths	3	6	5	14	10	12	50

CCF's Livestock Guarding Dog programme including imports, births and deaths from 1994 to 1999.

and deaths from 1994 through June 1999. The dogs are donated to farmers who are then asked to participate in the analysis of the working success of the dogs. The dogs are monitored from birth through maturity and scored for effectiveness using methodologies developed for scoring guarding dog behaviour (Sims & Dawydiak 1990).

As of yet, Namibia is the only African country where this management technique has been used for predator control. CCF's research is showing that the use of Livestock Guarding Dogs is a successful non-lethal predator control method that is showing to have an economic impact by reducing livestock loss to the farmer and that the dogs are doing what the farmers expect (Table 5). In Namibia, the Anatolian's have proven themselves successful guardians against the cheetah as well as leopard, caracal, jackal, baboon and humans. To this end, creative management strategies combined with knowledge of the predator species may provide for solutions to human/animal conflicts.

Table 5: Livestock Guarding Dogs benefits vs. results			
Economic Benefit	**No. Responses**		**No. Responses**
Yes	34	**Yes**	41
No	11	**No**	13
Too soon	1	**Not always**	1
Had dog/herder before	3	**No answer**	4
Unknown	3		
No answer	7		

Farmer's responses to the economic benefits of owning a Livestock Guarding Dog, and the farmer's expectations of whether the dogs are doing what they expected the dogs to do by the owners.

THE FUTURE

The primary problem for cheetah today, throughout its remaining range, is conflict with livestock farming and game management techniques. Developing strategies for maintaining free-ranging cheetah populations and habitats outside of protected areas are critical for the long-term survival of the species. Through knowledge of the cheetah's behaviour, farmers can learn to live together with these non-aggressive predators. Long-term monitoring of the cheetah population through demographics and over-all health are both important for the species future survival. The management of predators on private land is a complex, difficult issue and yet predator friendly livestock and wildlife management

practices can reduce conflict on farmland and provide solutions other than traditional lethal predator control. With combined scientific knowledge and cooperation with farmers, the cheetah could become one of Namibia's most valuable national treasures.

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