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Abstract: The North American Species Survival Plan (SSP) for the Cheetah *Acinonyx jubatus* has developed a cooperative and comprehensive research plan for the long-term management of the species. Networking with zoos, field biologists and scientists, the SSP has managed the captive population from a situation that was clearly not self-sustaining into a well-defined, growing population. This paper describes the development of the SSP and its long-range goals.

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## North American Species Survival Plan for Cheetah

*Acinonyx jubatus*

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The North American Species Survival Plan (SSP) for the Cheetah *Acinonyx jubatus* has developed a co-operative and comprehensive research plan for the long-term management of the species. Networking with zoos, field biologists and scientists, the SSP has managed the captive population from a situation that was clearly not self-sustaining into a well-defined, growing population. This paper describes the development of the SSP and its long-range goals.

*Key-words:* artificial insemination, FIP, global management plan, Master Plan, SSP

Cheetahs *Acinonyx jubatus* were first reported in zoos in 1829 at London Zoo and in 1871 the first in North America was recorded at Central Park Zoo, New York. Most Cheetahs in zoos in those days were short lived because of improper diet and inadequate housing. It was not until 1956 that Philadelphia Zoo first bred the species in North America. However, the first few litters born in captivity failed to survive and it was not until 1970 that San Diego Zoo became the first zoo in North America to rear Cheetahs successfully.

It was at about this time that zoos started to keep Cheetahs in separate enclosures away from the traditional cat houses and other large carnivores. This

coincided with the work of Eaton (1974), Schaller (1972) and, later, Frame & Frame (1981), who believed that wild Cheetahs avoided other predators by living away from them; in captivity, close proximity may reduce the chances of successful breeding. Increased importations of wild-caught Cheetahs from South Africa and housing the animals away from other large carnivores appeared to increase reproduction in captivity. The Cheetah population in North America peaked in the late 1970s but began to decrease in the early 1980s (Marker & O'Brien, 1989) and this decrease in reproduction caused much concern. At about this time it was documented that captive Cheetahs were depauperate of genetic variation (O'Brien *et al.*, 1983, 1986) which could make them more susceptible to disease. In the early 1980s an outbreak of feline infectious peritonitis (FIP) at Wildlife Safari, Winston, caused another major concern to managers and veterinarians (Evermann *et al.*, 1984, 1989).

In 1983 the American Zoo and Aquarium Association (AZA; then AAZPA) approved the development of the North American Cheetah Species Sur-

vival Plan (SSP). Two of the goals of the SSP were to increase reproduction of Cheetahs in captivity and to facilitate the exchange of information about the species between all participating institutions. The *Cheetah SSP Husbandry Manual* (Grisham, 1987) gave an overview of the existing facilities, diets and management programmes. No single management style was used at the collections which had bred Cheetahs and successful reproduction appeared to be the result of using a variety of methods to stimulate the animals to breed.

#### RESEARCH MASTER PLAN

The captive population of Cheetah was clearly not self-sustaining; high mortality and low birth rates which had been apparent in the Cheetah population for a number of years, seemed to be getting worse. As a consequence, the standard SSP Master Plan, which would entail genetic and demographic management of the species, would have been premature. In 1988, Cheetahs in the North American SSP were declared a research population and an extensive Research Master Plan was developed (Grisham & Lindburg, 1988). This programme comprised a systematic and co-ordinated effort to determine the reproduction and mortality problems facing this species. The purpose of this research was to increase fecundity, reduce mortality and develop a self-sustaining population that could be managed as a back-up to the wild population. Eminent scientists were recruited to develop specific research hypotheses, projects and protocols to investigate concerns about reproduction and physiology, nutrition, behaviour, mortality, genetics and infectious disease in the captive population. The goal was to gather baseline data which could be used to develop protocols for the long-term conservation of Cheetahs in zoos.

After 4 years of extensive research and co-operation with numerous SSP zoos, the results of the Cheetah SSP Research

Council were published in a special edition of *Zoo Biology* (Lindburg, 1993). The conclusions of this research were that: (1) no specific problem was detected which prevented ♂♂ and ♀♀ from breeding successfully; (2) infectious disease, especially FIP, in the captive population needed to be monitored closely; (3) infant mortality could be reduced by using specialized management techniques for the dam and cubs after birth, such as examining neonates within 24 hours, weighing the cubs, monitoring their progress using a closed-circuit camera system and giving them privacy away from the visiting public; (4) the captive population of Cheetah was being fed a nutritionally adequate diet.

The main problem appeared to be the way that Cheetahs were managed in zoos and it was concluded that managers needed to be more flexible in their methods. The provision of new stimuli and moving the animals around may increase the chances of successful reproduction (Beekman *et al.*, this volume; Bircher & Noble, this volume). Housing Cheetahs in single ♂-♀ pairs may not be advantageous (Caro, 1994) and ♂ coalitions have become more common in captive-breeding programmes. Protocols were established to monitor Cheetahs, in order to understand more about their behaviour, and intensive management programmes were developed to stimulate them to breed in natural settings (see also Beekman *et al.*, this volume; Bircher & Noble, this volume).

Research on the reproduction of Cheetahs has led to successful births through artificial insemination (AI). The work pioneered by David Wildt and JoGayle Howard in the use of AI as a management tool has greatly increased the possibility of utilizing important genes in under-represented animals in the North American population. To date, eight successful AIs have produced 15 cubs. This invaluable management tool will greatly assist the Cheetah SSP in its long-term goal of

creating a self-sustaining population (Wildt & Roth, this volume).

#### MASTER PLAN

In 1993 the Cheetah SSP held its first Master Plan Workshop to develop a Master Plan for the genetic and demographic management of the species (Grisham, 1993, 1996). The population in North America had grown from 193 animals in 1988 to 321 animals in 1993. The population appeared to be demographically viable and breeding would need to be carefully managed so as not to exceed further the 320 spaces allocated to the Cheetah SSP by the North American Felid Taxon Advisory Group (TAG).

In 1993 an analysis of the captive population produced the following information: (1) a generation length of 5.5 years; (2) 63 founders in the North American population; (3) genetic diversity retained at 97.03%.

Based on the amount of genetic diversity lost so far (i.e. approximately two generations), it was determined that the effective population size ( $N_e$ ) was c. 50, which resulted in a  $N_e/N$  ratio of about 0.2. These parameters indicated that 90% of genetic diversity could be maintained in this population for 100 years if the carrying capacity were to be increased to c. 640 spaces. However, improved management techniques would substantially decrease the amount of space required. If under-represented animals were bred successfully over 2 years, retention of gene diversity could be improved from 97 to 98%. With population-wide management, the effective population size could double. With this corrected set of population parameters the 321 animals in the North American SSP would be adequate to attain 90% gene diversity for 100 years.

In 1996 the Cheetah SSP Master Plan was revised. Because the population appears to be demographical viable breeding should be restricted to genetically important animals (Grisham, 1996).

No breeding recommendations have been made for animals of less than 4 years old and emphasis is placed on incorporating valuable genes from older under-represented animals. Specific recommendations were made for using AI on genetically important ♀♀ which had not yet produced offspring from natural matings. The SSP Management Group also strongly endorsed the development of a genome resource bank for Cheetah. This will be developed following AZA guidelines for the long-term preservation of germ plasm.

Analysis of the SSP population in 1996 revealed: (1) a generation length of 6.1 years; (2) a total of 64 founders; (3) genetic diversity retained at 96.9%. Based upon the amount of genetic diversity lost thus far (approximately two generations) it was determined that the  $N_e$  and the  $N_e/N$  ratio were the same as in 1993. Although a new founder had been added genetic diversity had decreased slightly because of non-recommended breeding of over-represented animals.

#### FIELD CONSERVATION

In 1994 a multi-institutional scientific team went to Namibia to collect information on wild Cheetahs that could be compared with the data gathered by the Cheetah SSP Research Council on the North American Cheetah population. The team, headed by the Smithsonian Institution NOAHS Center (New Opportunities in Animal Health and Science), Oklahoma City Zoological Park, Columbus Zoo and the National Cancer Institute, embarked upon a collaborative study with the Cheetah Conservation Fund in Namibia (Marker-Kraus & Kraus, this volume). The project was carried out in full cooperation with the Namibian Ministry of Environment and Tourism (MET), the Namibian Veterinary Association and local farmers. Information was collected from more than 20 wild Cheetahs and their overall health, genetics and reproductive physiology were compared to that of the animals in the North American

population. There was found to be little difference between the wild population and the North America SSP animals. The work also established that captive Cheetahs did not appear to have any additional health problems unique to captivity. During the study in Namibia, semen was collected and cryopreserved so that it could be used to augment the North American population. Namibian Cheetahs are largely free of exposure to feline immunodeficiency virus (FIV), so the cryopreservation of the semen from the wild population is particularly desirable.

While carrying out the study, the team also gave lectures and provided training to the local wildlife veterinarians on state-of-the-art techniques for inducing anaesthesia, monitoring health and carrying out genetic and reproductive evaluations. Lectures were also given to high-school and undergraduate university students emphasizing the importance of the Cheetah as a natural resource of Namibia and detailing the research being carried out on the species in North America. During this visit a positive collaboration was developed between the Namibian MET and the Cheetah SSP. Discussions were held concerning the development of a Population Habitat Viability Assessment (PFIVA) in 1996 to be conducted by the International Union for the Conservation of Nature and Natural Resources (IUCN) Conservation Breeding Specialist Group (CBSG).

In May 1995 at the White Oak Conservation Center, Yulee, the first Cheetah cub to be produced by using frozen semen collected in Namibia was born. Although maternal care was excellent the cub died on day 5. In November 1995 a second litter of cubs produced by using cryopreserved sperm was born at Rio Grande Zoo, Albuquerque. One cub died immediately and a second cub died on day 7 but the third cub, a ♀, survived and is doing well. These births demonstrate the first steps being taken to develop AI as a useful management tool to infuse new genetic

material into the North American population.

The development of a genome resource bank and the continued co-operative research with the Namibian MET and the Cheetah Conservation Fund have laid the foundation for the long-term survival of the Cheetah.

#### FUTURE

In April 1995 the Cheetah SSP sponsored a workshop on FIV in Cheetahs in North America (Grisham & Killmar, 1995, this volume). The workshop brought together the leading researchers on this lentivirus to discuss its effects on the Cheetah population and to develop a protocol for monitoring infectious disease in this species. The participants agreed that not enough was known about the transmission and pathogenicity of the disease and, therefore, monitoring sero-prevalence of FIV in the North American population was a warranted course of action. Recommendations for future research on FIV were also developed.

Several factors have led to the success of the Cheetah SSP including: (1) the development of the Cheetah SSP Research Council and the research carried out which helped to set standards for this species which are now being utilized by other SSPs; (2) the outstanding co-operation of participating facilities that provided information; (3) disease-surveillance programmes that were instituted to help maintain a healthy population; (4) the development of artificial insemination techniques which have greatly enhanced the ability to utilize the genetic diversity already present in the captive population that would otherwise be lost; (5) the ability to collect and cryopreserve semen from wild Cheetahs and use it to augment the captive population. Animals should no longer have to be removed from the wild to supplement captive-breeding programmes. Instead, free-ranging Cheetahs can be immobilized, semen can be collected and the animals can be released.

This germ plasm may be used to keep the captive population strong and genetically diverse.

Although baseline data have been gathered on this species there is still much more to be done. Regional captive-breeding programmes for Cheetah need to be combined into a global management plan in order to guarantee the long-term survival of the species.

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