POPULATION AND HABITAT VIABILITY ASSESSMENT FOR THE NAMIBIAN CHEETAH (*Acinonyx jubatus*) AND LION (*Panthera leo*)

11-16 February 1996
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Workshop Report
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SECTION 1

INTRODUCTION AND OVERVIEW

Introduction and Overview

PHVA Workshop for the Namibian Cheetah and Lion

Introduction

Reduction and fragmentation of wildlife populations and habitat are occurring at an accelerating rate worldwide. For an increasing number of taxa, these factors result in small and isolated populations that are at risk of extinction. A rapidly expanding human population, now estimated at 5.77 billion, is expected to increase to 8.5 billion by the year 2025. In Namibia, the current human population is estimated at 1.6 million and, at its current rate of increase, is expected to double to 3.2 million in 26 years (Population Reference Bureau, 1996). This expansion and concomitant utilization of resources has momentum that cannot be stopped, with the result being a decreased capacity for all other species to exist simultaneously on the planet.

In Africa, as in the rest of the world, human activities increasingly threaten the survival of natural environments and wildlife populations. As these populations are diminished, their ecological roles in ensuring a well-balanced, regulated, and sustainable ecosystem also are reduced. Still, most conservation actions are directed toward habitat and reserve protection, rather than the conservation and management of the wildlife components that are critical to the long-term survival of individual ecosystems.

Single species management for threatened species can take a variety of forms:

- Protection from invasive organisms and pathogens
- Habitat modification and management (e.g., prescribed burning or provision of artificial watering sites)
- Reintroduction or translocation
- Assisted reproduction
- *Ex situ* breeding or propagation, either in-country or abroad

Species as the compositional unit of a community or ecosystem are a convenient and discrete unit of management, particularly when that taxon is threatened and requires species-specific management. A Population and Habitat Viability Assessment (PHVA) provides focus at the species level and provides a forum to bring collaborative specialties together to ensure a balanced, integrated approach to species conservation.

Wildlife managers realize that management strategies that will reduce the risk of species depletion must be adopted to ensure viable ecosystem functions. These strategies will include increased communication and collaboration in: habitat preservation; intensified information gathering in the field; investigating the ecological roles of key species; improving biological monitoring techniques; and, occasionally, scientifically managing captive populations that can interact genetically and demographically with wild counterparts. Successful conservation of ecosystems and wild species necessitates developing and implementing active management programs by people, governments, and non-government organizations (NGOs) that live alongside, and are responsible for, that ecosystem.

The PHVA Process

Effective conservation action is best built upon critical examination and use of available biological information, but also very much depends upon the actions of humans living within the range of the threatened species. Motivation for organizing and participating in a PHVA comes from fear of loss as well as a hope for the recovery of a particular species.

At the beginning of each PHVA workshop, there is agreement among the participants that the general desired outcome is to prevent the extinction of the species and to maintain a viable population(s). The workshop process takes an in-depth look at the species' life history, population history, status, and dynamics, as well as assesses the kinds of threats putting the species at risk.

One crucial by-product of a PHVA workshop is that an enormous amount of information can be gathered that, to date, has not been published. It is estimated that 80% of the useful information about a given species is in people's 'heads' and likely will never be published. All participants are equal in the PHVA process, recognizing the contributions of all people with a stake in the future of the species. Information contributed by ranchers, game wardens, scientists, field biologists, and zoo managers all carry equal importance. To obtain the entire picture concerning a species, all the information that can possibly be gathered is discussed by the workshop participants with the aim of reaching agreement on the current information. These data then are incorporated into a computer simulation model to determine: (1) risk of extinction under current conditions; (2) those factors that make the species vulnerable to extinction; and (3) which factors, if changed or manipulated, may have the greatest effect on preventing species extinction. In essence, these computer-modeling activities provide a neutral way to examine what is going on currently and what needs to be done in the future to prevent extinction.

The value of the PHVA process also lies in enhanced communication. People often have been working with the same species for years but may have never discussed important issues face to face. During the PHVA process, participants work in small groups to discuss key issues, whether predator management, disease, human-animal interactions, or other emerging topics.

Each working group produces a brief report on their topic, which is included in the PHVA document resulting from the meeting. A successful PHVA workshop depends on determining an outcome where all participants, coming to the workshop with different interests and needs, "win" in developing a management strategy for the species in question. Local solutions take priority. Workshop report recommendations are developed by, and are the property of, the local participants.

The Namibian Cheetah - *Laurie Marker Kraus*

Originally, cheetah were found from the Cape of Good Hope to the Mediterranean, throughout the Arabian Peninsula to the southern part of the former Soviet Union. Population numbers have declined from more than 100,000 in 1900 to approximately 9,000 to 12,000 free-ranging cheetah inhabiting a range now restricted to North Africa, the Sahel, and East and southern Africa. Fewer than one-third of the countries in which cheetah exist have viable populations. Two population strongholds remain: Kenya/Tanzania in East Africa and Namibia/Botswana in southern Africa. The cheetah's greatest hope for survival lies in the relatively undeveloped countryside of Namibia, home to the world's largest population. Even here the species numbers are thought to have declined by approximately 50 percent between 1980 and 1991, leaving a population of fewer than 2,500 animals.

Decreasing cheetah numbers throughout Africa are thought to be a result of declining habitat and prey base. As humans convert more and more of the cheetah's habitat into farmland for livestock production, human/cheetah conflicts have emerged. Although wildlife reserves and conservation parks have been set aside as a haven for wild animals to roam freely, for the cheetah such parks and reserves have led to direct competition with other large predators. Notably lion and hyenas may take up to 50% of cheetah kill and a large percentage of cheetah cubs, making it difficult to sustain a viable population.

As a result of this competition, most free-ranging cheetah are found outside protected areas. Surveys show that in Namibia, 70% of wildlife lives on private, commercial farmlands ranging from 5,000 ha to 15,000 ha (10,000 to 40,000 acres). Ninety-five percent of the cheetah population lives on these private lands, where prey is available and other large predators generally are absent. But private ownership of wildlife has caused unique problems for conservation. Historically, the cheetah has been viewed as a pest and a threat to the livelihood of livestock farmers, and it is legal in Namibia to shoot an animal that interferes with one's property and livelihood.

In the 1980s, because of a variety of circumstances that included severe drought, game populations declined by 50 percent and cheetah populations came into greater conflict with farmers and domestic livestock. Additionally, during this period, 80 percent of one of the cheetah's main prey, the kudu *(Tragelaphus strepsiceros),* died from a rabies outbreak.

Combined, these events led cheetah to begin to prey on domestic livestock, resulting in increased conflict with the farmers who live-trapped the cats or shot them. By the latter part of the 1980s, the cheetah population had been reduced by more than half. The Convention in International Trade in Endangered Species (CITES) data report that between 1980 and 1991 more than 6,800 cheetah were removed from these farmlands and the conflict continues. The cheetah's survival requires all stakeholders in the future of the species to develop a clear understanding of each other's needs, with an aim to reach a compromise.

Since almost all huntable wildlife belongs to the landowners and has an economic value through live sale, meat production, and trophy hunting, wildlife conservation strategies are developed along with livestock and pasture management practices. Alternative farm management practices are being introduced to protect livestock from predators, including, but not limited to: placing donkeys with calving herds, as donkeys are aggressive and chase away cheetah; promoting more aggressive breeds of cattle; employing herders and large breeds of guard dogs; placing livestock in a kraal at night.

Molecular genetic studies have shown that the cheetah lacks genetic diversity, probably because of past inbreeding, which has limited its options for adapting to environmental change and challenges. Collaborative research conducted at the DeWildt Cheetah Breeding and Research Center in South Africa, the Wildlife Safari in Oregon (USA), and in the Serengeti National Park in East Africa revealed that cheetah have 10 to 100 times less genetic diversity than is normal in other cat or mammal species. Today's cheetah population is similar to laboratory mice that have been deliberately inbred for 20 generations.

Based primarily on studies of captive populations, the cheetah's genetic uniformity has led to reproductive abnormalities, high infant mortality, and increased susceptibility to disease. This disease susceptibility was demonstrated in the 1980s when viral outbreaks of feline infectious peritonitis almost destroyed several captive populations of cheetah.

The Namibian Lion - *Hu Berry*

Namibia is home to a unique and significant lion population that is seriously threatened by human conflicts, range loss, and potential disease threats. Although lion in Namibia represent only 1% of Africa's total population (estimated between 30,000 and 89,000), they are of tremendous tourism value within the country, and are an important conservation population. For example, approximately 43% of 280,000 tourists in 1993 visited Etosha National Park, where lion are a major attraction, and generated approximately N$500 million that year. For this and other reasons, the 200 lion remaining in Etosha are an invaluable and irreplaceable asset. Additionally, lion are important to the trophy hunting industry. Namibia is among only three African countries that still can offer the "big five" to hunters (lion, leopard, buffalo, white rhino, and elephant). The FIV-free status of lion in Etosha makes these populations

invaluable to worldwide lion conservation.

Historically, lion ranged over most of the northern half of the country and partly in the east, west, and south. Few historical, quantitative population estimates are available, though total lion numbers were estimated at approximately 500 in 1975 and approximately 700 individuals in 1980. Since then, the Namibian lion population has been declining, and now is estimated at only 300 animals. This trend indicates that up to a 50% decline in lion numbers may have occurred over the past 15 years, although censusing techniques used in the 1970s and 1980s were less precise than those used currently, which may lend a margin of error to the above estimates. A complicating factor is that 85% of the lion in Namibia currently are restricted to two protected areas, the Etosha National Park (180 to 200 lion) and Kaudom Game Reserve (50 lion).

The lion in Namibia has only recently (1995) been classified as a "protected species" under the Nature Conservation Ordinance (No. 4 of 1975). Before this classification, the Ministry of Environment and Tourism had no formal method of monitoring the incidence of problem-animal hunting, or deterring farmers from killing lion when there was a perceived threat to them or their livestock.

Despite the importance of these regulations, many threats to the Namibian lion population exist. Livestock, agriculture, and the human population constitute the greatest sources of conflict for the lion. During the 30-year period from 1965 to 1994, at least 1,000 lion were reported to have been destroyed on farmlands bordering Etosha. The number actually may be considerably higher since (as described above) before the 1995 protected species classification, local landowners were not legally obligated to report lion kills.

Such human-lion conflicts may actually become even more frequent given the projected growth in Namibia's human population. Furthermore, 55% of Namibian citizens currently live adjacent to, or in, the areas where lion occur, and the majority of these people own livestock (cattle, goats, donkeys, and horses).

Another important factor affecting Namibia's lion is the isolated and fragmented nature of the populations. This isolation also places these populations at increased risk to the deleterious effects of small population size, such as increased inbreeding. Additionally, of lion reportedly killed on farmlands outside of Etosha, the majority have been sub-adult males. A marked decrease in this age class may seriously impact the demographics and long-term survival of the small population there. In the event of a catastrophe (such as a disease epidemic similar to the canine-distemper outbreak in the Serengeti), a small, isolated lion population may suffer greatly.

To address these and other problems facing the two species, a Population and Habitat Viability Assessment (PHVA) Workshop for the Namibian cheetah and lion was held from 11-16 February 1996 at the Otjibamba Lodge and the Hamburgerhof Hotel in Otjiwarongo, Namibia. The workshop was a collaborative endeavor of the Namibian Ministry of Environment and Tourism, the Cheetah Conservation Fund, the Felid Taxon Advisory Group (TAG) of the American Zoo and Aquarium Association (AZA), the AZA Cheetah and Lion Species Survival Plans, and was facilitated by the IUCN/SSC Conservation Breeding Specialist Group. The meeting was hosted by the Cheetah Conservation Fund, Otjiwarongo, Namibia and generously sponsored by British Airways, White Oak Conservation Center, Columbus Zoo, NOAHS Center - Smithsonian Institution's National Zoo, Philadelphia Zoo, Fort Worth Zoo, Zoo Atlanta, Oklahoma City Zoo, Rio Grande Zoo, Houston Zoo, Caldwell Zoo, Franklin Park Zoo, Binder Park Zoo, and Nashville Zoo.

The PHVA Workshop - Day 1

Participants were welcomed, and the meeting was officially opened by His Excellency, Dr. Sam Nujoma, President of the Republic of Namibia (Appendix I). Mr. Kavetuna, Mayor of Otjiwarongo, and Mr. Marshall McCallie, U.S. Ambassador, welcomed the participants, followed by an informational session concerning Namibian conservation policy by the Honorable G.J. Hanekom, Namibian Minister of Environment and Tourism (MET) (Appendix II).

The first day's activities were attended by nearly 100 participants from 10 countries (Appendix III), including a representative group of the stakeholders in the future of the two species: Namibian MET officials, farmers, conservationists, and scientists. Overview presentations concerning the status of both the cheetah and lion, the role of conservancies in Namibia, problems facing commercial farmers, as well as presentations on small population biology and the goals of the workshop set the stage for the weeklong activities.

The first afternoon primarily was designed for dialogue pertaining to farmers' concerns; because of the rigorous needs in maintaining their farms, most could not attend the workshop after the first day. The farmers expressed their primary dilemma as determining how to maintain commercial livestock farms without being forced to kill cheetah and lion to protect their livelihoods. An hour-long discussion took place during which all stakeholders were able to voice their concerns to each other and to the Ministry, in an open forum.

This was followed by a brief presentation by the workshop facilitator on a suggested method for explicit communication of each stakeholder group's problems and needs in terms of the two species, so that each group could understand the other's perspective in relation to the cheetah and lion. Stakeholders then formed seven small, homogeneous groups of 6 to 10 people each: farmers with lion problems, ministry personnel, farmers with cheetah problems, and two groups each of conservationists and scientists. Each group was asked to list three to five of

their most urgent problems relating to the species, with instructions to state them using consensually-reached, issue-based statements (e.g., "The critical problems for us are . . . " and to record them on flipcharts.

The second portion of the small group task centered on generating a discussion of needs rather than positions, also using statement format (e.g., "We need . . ."). Participants were instructed not to focus on solutions, as that would be a task during the rest of the workshop. Instead, they were asked to explicitly state their own needs, followed by a "why" statement. For example, rather than saying "We need more open communication" or "We need to retrieve carcasses of dead lion and cheetah," participants were asked to use statements such as "We need more open communication to understand in what way Ministry policies or initiatives help protect these species" or "We need to retrieve carcasses of dead lion/cheetah to analyze threats, such as disease, to our populations."

Working groups then posted their results and a representative from each group gave a brief synopsis of the problems and needs identified. A group of four participants, each representing one of the stakeholder groups, then synthesized and presented commonalties and differences between the problems and needs expressed by each of the four stakeholder groups. Several common themes clearly emerged:

1. Communication/education/cooperation

2. Basic research
    -identifying critical threats
    -long-term monitoring to detect population trends
    -range, habitat, and prey to ensure viable populations
    -global management of captive populations

3. Funding to implement #s 1 and 2

4. Economic considerations
    -impact
    -asset value of cheetah and lion
    -integrated wildlife and livestock management (land-use)
        -restricting range of cheetah and lion
        -practical solutions to the needs of people
        -evaluation of appropriate, sustainable land-use systems

The identified problems and needs of the individual stakeholder groups were:

MINISTRY

Problems	*Needs*
(1) The critical problem for us is uncertainty of impact of removals on both cheetah and lion populations.	(1) We need to understand the limiting factors for our cheetah and lion populations manage the populations.
(2) Another problem is incompatible land-use objectives within the range of large carnivores.	(2) We need to improve the monitoring of cheetah and lion populations on a national scale to detect trends.
(3) A major problem is lack of resources to maintain effective communication with other stake-holders (resources: money, human, time)	(3) We need to increase economic incentives for landholders to tolerate large carnivores.
	(4) We need increased coordination within the farming community for collective planning and effective communication.

FARMERS WITH LION PROBLEMS

Problems	*Needs*
(1) Warthogs make holes in Etosha's perimeter fences. Erosion makes holes in the fences. Predators enter farm areas and create unacceptable losses to livestock.	(1) We need proper, effective fencing.
(2) Etosha border fences are not being maintained regularly because of a lack of government funding and serious staff shortages.	(2) We need fences patrolled regularly.
(3) Farms bordering +/- 50 km of Etosha fence are essentially quarantine compounds. Lion have been removed out of this area to protect black-faced impala and roan antelope.	(3) We need cooperation and communication improvement between farmers and Nature Conservation or MET.
	(4) We need a unit to be created that deals with all three mentioned needs and is equipped with the relevant and necessary equipment and money to rectify the situation.

FARMERS WITH CHEETAH PROBLEMS

Problems

(1) The critical problem is the loss of livestock and wildlife.

(2) Many community disagreements result from differences in opinion concerning the conservation and management of cheetah.

(3) We have very little knowledge about cheetah.

(4) The cheetah is endangered and close to extinction.

Needs

(1) We need basic knowledge about how to solve the livestock losses to minimize the economic impact.

(2) New livestock/wildlife management techniques need to be introduced to reduce livestock/wildlife losses.

(3) We should have appropriate education for all.

(4) We need ways to make the cheetah a valuable asset to the farmer to compensate for economical losses.

(5) We need ways to bring people together to discuss disagreements.

(6) We need appropriate research of cheetah on farm lands/range lands to assist the farmer/conservationists.

(7). We need to monitor cheetah numbers to prevent the possible extinction of the cheetah.

CONSERVATIONISTS I

Problems

(1) There are inadequate ranges and fragmented populations.

(2) There is conflict between humans and predators.

(3) There is inadequate funding for the conservation of cheetah and lion.

Needs

(1) We need to secure suitable range to maintain viable populations.

(2) We need to foster communication to achieve an understanding of the potential value of the predators.

(3) We need to generate funding for the conservation of cheetah and lion.

CONSERVATIONISTS II

Problems

(1) There are diminishing numbers of cheetah and lion because of:

- -killing of predators
- -habitat loss
- -climatic fluctuations
- -diseases/genetic problems
- -consumptive utilization
- -no incentive to conserve.

Needs

(1) We need incentive to conserve.

(2) We need understanding of diseases and genetics.

(3) We need practical solutions to the needs of people.

(4) We need capital.

(5) We need education programs.

SCIENTISTS I

Problems

(1) There are gaps our scientific knowledge of cheetah and lion survival and conservation.

(2) There are gaps in our knowledge of appropriate sustainable land use systems to the benefit of wildlife and private land owners.

(3) We have concerns about the long-term survivorship of the existing limited current lion population.

Needs

(1) We need financial and other support to carry out studies to address these problems.

(2) We need to define and quantify the real importance of the critical threats to these species, including recognition of chronic and acute threats and the relative priorities of these threats.

SCIENTISTS II

Problems

(1) Our problem is the lack of information for both cheetahs and lions regarding natural history and ecology (farms and national parks).

(2) Our problem is a lack of long-term studies of infectious diseases of both the cheetah, lion and their prey.

(3) Our problem is a lack of a management plan for captive cheetahs and lions.

Needs

(1) We need to gather baseline information for both species to allow making rational conservation management decisions.

(2) We need to establish long-term monitoring of infectious diseases that impact survival of viable populations and potential relocation.

(3) We need to establish a management plan for captive animals in Namibia for integration into existing global programs.

A good indication that stakeholders were successful in communicating their problems and needs, and in listening to the problems and needs of the other groups, is perhaps best reflected by a poem written by one of the farmers attending the workshop the first day (Appendix IV).

Continuation of the PHVA Workshop Process - Overview of Working Group Activities

The following 4 days of the PHVA focused primarily on the distribution, status and threats to the cheetah and the lion, and existing and proposed management strategies. The second day of the workshop began with a VORTEX computer simulation modeling demonstration on Etosha lion, and status reports on the cheetah and lion from Namibia, Zambia, and South Africa. Six working groups were established: Wild Management Goals and Strategies, Human/Livestock Interaction and Communication, Life History/VORTEX modeling, Disease, Genetics, and Captive Populations, each comprised of international as well as Namibian participants. The tasks of the working groups for the next 4 days then were to:

1. Identify the main issues and problems.

2. Determine goals in terms of identified issues and problems.

3. Develop promising strategies and solutions to address (1) and (2) in light of available data.

4. Prioritize the promising strategies and solutions in terms of the needs expressed by the various stakeholder groups on the first day of the workshop.

5. Turn the highest priority strategy into realistic action steps in terms of the ability to move forward in particular time frames (e.g., tomorrow; 1 month; 6 months; 1 year; 2 years, etc.) and, when possible, identify available and potentially available resources (e.g., people, time, potential in-kind contributions of equipment or training, potential funding sources).

6. Report daily (orally) on working group discussions so that input from other participants could be incorporated.

Working Group reports for cheetah and lion are included as Sections 2 and 3 of this document, respectively.

Summary of Working Group Recommendations

Cheetah

Although Namibia is believed to have the largest population of the endangered cheetah of any country in the world, it is thought to have declined to 2,000 to 3,000 animals from an estimated 6,000 in the early 1980s. Ninety percent of the national population exists on private lands, where many are killed as livestock and game predators.

For cheetah, the **Wild Management Goals and Strategies** working group noted the following problems (in order of descending priority):

1. Population decline.

2. Killing of significant numbers of cheetah (more than 6,000 in the past 20 years) by farmers on private lands.

3. The need for a coordinated national strategy for dealing with the disposition of problem cheetah.

For cheetah, the highest priority action identified by the Wild Management Goals and Strategies working group was to stop the population decline via strategies such as: improving and developing more accurate censusing and monitoring methods; monitoring population trends; and conducting public education and outreach.

Other suggested strategies to deal with (2) and (3) respectively were: minimizing conflicts on communal lands and commercial farmlands and development of a management program for problem cheetah trapped on private farms and communal areas. Details of the problems identified for both species, as well as specific suggested strategies and ways to implement these for cheetah, are outlined in the Management Goals and Strategies Working Group Report in Section 2.

The working group on **Human/Livestock Interaction Communication** identified general problem areas as: stock loss to the cheetah; farming practices and land use; communication; and education. The highest priority for action identified by this group was the reduction of stock losses by cheetah.

Cheetah kill small stock such as goats, sheep and cattle calves. Farmers may tolerate a small percentage loss to cheetah, however some losses are considered intolerable. In 1994, 74 cheetah were reported to be killed by farmers, with about half of these occurring in the Otjiwarongo district. Cheetah may be blamed for losses caused by other predators, such as lynx and jackals. On game farms, the calves of wild species such as sable, eland, and roan

also are killed by cheetah, as well as small game species such as springbok *(Antidorcas marsupialis),* impala *(Aepyceros melampus),* and blesbok *(Damaliscus dorcas).*

Promising priority strategies for resolving these problems included: protecting small stock with guard dogs, donkeys, or using herdsmen; synchronizing the livestock calving season with the game calving season so that losses can be reduced by "swamping" the predators in the hope that cheetah will hunt natural prey rather than domestic animals; controlling calves under 6 months of age in a protected camp; providing adequate prey base for cheetah to reduce the need to eat calves; removing bottom strands of cattle fence to allow free movement of small game; and controlling other predators, among others.

Estimates of habitat and population numbers were derived in both the **Life History/VORTEX Modeling** group through consensus of field biologists with data. Model output, as with any model, is limited by the input. The biological information for the cheetah population came from the studies of Laurenson et al. (1992), Caro (1994), Marker-Kraus et al. (1996), Nowell and Jackson (1996), and personnel working in the Ministry of Environment and Tourism (MET) who participated in this PHVA Workshop. The sensitivity of the population dynamics to interactions in variations of adult female mortality, proportions of males killed each year, the frequency and severity of catastrophes, and proportion of females with no litter each year were examined. The telemetry study provided initial crude estimates of male and female mortality rates with male rates about double those of the females. Mean litter size of off spring 1 to 6 months old was 3.7, and it is likely that the birth mean litter size is greater.

Results from modeling suggested that if the Namibian cheetah population continues to decline at the 4 to 7% annual rate experienced over the past 15 years, there is a 50 to 100% probability of extinction in the next 100 years. The population appears to have a robust growth potential of 10 to 15% per year if it is subjected to only natural mortality. Under these conditions the population could double in size in 5 to 7 years if left undisturbed.

As such, priority recommendations of the **Life History/VORTEX Modeling group** were:

1. Manage the cheetah population on the farmlands so that 10% or less of the adult females and 20% or less of males are removed annually. For a population size of approximately 2,500 animals this would be about 60 to 70 adult females per year. This would provide a margin of safety for uncertainties in estimates of density, uncertainties in knowledge of natural female mortality rates, in female reproductive rates, in directions and rates of migration, and in estimates of fluctuations in natural mortality.

2. Removal of males needs to continue to be given preference over the removal of females in the control of problem animals in the farmland population. Population viability and growth rates are not as sensitive to male mortality rates over a wide range. Total annual adult male mortality rates of 30-35% will have no effect on population growth

rates. It will be useful to further evaluate the genetic consequences of such a strategy.

3. Improve the estimates of annual female natural and especially removal mortality rates as a guide to possible population growth rate impacts and to provide management guidance on the number of removals that can be allowed and sustain a viable population. Reporting by the farmers of removals by sex will provide a useful estimate.

4. Improve estimates of the proportion of females not producing a litter (that survives to the age of 3-4 months) each year. This estimate and estimates of cub survival (observed litter size) to the age of about 1 year can serve as an indicator of environmental variation effects on reproduction. Correlation with environmental or habitat (prey density) data may provide a useful management index.

5. Evaluate the impact of continued excess loss of adult females during the dry phase years on stability of population size and on the management target for the population.

6. Estimate the confidence limits of the methods used to estimate population density, available habitat, and calculated population size as a basis for estimating the magnitude of change and the number of years of change required to detect different rates of population change (decline or increase). For example, what effort, frequency of measurement, and measurement reliability would be required to detect the 4-7% annual decline in population size estimated to have occurred since 1980? Estimates of these parameters can be done with modeling and statistical methods using currently available data and theory. These estimates would provide a basis for the amount of effort required to monitor the status of the population, to detect changes in the population, and to allow adjustments of management.

The **Disease** Working Group agreed that disease is a threat to future viability of cheetah populations in Namibia. Three general needs were identified: defining the diseases that are threats to both the wild and captive populations; setting standards for disease surveillance and preventive measures; and creating models of disease threats as catastrophes that could be modeled using VORTEX.

The highest priority identified by this group was defining the diseases that are real or potential threats to cheetah populations. Infectious diseases in cheetah included anthrax (especially in Etosha) and potential threats of feline coronavirus, CDV, FIV, and rabies. Other potential disease threats were identified and are listed in the Disease working group report.

Suggested needs toward implementing this strategy included: determining the prevalence of infectious diseases in Namibia; determining the pathogenicity of strains of infectious diseases in Namibia such as CDV and FIV; training Namibian veterinarians and laboratory personnel in

in Namibia such as CDV and FIV; training Namibian veterinarians and laboratory personnel in the procedures to diagnose diseases in and carry out clinical pathology for cheetah; training farmers and MET field personnel to collect biomaterials; defining the applied research projects to identify effective preventive measures; creating a captive management plan to minimize diseases; and identifying funding to meet the needs for surveillance, *in situ* training, and applied research.

Once these were identified, the working group then developed recommendations, which if approved by the MET, could be used to define disease threats:

1. Summarizing all available retrospective data and literature to define historic epidemics.

2. Informing veterinarians of proposed monitoring programs.

3. Conducting priority screening for diseases of potential concern with stored serum samples.

4. Initiating prospective disease monitoring through the collection, evaluation, and banking of biomaterials.

5. Evaluating habitat and environmental factors that concentrate pathogens.

6. Submitting a grant to NGOs and securing funding sources for a comprehensive, long-term disease-monitoring project for cheetah in Namibia.

7. After 3 years, collating all prospective and retrospective data to redefine the disease threats to Namibian cheetah, with results of this collation used to reassess the disease threats to Namibian cheetah populations and to define new priorities for surveillance and research.

Primary problems for cheetah identified by the **Genetics** working group were:

1. There exists a proven sensitivity of the cheetah's ancestors, and possibly the current population, to demographic reduction and genetic homogenization.

2. Physical/health problems have been observed in free-ranging cheetah, such as abnormal sperm characteristics which are developmental in origin, tooth/jaw anomalies, or kink in tail vertebrae. It is important to determine if whether these anomalies are indicative of inbreeding depression, infectious diseases, poison, or other factors and if their frequency is changing. Further, undesirable physiological traits may be reduced through outbreeding.

3. There is a lack of understanding of the management consequences of having small founder populations of cheetah on game farms/reserves.

4. The cheetah is a Namibian national treasure that also is a fascinating subject for genetic research. However, there is a lack of geneticists within Namibia with access to molecular biology technologies and funding sources to investigate these questions.

Suggested solutions to these problems (in order of priority) included:

1. Developing practical guidelines (by interested game farm managers and farmers aided by information obtained from the cheetah source) for selecting founders of known origin and for managing small populations based on demographic simulation models.

2. Assessing and recognizing components of relative fitness that may reflect historic or recent inbreeding; encouraging and sponsoring interested Namibian students/interns to train in laboratories of experienced wildlife geneticists outside of Namibia, allowing them to return and apply their training to the study of indigenous species.

3. Testing geographically isolated populations for the extent of phylogenetic distinctiveness.

4. Establishing controlled matings in captive settings using intercrosses between animals from geographically distinct populations, initially between *A. j. jubatus* and *A. j. raineyi* to evaluate the offspring for fitness; and identifying the cause of the historic bottleneck in order to anticipate and/or avoid a similar event in the future.

These problems and suggested solutions for cheetah are elaborated in the **Cheetah Genetics** working group report in Section 2.

The **Captive Populations** working group began with attempting to define the captive population of Namibian cheetah. For the purposes of this document, a captive population was considered to be comprised of non-free-ranging animals managed on an individual basis, and which were not self-sufficient. In this context, there were two types of captive-held animals: (a) those permanently held in captivity (i.e., pets and tourism); or (b) those held temporarily before translocation. There are 50 to 80 cheetah held in permanent captivity in Namibia, the majority as pets. The remainder are used for exportation and tourism, with most of these having originated as problem animals (i.e., preying on livestock).

Namibia currently has minimum legislation regulating facilities that hold cheetah. It was suggested that it might be appropriate to review current Namibian legislation and policy on maintaining animals in captivity, with an internal evaluation of legal standards concerning handling and housing of animals moving into and within captivity, possibly through a

coordinating body. The **Captive Populations** working group suggested that the Namibian Government should consider appointing a commission comprised of representative parties (MET, farmers, hunters, and others.) to examine existing regulations, in light of the recommendations of the PHVA, within the next 6 months and then to promulgate appropriate legislation.

The Namibian government should consider implementing a cheetah policy with the information in this PHVA document used as a starting point in the development and elaboration of a captive cheetah management plan to be developed over the next 12 months.

The **Captive Populations** working group also suggested that the Namibian government should consider the establishment of a central representative coordinating body, whose function would be to set standards for the captive management of cheetah (and lion) within Namibia. This possibly could be implemented within the next 12 months. In the interim, the government might consider a program to assess the general health and disease status of the existing captive cheetah.

Lion

The **Wild Management Goals and Strategies** working group identified general problem areas concerning lion as: accelerating decline of population and range; the loss of a significant number of lion (~ 1,000 over the past 20 years), particularly subadults, as a consequence of being killed by farmers; and an increasing incidence of FIV recorded in populations in Africa which would place the Namibian population under threat if FIV spreads. The working group identified as the highest priority problem the accelerated decline and range available to lion, with a possible concomitant decline in the population from 700 animals in the 1980s (note: these estimates may reflect different censusing techniques used in the past) to approximately 300 presently. The potential action strategies identified by the working group to address this problem (in descending order of priority) were:

1. Maintaining the lion's present habitat and prey base, particularly in Etosha and Kaudom, by communicating to MET and the government the importance of Etosha and Kaudom for the continuing viability of lion populations in Namibia and by carrying out maintenance as specified in Park Management Plans.

2. Implementing needed population research and monitoring programs in both Etosha through research, seeking of resources and funding, and monitoring, and through training of the Kaudom MET ranger staff in specific monitoring techniques.

Other goals included minimizing conflict on boundaries of the lion's existing protected range and maintaining an FIV-negative population, at least in Etosha. Specific strategies and

suggested action steps to reach the outlined goals for lion are delineated in the **Wild Management Goals and Strategies** working group report (Section 3).

The working group on **Human/Livestock Interaction and Communication** identified general problem areas as: stock loss from lion; farming practices and land use; communication; and education. The highest priority for action identified was the reduction of stock losses. Cattle losses on the southern border of Etosha may be in the range of 10 to 12 cattle per farmer per year per 500 head of cattle. In eastern Etosha, cattle losses may in the range of 50 to 60 cattle per farmer per year per 500 head. The reported number of lion killed by farmers in Etosha is approximately 20 per year, but could be as many as 40. Losses of livestock to lion also occur in Bushmanland, Caprivi, Kavango, and Damaraland.

Promising priority action steps identified by this working group to address stock loss from lion included:

1. Upgrading and predator-proofing of fences.

2. Increasing the incentive to tolerate lion by promoting their positive value through trophy hunting and ecotourism.

3. Establishing a central coordinating office to facilitate communication between farmers with problem animals and hunting operators or game farmers who may want the animal.

4. The capture of problem lion for relocation outside the country.

The **Life History/VORTEX modeling** working group developed simulation scenarios for the Etosha lion population using parameter values from the 6 year study (1980 to 1986) of this population by H. Berry, historical census and litter size data on the population, and information about lion killed on lands adjoining the Etosha National Park. The sensitivity of the population dynamics to interactions in variations in cub mortality, adult female mortality, carrying capacity, litter size, and inter-birth interval were examined. The impacts of several catastrophes, including an epidemic of CDV which then became endemic to the population, were modeled.

A base scenario for the population, constructed from the field data, indicates that (under the parameter values prevailing during a dry-phase) the lion population has a negative growth rate. Thus long-term survival of the population depends upon improved reproduction during the wet-phase years. The demographic impact of the numbers of lion killed during the years 1980 to 1985 is nearly sufficient to account for the observed 50% decline in the total population. If habitat conditions continue and if adult females continue to be subjected to excess mortality by hunting, the population (a) may continue to decline and (b) will be vulnerable to the effects of

unexpected mortality events like epidemics. An increase in mortality caused by the catastrophic introduction of CDV into the population could reduce the mean population growth rate (r) by 0.034, substantially increase the risk of extinction of the population.

Recommendations for action developed from the modeling included:

1. Estimate the confidence limits of the census methods as a basis for estimating the number of years required to detect different rates of population change (decline or increase) and as a basis for monitoring the population and adjusting management.

2. Analyze available data on litter size and cub survival on an annual basis to match with rainfall and provide an estimate of environmental variation to use in the models. These measures also may provide an index of changes in prey availability and nutritional status of the population. Consider using these two parameters as a basis for monitoring the status of the population and as useful indices of the effects of management interventions.

3. Evaluate the impact of continued excess loss of adult females during the dry phase years on stability of the population size and on the management target for the population. Develop estimates of the excess losses that can be sustained by the population during the dry-phase years.

4. Evaluate possible inbreeding depression effects and the impact of the excess loss of subadult males and breeding structure on the rate of inbreeding. Modeling different mortality and breeding scenarios can start this.

The **Disease** Working Group agreed that disease is a threat to the potential viability of lion populations in Namibia. As for cheetah, three general needs were identified: defining the diseases that are threats to both the wild and captive populations; setting standards for disease surveillance and preventive measures; creating models of disease threats as catastrophes that could be modeled for the Namibian lion populations using VORTEX.

The highest priority identified by this group was defining the diseases that are real or potential threats. For lion these included FIV, CDV, and rabies. Other potential disease threats also were identified and listed in the working group report.

Suggested needs toward implementing this strategy included: determining the prevalence of infectious diseases in Namibia; determining the pathogenicity of strains of infectious diseases in Namibia such as FIV and CDV; training Namibian veterinarians and laboratory personnel in the procedures to diagnose diseases in lion; training farmers and field personnel to collect biomaterials; defining the applied research projects to identify effective preventive measures; creating a captive management plan to minimize diseases; and identifying funding to meet the

needs for surveillance, *in situ* training, and applied research.

Once these were identified, the working group then developed action steps, which if approved by the MET, could be used to define disease threats:

1. Summarizing all available retrospective data and literature to define historic epidemics.

2. Informing veterinarians of proposed monitoring program.

3. Conducting priority screening for diseases of potential concern with stored serum samples.

4. Initiating prospective disease monitoring through the collection, evaluation, and banking of biomaterials.

5. Evaluating habitat and environmental factors that concentrate pathogens.

6. Submitting a grant to NGOs and securing funding sources for a comprehensive, long-term disease-monitoring project for lion in Namibia.

7. After 3 years, collating all prospective and retrospective data to redefine the disease threats to Namibian lion, with results of this collation used to reassess the disease threats to Namibian lion populations and to define new priorities for surveillance and research.

The **Genetics** working group defined several basic problems for Namibian lion, listed below in order of descending priority:

1. There is a question as to the genetic and demographic prognosis for the free-ranging populations of lion in Namibia.

2. Unusual behavior and pride structure have been observed among the Etosha lion. Additionally, there is an imbalance in age/sex ratio in the reported destruction of lion on farms bordering Etosha National Park (50% are subadult males). A lack of parentage and kinship data makes it difficult to interpret these observations and to assess the impact of the loss of large numbers of subadult males.

3. Etosha lion may be a recognizable subspecies that would be unsuitable as a source of genetic material to supplement depleted South African populations. The animals are unique in their FIV-free status and have the potential to be an invaluable resource for injecting new genetic material into compromised lion populations outside Namibia.

4. There is a lack of understanding of the management consequences of having small founder populations of lion on game farms/reserves.

Suggested solutions/strategies to address the above included the use of molecular genetic indices, particularly DNA analysis with mini- and micro-satellite probes with appropriate analyses, and consideration of facilitated genetic exchange. Details of these analyses are found in the lion **Genetics** working group report (Section 3).

The **Captive Populations** working group began with attempting to define the captive population of Namibian lion (as described above for cheetah). There are approximately six facilities holding lion in Namibia (totaling 50 to 80 lion), primarily for tourism.

1. Namibia currently has minimum legislation regulating facilities that hold lion. It was suggested that it would be appropriate to review current Namibian legislation and policy on maintaining animals in captivity, with an internal evaluation of legal standards concerning handling and housing of animals moving into and within captivity, possibly through a coordinating body. The **Captive Populations** working group suggested that the Namibian government consider appointing a commission comprised of representative parties (MET, farmers, hunters, veterinarians, NGOs, and others.) to examine existing regulations for keeping captive animals, in light of the recommendations of the PHVA, within the next 6 months, and then to promulgate appropriate legislation.

2. The Namibian government should consider re-examining current lion policy in light of the synthesized information resulting from the PHVA workshop.

The Namibian government should consider the establishing a central representative coordinating body, whose function will be to set standards for the captive management of lion within Namibia. This could be implemented within the next 12 months. In the interim, the government should consider a program to assess the general health and disease status of the existing captive lion populations.

Development of **Genome Resource Banking (GRB)** for both cheetah and lion was identified as a priority strategy by the **Wild Management Goals and Strategies, Disease,** and **Captive Populations** Working Groups. The three working groups agreed that there are several practical and applicable uses of a GRB to facilitate cheetah and lion conservation. A GRB, is the organized collection, storage and use of biomaterials, especially sperm, embryos, tissues, blood products, and DNA. The cryopreservation of such materials is an emerging "tool" that has enormous implications for the assessment, conservation, and sustainable use of natural resources. A GRB is not established for the purpose of replacing living animals in nature or in zoos, but should have as its mission the support of existing efforts to preserve a species with all its currently available genetic diversity (see lion section below). An organized GRB could

serve to provide a repository of frozen gametes, embryos, tissues, blood products, and DNA. The value of a GRB for a wild population could be enormous by helping to provide 'insurance' against catastrophes, especially emerging diseases, natural disasters and social/political upheaval. The cheetah and lion populations may suddenly become infected with sinister viruses, similar to the recent canine distemper epidemic that decimated the East African lion population. The availability of frozen serum and tissue that have been collected over time could be used to retrospectively identify the onset and cause of diseases that affect cheetah and lion. Pathogen-free gametes and even embryos could be made available to re-derive disease-free populations.

Specific recommendations concerning the needs for cheetah and lion GRBs are included as Appendix V. General considerations in establishing GRBs were:

1. A GRB Action Plan should be developed in accordance with guidelines established by the IUCN - The World Conservation Union's Conservation Breeding Specialist Group. Such documents detail the need for establishing a GRB and the important issues related to collection, storage, ownership, accessibility and use of biomaterials. Because a GRB Action Plan is being developed in North America under the umbrella of the Cheetah Species Survival Plan (SSP), it is recommended that collaboration between both regions be considered in the development of the proposed Cheetah GRB Action Plan. It is recommended that this proposed formal cooperative plan be initiated within 1 year with the initial primary partners being the Namibian M E T, the Cheetah Conservation Fund, the North American Cheetah and Lion Species Survival Plans (SSPs), and other relevant conservation organizations as determined by the Ministry of Environment and Tourism.

2. The biomaterials collected from cheetah and lion living on private or public lands should be the property of the government (country) of Namibia. It is recommended that the MET-Directorate of Resource Management make the final decision about the disposition of biomaterials. This will be controlled, in part, through the export permit process. Details of this process could be considered and set forth in the action planning document to be developed.

3. It is recommended that the scientific collection and storage of all biomaterials for cheetah initially might be coordinated by the Cheetah Conservation Fund in collaboration with Namibian State Veterinarians within the Ministry of Agriculture. Biomaterials from lion might be coordinated by the Namibian MET and the Namibian State Veterinarians within the Ministry of Agriculture. Establishing and securing a Cheetah GRB and a Lion GRB, including a site for secondary storage (as a second insurance site) might accomplish this. The coordinators might distribute the material by acting as a liaison between the MET, local veterinarians, interested scientists, zoos and other relevant organizations worldwide.

4. It is recommended that no monetary value be placed on any biomaterials to discourage the commercialization, or worse, the capture and exploitation of cheetah and lion. The cost of establishing and operating the proposed GRB might readily be supported by institutions throughout the world interested in conserving cheetah and lion. For example, workshop participants from North American zoos are confident in their ability to secure some funding to support the proposed Namibian GRB program. Additionally, it is recommended that the Ministry of Environment and Tourism consider accepting 'in-kind' support for such a program in the form of donated equipment.

5. Further research can enhance the efficiency of assisted reproduction in lion using cryopreserved sperm (e.g., hormonal stimulation of estrus and ovulation, time of ovulation and time of insemination using frozen-thawed spermatozoa).

6. As the proposed GRB Action Plan is prepared, it is recommended that the distribution and accessibility to biomaterials in the GRB might be made more readily available to organizations that are contributing to conservation programs in Namibia, either through direct monetary support of high priority programs such as those of the Cheetah Conservation Fund or through providing in-kind support and training.

7. The MET-Directorate of Resource Management, the Cheetah Conservation Fund and other relevant national organizations (as determined by the MET) should receive full acknowledgment by any individual or organization that uses biomaterials from the proposed GRB. Furthermore, any offspring produced from the use of cryopreserved gametes or embryos should remain the sole property of Namibia, in part for the purpose of documenting and advertising the contributions of Namibia to conserving one of its most precious natural resources.

On the last day of the workshop, the comprehensive set of problems, priorities, suggested strategies/solutions, and action steps for the conservation and management of Namibian cheetah and lion were reviewed, intensively discussed, and consensus reached on all. These form the basis of the working group reports that comprise Sections 2 and 3 of this document.