# GLOBAL CHEETAH MONITORING WORKSHOP

## 1 – 4 June 2004

## Ndutu Safari Lodge, Ngorongoro Conservation Area, Serengeti, Tanzania

## WORKSHOP REPORT

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**Hosted by:**

**TANZANIA WILDLIFE RESEARCH INSTITUTE (TAWIRI)**
**THE SERENGETI CHEETAH PROJECT**
**ENDANGERED WILDLIFE TRUST**
**CONSERVATION BREEDING SPECIALIST GROUP SOUTHERN AFRICA**
**THE ZOOLOGICAL SOCIETY OF LONDON**

**Sponsored by:**

**American Zoo Association Conservation Endowment Fund**
**Saint Louis Zoo**
**AZA's Cheetah Species Survival Plan**
**Regional Air Services**
**The Zoological Society of London**
**Ngorongoro Conservation Area Authority**
**Darwin Initiative**
**Ndutu Safari Lodge**

**In collaboration with**

**THE CONSERVATION BREEDING SPECIALIST GROUP SOUTHERN AFRICA (CBSG – SSC / IUCN)**

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Photographs on the front cover of this report were supplied by Mandy Momberg (Pilanesberg National Park) and the De Wildt Wild Cheetah Project.

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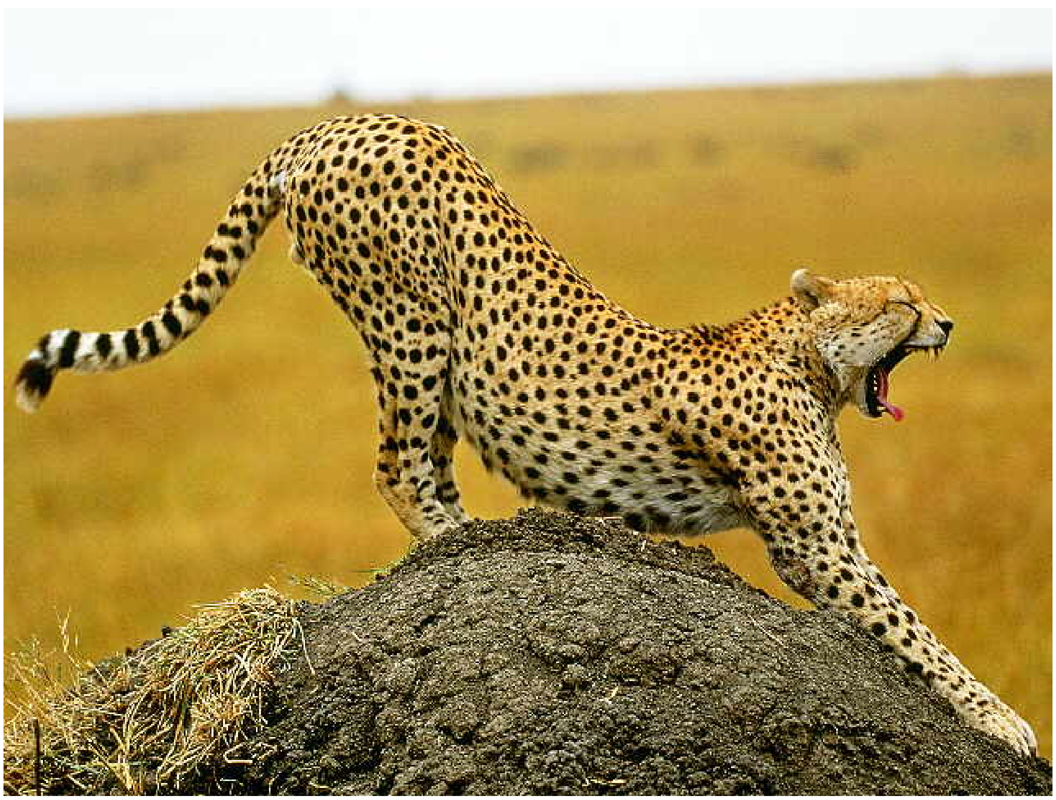
### Ndutu Safari Lodge, Ngorongoro Conservation Area

## WORKSHOP REPORT



### SECTION 1 AND 2

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# SECTION 1

# EXECUTIVE SUMMARY

## Background

Over the past 50 years, cheetah have become extinct in at least 13 countries and it is believed that 12 – 15 000 cheetah remain in the wild. The cheetah (*Acinonyx jubatus*) is listed as Vulnerable on the IUCN Global Red List and Appendix I in the Convention on International Trade in Endangered Species of Fauna and Flora (CITES). To address the need for cohesive global action to conserve cheetah, two Global Cheetah Conservation Action Planning workshops were held in South Africa in 2000 and 2001, resulting in the development of a global master plan for conserving cheetah. Cheetah conservationists from 14 countries contributed to the development of the *Global Cheetah Action Plan* at both workshops and the ensuing Plan covers subjects such as education and awareness, research, captive breeding, trade and a variety of other threats. Most importantly however, the Action Plan stresses the need for accurate census and monitoring data as cheetah conservation efforts are being hindered by a lack of reliable data on numbers, distribution and population trends. Without such data, we cannot identify and address threats to the long-term survival of cheetah and it is difficult to influence national policy in favour of cheetah conservation, identify conservation priorities for cheetah or assess the effectiveness of management action.

However, no accurate census of wild cheetah has ever been done and therefore, there exists an increasingly urgent need for good quantitative information on cheetah distribution and numbers across Africa. Unfortunately cheetah are difficult to census using conventional techniques, as they generally occur at low density and are largely non-territorial, very mobile, cryptic (i.e. difficult to spot) and often shy. They sometimes form local transitory hotspots, which are non-representative of overall density giving a false impression of many cheetah in an area. Current global cheetah population estimates are therefore nearly entirely based on often unreliable questionnaire data. During the Global Cheetah Action Plans workshops, an international Cheetah Census Technique Development workshop was proposed by a dedicated Cheetah Census Working group as a critical step towards developing a set of reliable, cost effective, repeatable census methodologies for use across a broad range of habitats and in areas where cheetah are rarely seen.

### Global Cheetah Monitoring Workshop

In June 2004, an international Cheetah Monitoring Workshop was therefore held at Ndutu Safari Lodge in the Ngorongoro Conservation Area in Tanzania, to address these issues. The workshop was organized by the Endangered Wildlife Trust, CBSG Southern Africa, the Serengeti Cheetah Project of the Zoological Society of London and the Tanzania Carnivore Project of the Tanzania Wildlife Research Institute (TAWIRI).

The workshop was sponsored by the American Zoo Association's (AZA) Conservation Endowment Fund, the Saint Louis Zoo, and the AZA's Cheetah Species Survival Plan. Additional support was given by the Wildlife Conservation Society, Regional Air Services, Ndutu Safari Lodge, the Ngorongoro Conservation Area Authority (NCAA) and the Darwin Initiative. A total of 34 people attended the workshop from 7 countries which included a variety of large carnivore monitoring experts and cheetah conservationists and biologists, to devise a set of standard methodologies that can be used to initiate a global census of cheetah numbers.

The objectives of the workshop were to:

- convene experts in large carnivore census techniques to evaluate the viability of the various census techniques currently available and to determine the most appropriate for cheetah across a wide variety of habitats;
- co-ordinate cheetah monitoring within and between range states;
- develop strategies to strengthen co-operation between role-players and range states;

- identify the most appropriate census techniques for use in the different range states based on the assessment of a number of factors (i.e. national capacity, cost), along with best practice guidelines for using these techniques
- co-ordinate calibration of techniques within areas and between range states
- identify priority areas within countries not represented at the workshop and elsewhere.

**Workshop Design**

The workshop ran over three days and the morning of the first day was dedicated to presentations covering various census techniques currently being used in the field and the results to-date (see section 3 - Presentations).

Over the second day and a half, participants worked in technique-based groups to develop a standardised methodology for using the six selected techniques. The evaluation of each technique included an assessment of the technique's appropriateness, cost, accuracy, precision, suitability and the necessary capacity for implementation. The ability to calibrate data across the different techniques was also assessed.

The technique-based groups covered:

- Direct counts: Visual observations / tagging
- Carnivore atlas / questionnaires / GIS data
- Spoor counting
- Working Dogs for Conservation
- Camera traps (Photographic capture-recapture)
- Photographic surveys

Participants chose the technique-based group in which they wished to work, according to the contribution they could make and/or their interest in learning about the technique. The technique was first fully described and the circumstances, under which it would be best suited or would never be used, were listed. A score (1-5) was then assigned to each technique under the criteria listed above with 1 being the least appropriate and 5 the most appropriate.

Between the intensive working group sessions, open plenary sessions were held in which working groups presented their discussions and conclusions to the entire group, discussed them openly and made adaptations where necessary in order to ensure that the conclusions and scores were as inclusive and representative as possible, drawing on the experiences of every participant. Finally, a technique prioritisation table was developed to assess, in plenary, which technique is most applicable under different scenarios and if this should be the technique of choice.

The last afternoon was used for regional priority setting and performing a gap analysis of the countries represented at the workshop as well as those not represented. Working groups were identified according to specific countries and /or regions and regional groups were tasked with describing the conditions in their particular region and, using the information presented the day before, recommending the most suitable census technique for use in that area, according to the scores given under the relevant criteria for each region.

This last session therefore aimed to bring the three days' of work together by developing a global plan for cheetah monitoring through identifying priority areas, applying appropriate, recommended census methodologies for each region and developing a "best practice" method of applying them under various conditions throughout the range of wild cheetah.

An additional outcome was the proposal to develop a detailed Cheetah Census Technique Manual to ensure standardisation and offer "best practice" guidelines for censusing and monitoring cheetah under different environmental conditions and with varying levels of national capacity.

This manual will provide the following:

- A summary of each technique and rules for application in the field;
- A description of the statistical data analyses appropriate for each technique;

- Identify additional data to be collected for each survey area that can be used in predictive GIS mapping. This will enable refinement of existing predictive mapping techniques through the inclusion of additional variables relevant to cheetah distribution and abundance; and
- A list of priority areas for survey, areas for survey calibration and describe the overall survey framework.

This workshop was facilitated by CBSG Southern Africa, a regional network of the Conservation Breeding Specialist Group (IUCN / SSC - World Conservation Union's Species Survival Commission).

*Participants at the Global Cheetah Monitoring Workshop 2004*

# SECTION 2

# THE CBSG WORKSHOP PROCESS

The CBSG has made its mark on the conservation of threatened flora and fauna worldwide. CBSG is one of the more than 120 Species Survival Commission (SSP) Specialist Groups of the IUCN - World Conservation Union - with over 20 years' experience in developing, testing and applying scientifically-based tools and processes for risk assessment and species conservation decision-making. These tools based on small population and conservation biology, human demography, and social learning dynamics are used in intensive, problem-solving workshops to produce realistic and achievable recommendations for both *in situ* and *ex situ* population management. CBSG tools include Conservation Assessment and Management Plans (CAMPs), Population and Habitat Viability Assessments (PHVAs), Conservation Master planning, Species Action Planning, population modelling exercises and a range of training and skills development workshops.

CBSG workshops bring together the full range of individuals and groups with a strong interest in conserving and managing species in their habitats or the consequences of such management. One goal in all workshops is to reach a common understanding of the state of scientific knowledge available and its possible application to the decision-making process and management actions. The decision-making driven workshop process with intensive deliberation among stakeholders is a powerful tool for extracting, assembling, and exploring information. This process encourages developing a shared understanding across wide boundaries of training and expertise. These tools also support building of working agreements and instil local ownership of the problems, the decisions required and their management during the workshop process. As participants appreciate the complexity of the problems as a group, they take ownership of the process as well as the ultimate recommendations made to achieve workable solutions. This is essential if the management recommendations generated by the workshops are to succeed.

CBSG workshops focus on small group dynamics, which step through a series of tasks allowing for explicit problem restatement, divergent thinking sessions, identification of the history and chronology of the problem and expert judgements, paired and weighted ranking for making comparisons between different techniques in this workshop.

From the onset of the Global Cheetah Monitoring Workshop it was clear that a slightly different approach was needed. The workshop had a specialised focus which was to determine the best census technique to use under different environmental circumstances; evaluations of existing monitoring programmes being used in different regions had to be undertaken and priorities had to be set for new areas with actions defining the way forward. This workshop focused on understanding various techniques available for determining cheetah distribution and population sizes, and the most or least appropriate environment in which they should be applied, taking into account factors affecting the accuracy of the technique and where possible, developing effective responses.

**Workshop Processes and Multiple Stakeholders**

CBSG workshop processes provide an objective environment, expert knowledge and a neutral facilitation process that supports sharing available information across institutions and stakeholder groups, reaching agreement on the issues and available information, and then making useful and practical management recommendations for the taxon and habitat system under consideration. The process has been successful in unearthing and integrating previously unpublished information for the decision-making process. CBSG's interactive and participatory workshop approach produces positive effects on management decision-making and in generating political and social support for conservation actions by local people. CBSG participants recognise that the present science is imperfect and that management policies and actions need to be designed as part of a biological and social learning process. The CBSG workshop process essentially provides a means for designing management decisions and programmes on the basis of sound science while allowing new information and unexpected events to be used for learning and to adjust management practices.

# GLOBAL CHEETAH MONITORING WORKSHOP 2004

## 1 – 4 June 2004

**Ndutu Safari Lodge, Ngorongoro Conservation Area**

## WORKSHOP REPORT

## SECTION 3

## PRESENTATIONS

## 1. Dr. SARAH DURANT – TANZANIA WILDLIFE RESEARCH INSTITUTE (TAWIRI), TANZANIA

### Part I: Introduction to survey methodologies

### Background

This workshop was initially envisaged as a key goal of the Cheetah Census Working Group. The Cheetah Census Working Group was established in 2001 at the first Cheetah Action Plan Workshop with the ultimate long term aim to develop a reliable, cost effective, long-term and repeatable census methodology that can be used across a broad range of habitats and in areas where cheetah are rarely seen. This workshop is a critical step on the path towards this aim. Until we have a reliable survey protocol, it is impossible to estimate numbers, assess the impact of conservation management and hence to influence policy.

### Selecting index

Developing a methodology for surveying cheetah includes a number of steps. First, an index of abundance needs to be selected. Such an index can range from visual counts of individually identified animals, through to counts of signs such as spoor or faeces. To be suitable, the index should reliably reflect changes in abundance of the population of interest. Whilst we often assume that an index has a straightforward correlation with abundance, this assumption is often not valid. When choosing an index it is therefore always important to seek information on whether there is a clear positive relationship between the index and abundance. Aside from a complete lack of a relationship between the index and abundance, another two common problems with the relationship between an index and abundance relate to threshold effects. At high densities, a population can reach a certain threshold where there is a levelling off in the detectability of index, beyond this threshold the index ceases to increase with population size. Secondly, and of greater relevance for cheetah, when populations fall below a certain threshold, detecting change in very low numbers can be extremely problematical. Overall, the best index is the one that is the most sensitive to population change and whose sensitivity does not vary with population density. The optimum sensitivity possible is an index with a 1:1 correlation with population change over all densities.

The variability of the index-abundance relationship is also important, as the higher the variability the more difficult it is to statistically detect underlying change. A suitable index should have a reasonable statistical probability for detecting trends, and so its variability should be as low as possible. There is generally an implicit assumption that the relationship between an index and abundance remains constant over time and between areas. However what limited information is available suggests that population indices and abundance have high variability between areas and over time and are rarely related via a simple positive linear relationship. For any technique - calibration in areas of known population density is extremely important.

### Survey design

Once an index is selected, the survey needs to be planned to best ensure that an agreed level of population change is statistically detectable. There are two key issues in finalising this process, firstly managers need to decide what percentage population change they would like to be able to detect, e.g. do they want to be able to detect a 10% or 20% change in populations size, or would they be content to be able to detect a 50% or even only an 80% change in population size. Secondly managers need to decide on the degree of certainty or statistical probability they would like for detecting change should it happen, e.g. do they want to be certain of detecting change 90-95% of the time, or are they happy to be able to detect change only 50% of the time. Generally the survey effort becomes greater as the detection probability increases and the detectable % change in population size decreases. Example scenarios include planning a survey for a 95% detection probability of a 20% change in population size, an 80% detection probability of a 10% change in population size, or a 90% detection probability of a 50% change in population size.

All indices vary through fluctuations in both population size and measuring error and the higher the variability, the more difficult it is to detect change. The coefficient of variation (CV) (a standard measure used to compare the variability of samples between populations) gives an indication of the type of variability that will be encountered during surveys, and allows us to establish a survey design that will permit detection of change with the required sensitivity. Information from the Serengeti Cheetah Population, using an index of the total known individual cheetah in the study area, gives a CV of 0.20 over 26 years. This is a relatively low CV and puts cheetah on a par with large mammals (Gibbs 2000). It is likely that an alternative index, based on spoor counts, or camera trap estimates, would have a higher CV, and hence a survey using one of these indices would find it more difficult to detect population change.

For a given variability in an index, and a given sensitivity of an index to population change, the main tool a manager has available to decrease the detectable percentage change and increase the certainty of detecting change is to repeat surveys and/or conduct them at more frequent intervals (Fig. 1). The higher the CV, the more frequently surveys need to be conducted for any given level of detectability and certainty. Survey design is therefore inevitably a compromise between the level of change managers are prepared to detect, the certainty with which they want to detect it and the effort and resources they have available for the survey.

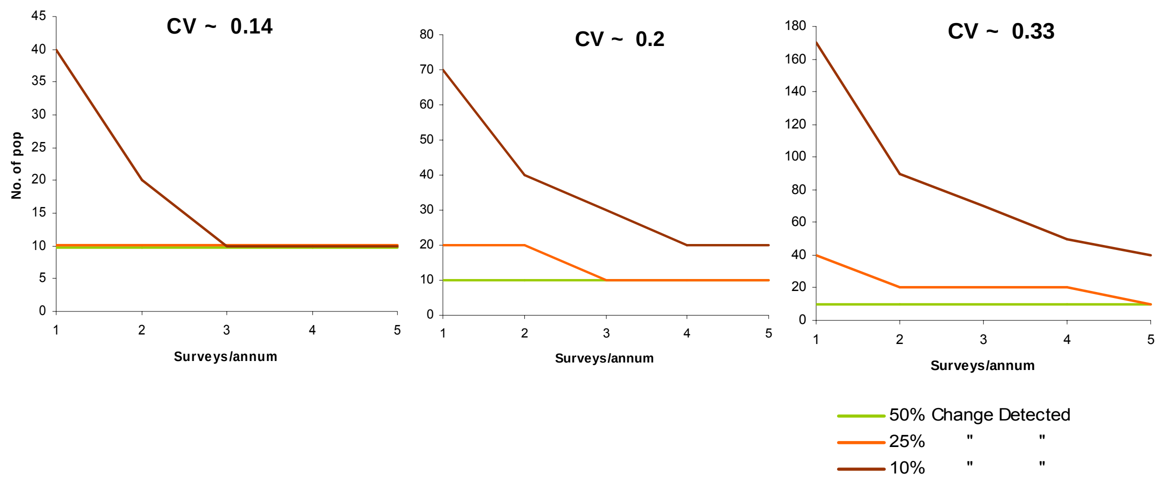



**Figure 1:** Assumption: 95% probability of detection of population change

N.B. survey intensity will decrease as the probability of detection drops

**Range of indices available for cheetah surveys**

**1. Presence/absence data**
E.g. carnivore atlas/questionnaire
**Advantages**
Relatively easy to collect
Good for a rapid assessment of an area prior to a full survey
**Disadvantages**
Insensitive to population change
Vulnerable to threshold effect - an area may register presence even if a population is in rapid decline

**2. Demographic/Tagging Surveys**
Where all cheetah within an area are photographed and individually recognised
**Advantages**
Relatively accurate
Sensitive to population change
Can provide other useful information such as demographics
Handling animals for tagging provides an opportunity for obtaining other useful information such as monitoring health and genetics of the population

**Disadvantages**
Costly in time and money
Time consuming to implement
Relies on accurate identification of individuals

**3. Tourist photograph surveys**
**Advantages**
Relatively easy to implement, provided an infrastructure exists
Potentially sensitive to population change
**Disadvantages**
Can be time consuming in areas where no infrastructure is in place
Photographs submitted restricted to cheetah that are relatively habituated and which frequent most visited areas
Vulnerable to disruption in tourist habits
Relies on accurate and rapid identification of individuals

**4. Transect surveys**
E.g. Distance based methodologies on driven/walked transects or point transects
**Advantages**
Relatively easy to implement
Relatively cheap
Can provide other useful data such as densities of other carnivores in the area
**Disadvantages**
Will not work in areas where cheetah are shy
May not be practical in bushy areas where cheetah are difficult to see

**5. Camera traps**
**Advantages**
Potentially accurate when using individual recognition
Can provide information about other species in an area
**Disadvantages**
Works best in forested areas where animals are forced to use particular tracks and paths. To date they have not been shown to provide good estimates of abundance for cheetah.
Set up of equipment is costly, and can only be used in relatively secure areas such as Protected Areas (PA), otherwise likely to be stolen.

**6. Spoor counts**
**Advantages**
Relatively easy to implement
Relatively cheap
Can provide other useful data such as densities of other carnivores in the area
**Disadvantages**
Will only work in areas where spoor can be detected
Relies on accurate identification of spoor
Needs a network of roads

**7. Working Dogs for Conservation**
Use of dogs to find scat either for DNA analysis or as a measure of indirect sign
**Advantages**
Potentially very accurate (when using DNA analysis)
Relatively cheap to implement survey
Can provide other useful information through scat analysis such as % of livestock in diet
**Disadvantages**
Depends on trained dogs for scat location
May be problematical for permits, particularly in protected areas
DNA analyses expensive
Dogs may be eaten in areas with lots of leopards
To date untested in Africa

**8. GIS**
Use of spatial data for predictive mapping of distribution
**Advantages**
Cheap
Relatively easy
**Disadvantages**
Insensitive
Carnivore distributions show a weak relationship with existing predictive maps, as the taxon is relatively non-habitat specific
**Proviso:**
A planned standardised survey could provide information required to deal with some of the disadvantages of GIS, by collecting standardised data across habitats and regions that could increase the accuracy of predictive models.

## Part II: Trials in the Serengeti

Over recent months the Serengeti Cheetah Project has made the testing of cheetah census techniques the focus of its research programme. The Serengeti Cheetah Project is uniquely situated as a testing site for these techniques as it has reliable estimates of total population size for calibration. In this section we present some preliminary results on the techniques tested to date, including an assessment of the relative cost broken down into capital equipment, manpower and consumables.

### 1. Total counts

The Serengeti population has been monitored since 1974 using total counts, a technique that requires 240 sightings of groups of cheetah per year over an area of 2200km$^2$.

- **Equipment:** 4WD vehicle, Binoculars, Camera, GPS
- **Manpower:** 1 trained field person working for most of the year
- **Running costs:** Fuel, vehicle repairs, house rent, photographic, etc. ~ $20,000-25,000 per year
- **Accuracy:** Good
- **Sensitivity:** Good
- **Suitability:** Unlikely to be suitable for areas with dense cover
- **Training needs:** Minimum of one month

### 2. Tourist surveys

The project was initiated late 2000, with a high response in the first two years (2001 and 2002). There has been a marked decline in response since 2002. In 2001 and 2002, a masters student John Shemkunde, from Tanzania National Parks, actively promoted the scheme in the park. There is therefore a need to find alternative ways of promoting any tourist campaign if it is to work in the long term: e.g. web site, more active and rapid feedback and general PR. However, despite large differences in numbers of photos received in 2001 and 2002, the photos covered a relatively constant proportion of population in 2001 and 2002. Plotting the proportion of the population monitored against the number of groups photographed each year showed that the method could be used to monitor cheetah, provided photos received could be matched from at least 100 cheetah groups each year.

- **Equipment:** Computer, matching software
- **Manpower:** 1 trained person working for most of the year
- **Running costs:** Leaflets: printing and distribution c. $1000-2000 per year
- **Accuracy:** Probably Medium - however currently no estimates of C.L.
- **Sensitivity:** Probably Medium
- **Suitability:** only for areas visited frequently (probably PAs), not for areas with little or no tourism, or where cheetah are shy
- **Training needs:** Skilled work - needs minimum of one month training

### 3. Transects
A transect survey was initiated in 2002 and 2003 to monitor the more common carnivores on the Serengeti plains. However this survey showed that it would be possible to also use this method to

monitor cheetah at roughly twice the survey effort, resulting in 4 surveys per year taking a total of 120 man days. A similar survey in less open habitat would require a much greater investment. As a rule of thumb, cheetah are seen approximately 1/7th of the frequency in the more wooded habitats in the northern Serengeti as on the plains, despite a probably similar density. Therefore any survey in the woodlands is likely to be 7 times more expensive than one on the plains in terms of cost and manpower. Costs below are outlined in terms of surveys in open habitats.

**Equipment:** minimal, if participants can loan vehicles for duration of survey
**Manpower:** 120 man days
**Cost:** $8,900
**Accuracy:** Probably medium - standard means of estimating C.L.
**Sensitivity:** Probably Medium
**Suitability:** Open areas, and where cheetah are not shy
**Training needs:** One day of training for driver and observer teams on each survey

**4. Spoor surveys**

Two spoor surveys were carried out in the Serengeti, the first together with Paul Funston. One was conducted in the wet season the other in the dry season. Overall a total of 750 km was covered by single driver/observer team over 16 days in which a total of 15 records of cheetah spoor were seen. The number of spoor recommended for accurate estimation of density is 30, hence the total kilometres required for a full survey is 1,500km. Although this survey was conducted in open habitat as this was where cheetah population size is known, the survey would not take any more time in more bushy areas.

**Equipment:** Minimal, but depends on loan of vehicle for duration of survey
**Manpower:** 32 days x 2 people = 64 man days
**Running costs:** $3,000
**Accuracy:** Probably medium - standard means of estimating C.L.
**Sensitivity:** Probably medium
**Suitability:** can be used anywhere with suitable substrate
**Training needs:** Probably around one week, provided a good tracker is available.

**Serengeti trials: Summary**

| | Field project | Tourist survey | Distance based transects | Spoor counting |
|---|---|---|---|---|
| Cost $ | 20,000-25,000 | 500 | 8,900 | 3,000 |
| Capital equip $ | 15,000-30,000 | 12,000 | none | 15,000-30,000 |
| Manpower | 12 months x 1 = 12 months | 6 months x 1 = 6 months | 6 days x 20 = 4 months | 1 months x 2 = 2 months |
| Accuracy | Good | Medium | Medium | Has potential |
| Sensitivity | Good | Medium | Medium | NA |
| Overall suitability | Limited | Limited | Limited | Good |
| Minimum Training needs | 1 month | 1 month | 1 day | 1 week |

**A word about genetics**

As part of an assessment of the genetic viability of the Serengeti Cheetah Population, the Serengeti Cheetah Project has been collecting faecal samples from known cheetah, focussing on adult males (for paternity) and mothers and cubs. This study also has relevance for assessments of population size that are based on scat analysis for DNA, such as surveys using sniffer dogs. As of March 2004, faecal samples from 90 different cheetah have been analysed for 13 loci by Dada Gottelli at Zoological Society of London. The average number of alleles per locus is 6.62. This level of analysis should be sufficient for discrimination between individuals when using genetic techniques to survey populations

## 2. Dr. ULLAS KARANTH – WILDLIFE CONSERVATION SOCIETY, INDIA

### CAMERA TRAP DATA AND MARK-RECAPTURE ANALYSIS

1. Cheetah are individually recognisable from photos / videos based on their spot patterns. In the future, perhaps cheetah can also be individually identified based on their scent (using trained dogs) or DNA (from scats or hair). Such an ability to identify individuals provides researchers and managers with some very powerful tools for monitoring cheetah populations across space and time: Population survey models and estimators based on **capture-recapture sampling (CR)** (Otis *et al*. 1978; Nichols 1992; Williams *et al*. 2002). I believe we should make the best use of these well-developed approaches, rather than try to reinvent the statistical wheels specifically for cheetah.

2. CR (and other sampling-based survey methods) recognise and deal with the fact that the cheetah **counts** we obtain in the field can be used to estimate the **real numbers** or densities of cheetah, **only** if the very real problems **spatial sampling** (you can not survey 100% of the study area), and, **incomplete counts** (you don't see or catch all cheetah even where you go) are addressed adequately. Many of the ad hoc cheetah monitoring approaches that rely on the concept of 'censuses' (the assumption that all animals are detected everywhere) often fail to address these core problems, and therefore, may not generate reliable results.

3. CR-based approaches can be used to reliably estimate cheetah numbers in short term surveys (30-45 days) in which the 'population closure' can be assumed. They involve sampling the populations repeatedly (sampling occasions) during the survey, and building up **individual capture-histories** of cheetah that were detected (via photography, physical capture, DNA etc) across a number of sampling occasions (>2). For example, a capture history of "Cheetah A – 00110" indicates that a particular animal "A" was caught only on third and fourth occasions of a five sample survey. Such simple capture-history data can be analyzed using programs such as CAPTURE or MARK. These analyses allow us to test for population closure, compare and select from among alternative models / estimators the best one for our data and then go on to estimate capture probabilities and numbers of cheetah using the selected model / estimator.

4. If such closed model CR sampling of cheetah can be carried out every year over the long-term, then these multi-year capture-recapture data can be combined in 'Pollock's Robust Design' analyses (Williams *et al*. 2002, Karanth and Nichols 2002) to generate estimates of year-to-year survival rates and recruitment, thus providing the investigator with the full understanding of the population dynamics of cheetah.

5. CR sampling based approaches that do not require individual identification of cheetah, but only require surveys that report the presence / absence (or more appropriately detections / non-detections) of cheetah are now available. Such approaches (Mackenzie *et al*. 2003) and associated software PRESENCE can be used to estimate proportion of area occupied by cheetah or 'patch occupancy' in large scale 'atlassing' efforts.

6. Because surveys that try to generate indices of relative abundance of cheetah (number of tracks seen / 100 km surveyed, numbers caught / year etc...) cannot estimate detection probabilities, they are far less reliable than results generated from CR-based surveys that can estimate these probabilities. When expensive / intensive tools like camera traps or field photography are employed in surveys, there is no justification for being satisfied with an 'index'. Paying a little more attention to survey design and analysis can possibly generate CR based, reliable estimates of abundance. In the absence of the ability to identify individuals (where you can't photograph cheetah etc), one may have to rely on such indices, but these results should always be viewed with caution and tested against valid CR- based estimates wherever possible.

### 3. GUS MILLS – SOUTH AFRICAN NATIONAL PARKS / ENDANGERED WILDLIFE TRUST, SOUTH AFRICA

### PHOTOGRAPHIC SURVEYS

- Two cheetah photographic surveys have been conducted in South African National Parks. 1990 / 1991 Kruger National Park and 1998 / 1999 in the South African part of the Kgalagadi Transfrontier Park
- The surveys rely on photographs taken and submitted by tourists, park officials and the research team. Identification of individual cheetah was done by visual examination of the spot and tail patterns.
- Posters advertising the projects were displayed in the media and at entrance gates and tourist rest camps and entry forms were handed out to visitors at reception desks.
- Sponsored prizes were obtained to encourage people to take part. Prizes were given to entrants providing the most useful information rather than to those who took the best photos.
- A dedicated researcher was appointed to co-ordinate the projects, analyse the photos and prepare a report.
- Projects ran for about a year.
- In a recent Wild Dog study rarefaction was used to refine the photographic survey, to find confidence limits for the method and to determine an adequate sample size of photographic entries required for a survey.
- Rarefaction is a method used to evaluate the species richness of biological communities. The programme randomizes the input data and generates a curve of the expected number of species represented by a random number of individuals in the sample.
- Rarefaction provides statistical robustness to the resulting curves in comparison to simple cumulative plots: variance and standard deviation values are given for each point of the curve, which help in determining sampling heterogeneity.
- The “community” was the total number of Wild Dogs observed in a sampling region (park or region of the park). Each “species” consisted of an individual dog, and the number of sightings for each dog represented the number of “individuals” in the species.
- When a region was extensively surveyed, the expected number of dogs formed an asymptote (slope approaching 0) to a point where additional entries would only provide a small addition of wild dogs in the population estimate.
- Asymptotes started to form around the number of sightings that were necessary to detect 95% of the Wild Dogs. These points may be used as confidence limits ($\alpha = 0.05$) in regional surveys and aid in estimating an adequate sample size.
- A curve that shows a clear asymptote indicates an extensive sampling in the region, while a linear relationship suggests that more sampling is required. The length of an asymptote can also show redundancy in the photographs: a long asymptote suggests that too many entries have been analysed, and this surplus of effort could have been distributed in regions needing more sampling.
- The rarefaction analysis provides a model that can readily be used during a survey to determine if enough entries have been received.
- A certain quantity of received entries (I suggest at least 100) is also necessary to run the rarefaction analysis.
- Photographic records can be a reliable method in identifying and counting cheetah, especially when the public is fully aware of the primary goal of the photographic contest. Surveys achieved in separate regions are more precise than combined results of the entire study area, and better results may be produced if effort is focused on smaller regions to obtain a uniform sampling effort.
- Requirements: • Dedicated, suitably qualified researcher • Vehicle • Good communications: radio or mobile phone • Computer facilities and email • Digital camera • Posters and entry forms • Sponsored prizes; e.g. accommodation at lodges • Postal facilities to acknowledge entries
- Advantages •Possible to obtain an accurate population assessment of an area. •Additional demographic and ecological data can be obtained, e.g. cub survival, ranging patterns, feeding habits. •High public relations profile and education value
- Disadvantages: •Time consuming and expensive if done properly •Only suitable in areas where cheetah are tame and tourists are many

## 4. KELLY WILSON – DE WILDT WILD CHEETAH PROJECT, SOUTH AFRICA

## DE WILDT WILD CHEETAH PROJECT: EXPERIENCES FROM COUNTING CHEETAH

### Introduction:

During field studies conducted on ranchlands in South Africa, the following methods were tested as possible methods to accurately determine the numbers of free ranging cheetah in the specific area:

- Interview (Atlas) method
- Capture / recapture with remote triggered cameras
- Range use studies with conventional telemetry.

### Study area:

The study area is in the South Western corner of the Limpopo Province in the Thabazimbi Magisterial District. The area is typically bushveld with densely encroached woodland areas as the primary habitat available. The majority of the area is game fenced as wildlife ranching is the primary land-use in the area. Other land-use includes crop farming (along rivers) as well as stock farming. The area is approximately 6,950 $km^2$ in size.

### The Interview Method:

A total of 199 farmers were interviewed covering a total of 366 farms. The questionnaire was divided into two sections: Farm details (name of owner, farm name etc) and cheetah information (sightings, date, group size, frequency, and other predators). The data were analysed using SAS software (*SAS® 2002. SAS Institute Inc., SAS Campus Drive, Cary, North Carolina 27513 version 8.2*) and were represented as frequency distributions. Chi Square tests were carried out to determine relationships between variables. The data were mapped with GIS software. The interview method is especially effective in ranching areas to obtain baseline data on cheetah distribution. Unfortunately this technique relies on the memory of the interviewee. The interview method is effective in determining attitudes and perceptions of landowners but is not applicable for obtaining accurate cheetah numbers. This method produced a rough result of 0.6 cheetah per 100 $km^2$. This method is an appropriate method of obtaining data relatively quickly over a large study area.

### Capture / Recapture method:

Remote triggered camera trapping was used to cover an area of 30 $km^2$. The method used was adapted from Karanth and Nichols (2002). A trail was done using 4 camera traps in order to determine the suitability of the method for censusing cheetah. Camera traps were placed in areas of known cheetah activity. The placing of the traps was done in such a way to include at least two camera traps in the estimated range of one cheetah. Cheetah photographed were identified by spot patterns. The identification was done manually and the capture histories recorded in a capture matrix. The data were analysed with CAPTURE software. The results were 2.3 to 5.4 cheetah per 100 $km^2$. The initial purchase of the equipment is expensive, but the results obtained from this method are accurate, scientifically acceptable and repeatable.

### Range studies - Telemetry:

Range use studies on cheetah in the study area were done to determine range size, range overlap and habitat utilisation in ranching areas. Cheetah were captured using capture cages, fitted with radio telemetry collars and re-released. Monitoring from the ground was not possible as the mean wildlife ranch size is 1200 ha and transversing several different properties was time consuming and often impossible. An ultra-lite aircraft (Aquilla Trike) was used for aerial tracking which proved to be successful and cost effective (15 litres of unleaded fuel / hour). A 100% success rate was obtained in locating the cheetah and a 97% success rate of visual observations. The localities of the cheetah were captured on a GPS and mapped on a GIS software programme. The mean range size using the Minimum Convex Polygon method was 320 $km^2$ with a total range of 360 $km^2$ and a 50% kernel of 50 $km^2$. This method also produced additional info on predation rates as well as preferred prey species.

### Summary:

The interview method is the most effective method for a pilot study in an unstudied area. A more detailed study on cheetah numbers on commercial ranch lands is proposed using a combination of methods including spoor frequency counts, range use and camera trapping. The camera trapping technique appears to be the most reliable census method in this study area.

## 5. ALEXANDER LOBORA & LARA FOLEY – TANZANIA WILDLIFE RESEARCH INSTITUTE (TAWIRI), TANZANIA

## EMPIRICAL METHODS FOR IDENTIFYING AND PRIORITIZING WILDLIFE SURVEYS USING GIS

### 1. Defining a Geographic Information System

"A set of tools for collecting, storing, retrieving at will, transforming, and displaying spatial data from the real world for a particular set of purposes." from Principles of Geographical Information Systems for Land Resources Assessment, P.A. Burrough, 1986.

### 2. The Powers of GIS

*Spatial Data Storage and Management*

- Stores and updates large amounts of complicated spatial data;
- Queries / summarizes spatial data already in a GIS database.

*Spatial Analysis & Modelling*

- Make many distance and / or area calculations (e.g., # people within 5km of protected area);
- Compare spatial data from one place over time--temporal analysis (e.g., land-use change);
- Make selections based on complicated spatial criteria (e.g., site selection);
- Represent spatial patterns and relationships in dynamic models (e.g., global climate change).

### 3. GIS and Conservation "The Jaguar case study" (Sanderson *et al*. 2002)

Main objective: To assess the status and distribution of the jaguar across the range and to develop geographic priorities to guide conservation of jaguar into the next millennium.

Specific objectives:

- Comprehensively assess the state of knowledge about the ecology, distribution and conservation status of the jaguar;
- To identify priority areas for its conservation and a range wide basis;
- To build an international consensus for conservation of the species.

Methods:

- Jaguar Geographic Regions (JGR's) was developed by assembling ecoregions of North and Latin America developed by WWF;
- Prior to the workshop, researchers were provided with a base map (JGR's);
- Asked to identify their area of knowledge of whether jaguar where present or absent;
- Experts then asked to fill out datasheets for every point observation where they have seen the species within the last 10 years;
- Experts mapped appropriate jaguar ranges (jaguar present);
- Experts where asked to map important areas for long-term jaguar conservation based on (i) jaguar population (ii) prey (iii) habitat (iv) threats to jaguar.

The data above were then received and synthesized to produce working maps for analysis, review and distribution at the workshop.

**During the workshop**

- The first day was spent going through the data and resolving conflicts.
- Build consensus amongst experts on what the final maps should look like in terms of jaguar range and jaguar conservation units.

These data were subsequently reviewed to produce final maps indicating the following: -

1. Jaguar extent of knowledge.
2. Jaguar point data.
3. Approximate jaguar range.
4. Jaguar conservation units.

**Final model development**

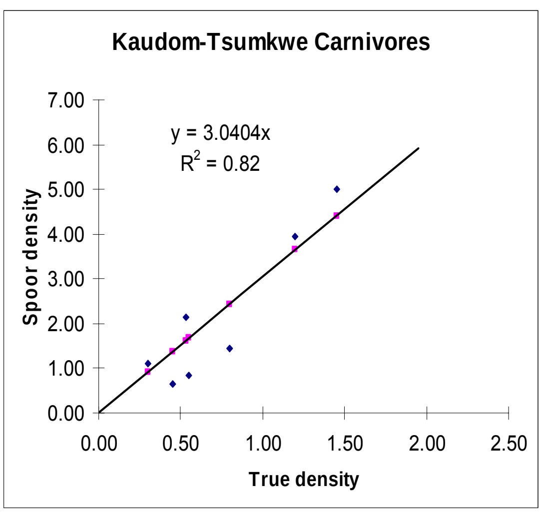
- Assessment of factors that was good, medium and bad for jaguar survival, where done.
- 70% of jaguar current range was considered to have a high probability for jaguar survival.
- Then prioritised jaguar conservation units across the range of habitats available to jaguar
- Weighing skills developed and combined with an individual expert score.
- Then ranked and applied these scores across the range of the jaguar and finally came up with the consensus map of jaguar status across its range.

## 6. PAUL FUNSTON – TSHWANE UNIVERSITY OF TECHNOLOGY, SOUTH AFRICA AND SARAH DURANT – TANZANIA WILDLIFE RESEARCH INSTITUTE (TAWIRI), TANZANIA

### ESTIMATING POPULATION DENSITY OF CHEETAH AND OTHER LARGE CARNIVORES FROM SPOOR DENSITY

Large carnivores are difficult to survey because they generally occur at very low densities and in most cases are either cryptic or shy. Thus most conventional techniques for estimating large mammal abundance are generally not appropriate, necessitating further development of other indices of abundance. One of the promising indices for measuring population densities of large carnivores is that of spoor frequency as a measure of actual density, which was used successfully for low density large carnivores in Namibia (Stander 1998) (see Figure 1a). In investigating the suitability of spoor as a reliable indirect measure of density it is necessary to determine whether the same degree of precision and accuracy can be obtained for species, or situations, where particular spoor cannot be ascribed to a particular individual during calibration.

In developing the technique further, a study focusing on lion, and other large carnivores in the Kgalagadi Transfrontier Park (KTP) determined the relationship between actual and spoor density in four intensively studied study areas (Funston *et al*. 2001). Actual density was determined through a combination of marking individuals, radio-telemetry, ground observations, and attracting lion to 'call-up' stations. Spoor density was determined through intensive spoor transects, conducted within the study areas, covering a total of 4,078 km. A strong linear correlation with increasing lion density and increasing spoor density was determined (Figure 1b), the slope of which was similar to that found by Stander (1998) in Namibia. Furthermore the spoor data accurately described lion population structure in KTP and the relationship between the densities of the other large carnivores as well as the large ungulates was well described by the relationship determined for lion (Figure 2a), suggesting a broader potential use of the technique.



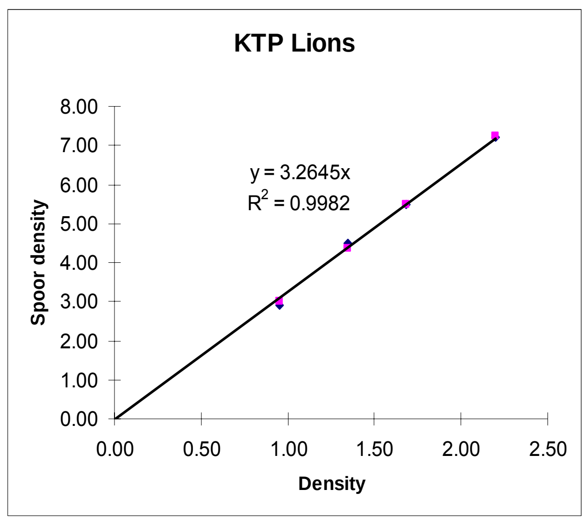
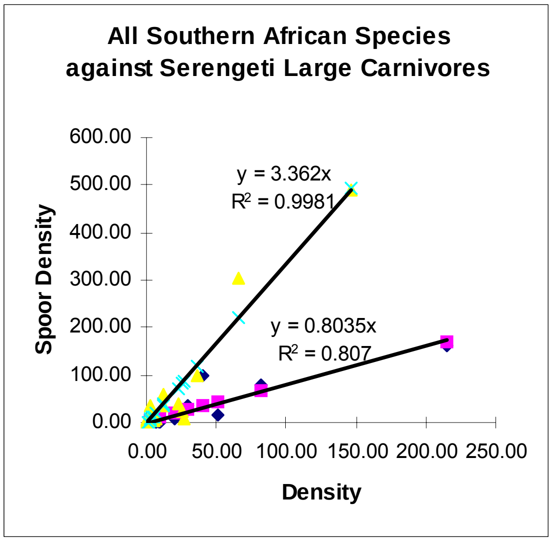




**Figure 2:** The relationship between spoor density and actual density of (a) large carnivores in the Kuadom area of Namibia (Stander 1998) and (b) lion in the Kgalagadi Transfrontier Park (Funston *et al*. 2001).

In assessing the possible use of this methodology for censusing cheetah and other large carnivores on the Serengeti plains, however, a substantially different relationship was found (Figure 2a). As the slope of the regression was substantially flatter than that of Namibia / KTP this would suggest that the substrate in the Serengeti is substantially less suitable for revealing spoor. Preliminary estimates suggest that although cheetah occur at about ten times higher densities on the Serengeti plains (+ 5.5 cheetah / 100 km²) when compared with KTP (0.6 cheetah / 100 km²), the average spoor frequency (distance between each spoor) in the Serengeti is about the same as that in KTP (see Table 1). This is supported by the fact that in both areas cheetah seem to be similarly contagiously dispersed (Table 1). Although the relationship does not seem to hold across all habitats, the correlation between Serengeti large carnivore numbers and spoor density was nevertheless relatively strong, especially for lion and cheetah with a different relationship for spotted hyaena (Figure 2b).



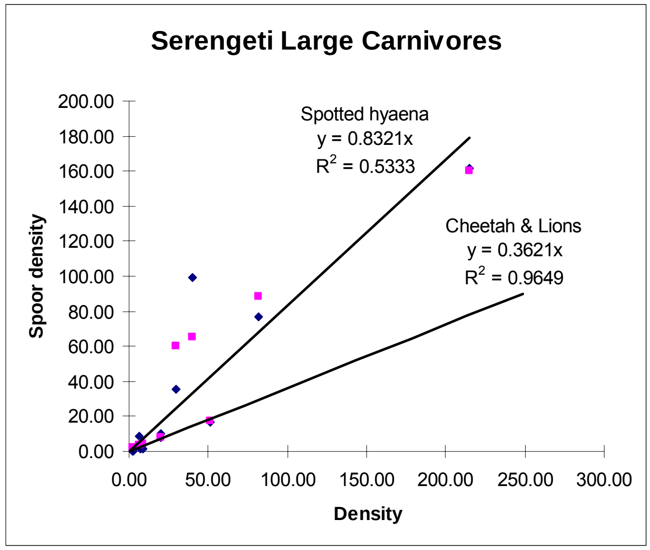




**Figure 3:** A comparison of the spoor density vs actual density relationships for (a) southern African arid areas with the Serengeti, and (b) cheetah and lion compared with spotted hyaena in the Serengeti.

**Table 1:** Estimated numbers and densities of cheetah in the Kgalagadi Transfrontier Parks and the Serengeti plains in the dry season with average spoor frequency and a measure of dispersion.

| | Area | Estimated numbers | Density /100 km² | Mean spoor frequency | Variance | Dispersion |
|---|---|---|---|---|---|---|
| KTP | Dune | 89 | 0.6 | 72.2 | 7213.6 | 99.9 |
| | Tree | 115 | 0.6 | 83.9 | 10051.2 | 119.8 |
| Serengeti | Short grass | 30 | 2.3 | 89.9 | 11476.1 | 127.7 |
| | Long grass | 80 | 9.2 | 90.4 | 14023.7 | 155.1 |

Thus it would seem that this technique holds substantial promise for censusing cheetah across a wide variety of different habitats but that it is dependent on an independent calibration exercise, therefore areas with very low densities may be difficult or very expensive to survey. Nevertheless given the obvious interest in the technique as a way of determining cheetah numbers it is probably worth investing in more sampling across a variety of habitats. Furthermore even without calibration spoor density could be successfully used as an index of density and population change over time within an area.

## 7. MEGAN PARKER – WORKING DOGS CONSERVATION, USA

### WORKING DOGS FOR CONSERVATION - Using specially trained detection dogs for wildlife surveys

Humans use dogs in many aspects of life for assistance in detecting, locating and retrieving objects. We evolved with canids and have long exploited their superior olfactory abilities and their tendency to please us.

Dogs have been trained to assist research projects to increase wildlife sample sizes for science, conservation and management. Faecal depositions (scats) can be detected and located by trained dogs and collected for information on a species' presence or absence, diet, parasite loads, disease, endocrine extraction, density, or DNA extraction for demographic, sex ratios or kinship. Dogs are able to discriminate between complex odour profiles and generalize or specialize, depending on their specific training. An example of this type of discrimination is demonstrated by narcotics dogs, trained to either discriminate to one type of narcotic, or may be trained to detect a suite of illegal substances. Bomb, customs and arson dogs are trained in this same way. Conservation detection dogs can be trained to detect samples from one species or from different species in a diversity of environments. Although scenting conditions are best with humidity, dogs have proven to work with consistency in mountains, snow, oceans, forests and deserts.

Dogs and their handlers require training to locate samples in complex environments, much in the ways that search and rescue and disaster dog teams are trained. Over time, dogs do very well at moving across complex landscapes, where environmental conditions vary considerably and the amount and intensity of scent can cluster or be scoured by wind and convective currents.

Conservation detection dogs have been trained to detect and locate scats, urine and fossorial species of interest, including; grizzly bear scats, black bear scats, mountain lion scats, wolf scats, lynx scats, black-footed ferret (presence in a prairie dog town), desert tortoise (live species), and northern right whale scats on open ocean. Dogs have been trained to discriminate between bear species and Dr. Linda Kerley is using dogs in the Russian Far East to identify faeces and urine from individual amur tigers.

Interest in faecal analysis is growing as researchers turn to non-invasive measures for determining population parameters. Human detection of faeces can be quite limited in most environments. Where tested, dogs are significantly better at accurately locating scats compared to trained human observers. Dogs can increase detection and sample rates of scats considerably and can locate scats in some environments where humans are incapable of detecting and locating scats. Dogs increase the area effectively searched by 'searching' areas upwind, in olfactory range.

# GLOBAL CHEETAH MONITORING WORKSHOP 2004

**1 – 4 June 2004**

**Ndutu Safari Lodge, Ngorongoro Conservation Area**

## WORKSHOP REPORT

**SECTION 4**

**WORKING GROUP REPORTS**

**TASK 1 – TECHNIQUE-BASED WORKING GROUPS**

# TECHNIQUE-BASED WORKING GROUPS

After the presentations, participants worked in technique-based groups to develop a standardised methodology for using six selected monitoring techniques. The evaluation of each technique included an assessment of the technique's appropriateness, costs, capacity required, accuracy and suitability. The ability to calibrate data across the different techniques was also assessed.

The technique-based groups covered:

- Direct counts: Visual observations / tagging
- Carnivore atlassing / questionnaires / GIS data
- Spoor counting
- Working Dogs for Conservation
- Camera traps (Photographic capture-recapture)
- Photographic surveys

The following questions were provided to each technique-based group at the start of the working group session, ensuring direction and continuity to enable ranking and technique comparison at the end of the session:

1. Survey design issues:
    - Describe how you would design a survey using the index.
    - Describe how you would implement it in the field.
    - How would you analyse the data?

2. Accuracy and Precision:
    - Is your index valid?
    - Is there currently a means of estimating confidence intervals?
    - Is there a reasonable and quantifiable statistical probability of detecting trends using your index?
    - Is there a straightforward relationship between your index and abundance?
    - Does your index-abundance relationship vary between areas and / or over time
    - How sensitive is your index?
    - Is your index sensitive to measurement error?

3. Suitability:
    - What is the general suitability of your index? Can it be used across a wide range of habitats / regions?
    - Calibration – has the index been calibrated between different areas? Is it possible to calibrate the index? Does it matter?

4. Cost issues:
    - How much would a survey cost?
    - What equipment is needed for a survey?
    - How much manpower is needed?

5. Training / Capacity:
    - What training is needed? Is it available within the country?
    - Does the survey need external statistical expertise for full analysis?
    - Does the necessary infrastructure exist?

# DIRECT COUNTS: VISUAL OBSERVATIONS / TAGGING TECHNIQUE

**Group members:** Laurie Marker (Cheetah Conservation Fund, Namibia), Sarah Durant (TAWIRI and Zoological Society of London, Tanzania) and Hadley Becha (East African Wildlife Society)

## 1. SURVEY DESIGN

Visual observation

Implementation:
Aim for 240 sightings per year in 2200km², takes a minimum of 2 years start-up.

**Methodology:**
Drive to high points and scan with binoculars (it is possible to detect cheetah up to 3km away, occasionally further).
Drive to cheetah carefully, avoid driving directly at the animal and photograph all individuals in the group, right and left side.
Individuals are matched to an index card system / or through software.
A full-time person is needed working year round just covering demography.

**Data Analysis:**
For each individual, estimate the intersighting interval and use this to estimate median time of death as described in Durant *et al.* 2004.

Implementation sites?
Open areas such as the Serengeti Plains, same methodology could be implemented in Masai Mara however needs a time series of data.

Tagging

**Aim:** Extensive trapping and radio collaring / tagging. Marking individuals, to get to the point of not trapping / tagging new individuals older than 3 years.

**Methodology:**
2 years start up (not within protected areas, but with support from communities / farmers)
Trapping methodology is described in Marker *et al*. 2003a. 2003b.

**Data analysis:**
Population count can be obtained from the total number of radio-collared animals plus estimates of time of death from returned tags. For those animals (between 10-20%) for which no returned tags are obtained, estimates for time of death can be obtained from trapping and retrapping rates (Marker *et al.* 2003b), in the same way as the intersighting interval above (Durant *et al.* 2004).

Implementation sites?
Namibia – Waterberg Conservancy. There are some start up initiatives in South Africa and Botswana.

## 2. ACCURACY AND PRECISION

1. Valid? – yes
2. Confidence limits? – Not appropriate if a true total count is required, although possibly some attention is needed for the implications of the time of death estimates. However even so, confidence limits are likely to be tight.
3. Good statistical probability of detecting trends
4. Straightforward relationship between index and abundance
5. Index – abundance relationship should not vary between areas and over time.
6. Index is high in sensitivity but is relatively insensitive to measurement error. Although some error over misreporting / identifications of individuals and estimating of time of death.

7. With tagging it is never certain that all animals have been tagged, since tagging depends on being able to capture all individuals in a population and some individuals may be impossible to trap or dart. This is less likely to be the case when using visual observations. Although individuals may be too shy to photograph, these individuals are generally seen, albeit at large distances and hence some idea of the proportion of the population which is not identified can be assessed.

## 3. SUITABILITY

Visual observation

Only usable in open areas and areas where cheetah are habituated.

Tagging

Usable in areas where cheetah can be caught and handled safely as well as where there are recognised procedures for obtaining trapping / handling permits. Obvious visual tags and radio collars are often unpopular in tourist areas.

Calibration - These types of surveys provide the baseline for calibrating other survey techniques.

## 4. TRAINING / CAPACITY

Field:
Visual observation: A minimum of 1 month training of skilled professionally trained field person to degree level or equivalent with a background in wildlife ecology will be required. Training would need to focus on cheetah recognition, location and ageing, off road driving skills, data collection, and general bush skills. Availability of skills within countries is variable, some countries have a complete set of skills others have none. Skill training is available within countries at major study sites.

Tagging: A minimum of 1 month training is required of skilled professionally trained field person to degree level or equivalent with a background in animal handling and capture techniques and wildlife ecology. Training will be needed in cheetah immobilisation and handling, ageing, data collection, trapping, communication skills and telemetry techniques. Skills within countries are variable, some countries have complete set of skills others have none. Skill training is available within countries at major study sites.

**Data Analysis:**
Visual observation and tagging: All relevant analyses to-date have been done within project, but external statistical support would be beneficial.

**Infrastructure:**
Visual observation: Limited infrastructural requirements.
Tagging: An extensive trapping infrastructure is important for a successful tagging programme. This only exists in certain areas, some potential exists in other areas for such infrastructure development. In some areas there is no such potential. Airplane access is needed for radio telemetry.

## 5. COSTS

Visual observation

**Consumables:** US$20,000-US$25,000 per year (includes fuel, vehicle repairs, equipment repairs, house rent / tent, travel, photographic development, communication).
**Equipment:** Vehicle (US$15,000-US$40,000), camera (US$2000), binoculars (US$300), GPS (US$300)
**Manpower:** One full time trained person.

Tagging

**Tagging:** US$25,000 per year with an additional US$15,000-20,000 for aerial tracking
**Equipment:** Vehicle (US$15,000-US$40,000), radio tracking equipment (US$10,000), camera (US$300), binoculars (US$300), GPS (US$300), darting and handling equipment (US$1000)
**Manpower:** One full-time trained person and volunteers.

# CARNIVORE ATLAS / QUESTIONNAIRES / GIS DATA TECHNIQUE

**Group members:** Lara Foley (Tanzania Carnivore Atlas Project, Tanzania), Nettie Purchase (Researcher, Zimbabwe), Alex Lobora (Tanzania Carnivore Atlas Project, Tanzania), Deon Cilliers (De Wildt Wild Cheetah Project, South Africa), Sultana Bashir (Serengeti Cheetah Project, Tanzania), Brenda Daly (CBSG / EWT, South Africa)

**Input from Laurie Marker (Cheetah Conservation Fund, Namibia) on Day 2, morning session
**Also some input from the Namibia Carnivore Atlas project (based on printed report)

What is our index?
Presence / absence of cheetah – this could be refined further depending on local context.

- The atlas approach should be the starting point as it generates baseline data and leads to further surveys. It is ideal as a pilot study method.
- The atlas approach allows for identification of gaps in information.

**1. SURVEY DESIGN**

1. First define objectives of the survey design very specifically.
2. Collection of data:

   A. Local scale

   - Literature search and compilation of data available from all sources: research, universities, government, museums, hunting records, NGOs, Problem Animal Control reports, etc.
   - The target audience needs to be identified and the questionnaires are completed using the direct interview method. The following data can and should be obtained:
     - Presence / absence
     - Abundance if possible
     - Spatial data
     - Recommend total count or systematic survey design
   - A concurrent implementation of an awareness campaign should be done. Potential respondents and all other relevant 'stakeholders' should be targeted to ensure buy-in.
   - Synthesise and analysis of the data should be done and distribution and spatial data represented by mapping.
   - Spatial relations are to be analysed and quality of the data determined
   - An attempt should be made to calculate abundance if possible but only if the biological information is available and data quality is good.
   - Identification of areas requiring further study and implement other methods should take place
   - Identification of areas of conservation concern could be done, depending on the initial objectives of the survey.

   B. National scale

   - The same procedure should be followed as for the local scale, with the following:
   - A combination of direct and indirect questionnaire methods could be combined to aid in determining the target audience.
   - This must be done over a longer time scale.
   - An attempt must be made to survey systematically.
   - Data analysis to be done as for the local scale but not recommended for calculation of abundance.

   C. International scale

   - This requires local and national atlas data availability.
   - Compilation and analysis of existing data and identification of gaps should be done.

Other suggestions / points:

- Distribution of indirect questionnaires can be done by e-mail list serves and phone interviews.
- The study design will be constrained by resources available and the timescale.
- A decision on the level and type of data required should be made and based on objectives and resources, e.g. open or closed questions.
- All users of the target survey area should be included in the survey.

Implementation: In this instance case studies were used from each country represented in the group
South Africa – direct interviews were used as no time limit was imposed. One individual covered 400,000 ha of commercial farms over 28 days, 290 farmers interviewed (398 farms) (Cilliers *pers. obs*). Data collected included presence / absence; number of sightings in previous year; attitudes and other carnivore sightings.
In South Africa only farmers and farm workers were interviewed on farms and group ranches.

Zimbabwe – surveys done on commercial farms were similar to South Africa, however additional data was collected which included land-use so correlating presence / absence with land-use type, e.g. livestock versus crops. In communal areas, village meetings were held with a translator present, this proved to be a much slower process as the interviews take longer. Indirect methods are not possible and it is important to do direct or group interviews are required. Respondents are first asked to identify cheetah. Gaps in the data were found with professional hunters and not systematic in terms of time or area.

Tanzania – A Carnivore Atlas Pack was developed by the Tanzania Carnivore Project within TAWIRI. The pack includes a briefing sheet requesting information on carnivore sightings of 35 species in Tanzania and two data recording sheets. One data sheet requires very simple presence / absence data only and the second sheet requests more detailed information on all carnivore sightings in a year. The latter was used when serious wildlife enthusiasts and conservation professionals were targeted. Data fields included species, numbers, sex and location (GPS or on UTM grid square). All key stakeholders were invited to an inception workshop to launch and publicise the project (based on Bird Atlas Project). Broader bases of stakeholders were taken into account and developed an identification manual for participants were developed.

Namibia – Included 4182 farms; 537 participants. Both visual and spoor data was recorded using a visual key as it was more accurate. Foreign tourists were also included in an indirect survey.

**Data Analysis:**
South Africa – Presence / absence was recorded and overlaid on maps of farms in a GIS format. cheetah groupings were identified and sightings were cross-referenced with neighbouring farms comparing date of sighting to avoid duplication. The Chi square test was used in data analysis to investigate possible relationships between variables and is not a technique for estimating density. It is a statistical method for testing relationships between two variables e.g. a relationship between farm size and cheetah occurrence? (Wilson, in prep).

Zimbabwe - Presence / absence data was plotted on a map of commercial farm boundaries and ward boundaries so incorporating the data from both the commercial farm survey and communal land survey. If a cheetah was reported as seen by one villager within a ward, then cheetah were recorded as present for the whole ward, even though a ward may extend over 50 villages. A very rough estimate of abundance was made for cheetah on commercial farmland (1 per 100km$^2$) by assuming that the home range for a cheetah was, on average, 3 commercial farms. The total number of cheetah reported (excluding outliers), was then divided by the total area over which the survey took place. It is important that more detailed information regarding cheetah movements and home range sizes be collected using collared cheetah so as to refine estimates of abundance

Tanzania – Data are being entered into an MS Access database, one unit is equal to ½ a degree latitude / longitude grid square, roughly 50 km$^2$. Atlas questionnaire data are to be supplemented with field surveys, for example camera trap surveys, which may allow for localized abundance calculations. Calibration may be done with questionnaire data and there is the possibility of doing some spatial statistics and GIS analysis.

## 2. ACCURACY AND PRECISION

The accuracy of the technique relies on the accuracy of the information collected, thus the ability of the respondent to identify a cheetah. Interviewer ensures that the respondent is reporting on the correct animal e.g. by asking questions about its behaviour etc. In this instance the accuracy of the technique in estimating abundance was evaluated and not the accuracy of identification of cheetah by people in the field.

1. Valid? This technique is valid, for presence and absence on a national and international scale
   a. Has a potential for abundance measurements on a local scale (there is also a potential for great overestimation of abundance)
2. Straightforward relationship to estimate abundance?
   a. Not a straightforward technique as the interpretation of data is difficult and often can not be compared directly with other data sets
   b. Each technique will be different based on locality
   c. May be able to get numbers from off-take and government records but only if hunting efforts remain constant over time
3. The method is accurate for presence but not necessarily for absence. It may require another method to determine cheetah presence / absence and may need ground-truthing. It is also dependent on human density and habitat type, e.g. if human density is high then local people can probably provide accurate information of sightings.
4. Accuracy in picking up trends? Long term trend (5 - 10 year) needs to be considered, not accurate or precise enough to pick up short term trends. Namibia and South Africa are currently looking at trends and potentially in Tanzania.
   How to improve accuracy?
   a. Awareness and education, public relations, identification using pictures and spoor (to ensure reliable identification)
   b. Use GIS to predict areas where surveys are not possible; ground-truthing however is necessary.
   c. By combining data with information on biology and home range behaviour.
5. Statistical models could be developed for this technique however this may be difficult with some biases
6. Sensitivity – sensitive over time to detect trends.
   - Biases
     - South Africa: Based on perceptions therefore possible tendency for overestimation.
     - Tanzania: Non-systematic and based on interest of respondents therefore bias towards keen residents, bias geographically towards tourist areas. Not all regions covered.
     - Method is not accurate in determining absence.
   - Data quality – depends on the respondents accurate identification of cheetah, the effort in searching for cheetah (time and resources) and public awareness
   - Abundance – Hansen and Stander (2004) use the atlas method in combination with results from ongoing field research projects and other published data to obtain population densities.

## 3. SUITABILITY

- Useful in a wide range of habitats: human and ecological
  - Not useful in areas where access is difficult or with low resident human populations or low numbers of visitors
- Calibration – tends to be used without calibration
  - Starting point – can be improved with other methods and further research.
  - Not a useful technique if it is a once-off survey; best used in conjunction with other methods and data from other studies.

## 4. COSTS

- Exploration of existing data
- Salaries
- Equipment - Computer, vehicle, GPS, GIS software
- Distribution network, questionnaires, printing

| | Local | National | Regional |
|---|---|---|---|
| Cost | US$2-5000* | US$30-35,000* | ? |
| Training / Manpower | Interviewer / Project manager<br>Training: 1 week – 1 month | Project manager Interviewer(s)<br>Analyst | Project manager<br>Analyst |

*+ initial costs US$15,000 (vehicle, computer, software)

Cross-cutting recommendations
1. Appreciate culture of respondents and choose your interviewer appropriately e.g. male versus female interviewer, language, etc.

**5. TRAINING / CAPACITY**

- Interviewer – need to have at least high school level education (secondary education)
    - Ability to read / write
    - Good social skills
    - Good understanding of the cheetah and local conditions
    - Training time: 1 week to 1 month
- Project manager – Bachelors / University degree in environment or social studies
    - Able to develop design surveys and questionnaires
    - General understanding of GIS is necessary
    - Organize an awareness campaign
- Analyst / consultant – for statistical and GIS work

**Plenary session comments and discussion**
1. Sensitivity to change is an issue: the method can be sensitive but only with long-term data. Does this method detect change and what is the accuracy?
    - Not really for abundance but could detect change in distribution.
    - Laurie Marker has used this method for abundance in Namibia based on a distribution frequency compared to trapping and other available data. However it should be noted that for any extrapolation from frequency of sightings or trapping to abundance implicitly assumes that sighting or trapping efforts remain constant over the period in question which is seldom the case.
2. Caveat for accuracy score is really based on accuracy for presence. Absence is more difficult to assess and as a result, less accurate.
    - Teasing out true absence from non-detection is an issue. A number of good references take the probability of detecting signs into account e.g. Wilson and Delahay (2001)
3. Proper identification might be a problem; it's important to have pictures in the questionnaire / interview, for proper identification
4. Suggestions to compile an international database of atlas information on cheetah sightings. Laurie Marker's database is a good start (Appendix 4).
5. Benefits:
    Useful technique on a national and international scale
    a. Useful as a start / pilot study: most studies have started, using this method.
    b. Creates awareness.
    c. Can also collect a lot of other information through interviews such as conflict data, local attitudes, land-use, etc.
    d. Useful to monitor change in cheetah populations in a dynamic environment, using GIS and predictive mapping.

# SPOOR COUNTING TECHNIQUE

**Group members:** Paul Funston (Tshwane University of Technology, South Africa), Ann Marie Houser (Cheetah Conservation Botswana, Botswana), Harald Förster (Okatumba Wildlife Research, Namibia), Arthur Bagot Smith (Private Veterinarian (Cheetah Conservation Fund), Namibia)

### 1. SURVEY DESIGN

Sampling design:
Two systems could be considered when designing a spoor count survey to estimate relative cheetah abundance or area specific population size (both of which would produce trend information); the latter has proved to provide a reliable and applicable calibration. The two systems do not necessarily reflect cheetah movements, but rather practicality of design and are influenced by whether the area to be surveyed is comprised of large open or unfenced areas, versus areas that comprise contiguous fenced ranches. Thus two separate, but similar designs are proposed:

1. Open-unfenced areas (large national parks, game reserves, wildlife resource areas, communal lands (Stander 1998, Funston 2001).
2. Closed-fenced areas (domestic livestock ranches, game ranches and smaller game reserves – an area less than 300 km²).

There are two methods that can be used to collect the data within these areas, both of which are essentially transects, and may need to be specific for the area chosen. These include:

1. Random transects – where a set of transect routes is specified *a priori*, either within a fenced or unfenced area, and is sampled at an interval that would be practical, and result in independent data samples. These transects allow for cheetah to cross sampling paths in a random fashion.
2. Fence line transects – where a boundary route circumnavigating the farm boundary is sampled, at an interval that would be practical, and result in independent data samples. These transects tend to funnel cheetah along a physical barrier.

The variables to be calculated during a survey include:

1. Spoor frequency / interval: the average interval between each spoor sample.
2. Spoor density / count: the number of fresh and unique spoor recorded per 100 km (an individuals spoor is only counted once per transect).

Other variables that need to be measured include:

- Starting odometer reading
- Starting GPS co-ordinate
- Starting time
- Habitat type
- Substrate
- Weather over last 24 hours
- Trackers name
- Distance between of spoor sample (spoor frequency)
- Number of individual cheetah at each spoor sample, with an estimation of sex and age where possible
- Total distance covered
- Distance / time / day

Thus when designing a survey the following should occur: The transect design should incorporate existing tracks that are suitable for detecting spoor and should be some distance apart (three to five kilometres). The vehicle should be driven at about 13 km / hour along these transects with a tracker sitting in a specially modified chair mounted at the front of the vehicle, or two trackers standing on the load body or side of the vehicle. The spoor of all the larger carnivores, and possibly ungulates (unless their densities are too high to make it practical) should be counted. Only spoor that is 'fresh' (estimated to be less than 24 hours old) should be collected, as older spoor is not be used in the analysis (older spoor can be collected as a measure of dispersion, etc.). When encountered, the species, group size, age and sex of the large carnivore spoor should be determined. 'Spoor frequency' is the number of kilometres per spoor (Stander 1998).

**Sampling Intensity**

It would be wise to start data collection during dedicated sampling periods (open) or on a weekly basis for approximately two months (closed) initially, and then check how precise the estimate is in order to plan the sampling programme for the duration of a year (a year is thought to be the longest time needed to survey an area sufficiently). The coefficient of variance (CV) of the mean spoor interval (frequency) is a good measure of how precise the estimate is, and has been found to level off at 15 – 20%, which equates to approximately 30 spoor samples (Stander 1998). If there is a levelling off then the decision to terminate sampling could be taken. If there is no indication that the CV has started to level off then there will be a need to either continue or adjust to a different (monthly) collection schedule.

The determination of substrate suitability will be necessary at the beginning of the project. It is important to take into account the soil in the areas and the ability to pick up spoor, as well as the habitat and seasonal weather conditions in that area that can effect spoor identification. It is possible that in an area of varying substrate suitability that transects are laid out specifically along roads / tracks of more suitable substrate, provided that these still conform to a random pattern. The accessibility due to roads or lack thereof, or farmer permission and gate access are possible constraints to be considered.

**Implementation in the Field**

In order to implement this technique in the field, this procedure should ideally be tested and a calibration determined from a minimum of two areas of known cheetah populations. By knowing the number of cheetah in a given area, a regression from the spoor located in a given amount of time should be able to accurately determine a mathematical formula that describes the relationship.

**Calibration**

The calibration of this technique will be dependant on the techniques of other counting methods.

**Analysis of Data**

In the case of small data sets, the spoor interval data could be exposed to bootstrap expansion. The coefficient of variation is determined by randomly taking 2,4,6,8…..n samples from the data and determining the mean of that result.

## 2. ACCURACY AND PRECISION

Spoor counts as an index of population size is thought to be valid, given a calibration exercise to prove the mathematical relationship. In the event that a calibration exercise is not conducted it should be a reliable measure of population trend. This confidence is due to the relatively low CV's (15 – 20 %) already obtained in other studies (Stander 1998, Funston 2001).

Through the use of replication (3 sampling periods) and regression there should be a means of estimating confidence intervals for this index, assuming the variance associated with frequency approximates the variance of estimate. The studies conducted to date suggest that the relationship between this index and abundance is linear, but that the slope of the curve is affected primarily by the substrate (affecting detectability of spoor), but also possibly by cheetah dispersion and movement patterns in different areas.

The index-abundance relationship has been found to vary between areas (Kalahari versus Serengeti soils), because spoor detectability is affected by substrate. The index is also possibly sensitive to measurement error due to the trackers ability to accurately detect spoor, but this can be tested during a training and evaluation exercise.

**Advantages**

A lot of data are collected at minimal effort and cost, which can generate a lot of information and moderate statistical power. It is important not to gather too much information causing you to spend more time and resources than is required to get the amount of data needed for a one-year study period. That is why the collection should be weekly for an initial period of two months, the coefficient of variance should then be checked to determine if you can proceed at that rate or need to make adjustments to the sampling protocol.

It is a general and widely workable model that can be adjusted via calibration to accommodate the variety of substrate, movement and habitat types. This formula needs to be calculated with known cheetah populations, and then a working census formula can be developed.

### 3. COST AND TRAINING

| | | |
|---|---|---|
| Initial start up costs: | Vehicle | US$ 10,000-15,000 |
| | Computer | US$ 1,000 |
| | GPS | US$ 500 |
| Running Costs: | Wages for two trackers and one assistant | US$ 6,000 |
| | Fuel | US$ 10,000-12,000 |
| Calibration Costs: | These costs will be determined by the other census techniques used to collect the data, which will also contain an initial start up cost. | |

It will be important to have the analysis done by an external statistician who is familiar with the formulas and techniques used to answer the appropriate questions asked from the data collected. After the initial formulas have been determined it should be possible to train a qualified member of the staff to plug in the appropriate data to get the results you are looking for. If an external analyst is used it would be wise to cross train them in the field methods used so they can better understand what data are being collected and how, so they can make adjustments in the methods or calculations as is needed.

### 4. TRAINING / CAPACITY

Communication and assessment of the trackers' abilities is probably the most important issue in order to collect data that will give an accurate account of the population.

It will also be important to find a qualified analyst who can give advice on techniques required to correctly analyse the data to answer the question of population density.

Infrastructure - this exists but needs to be expanded depending on the area. There is collective experience in most areas, and there are people from the community that have the skills to be effective trackers. It will just take time to find and refine them to the needs of the project.

**Plenary session comments and discussion**

- Concerns were raised about determining the accuracy of the tracker's ability.
- Issues pertaining to the possibility of double counting spoor when using fence line counts were raised, this should be accounted for with consistency of data collection and regression.
- A simple linear model is not suitable because of regression problems. As yet there is no evidence to suggest that as cheetah density increases so spoor density also increases in a linear fashion e.g. surveys done by Funston and Durant in the Serengeti suggest that spoor may not increase with increased cheetah density when extrapolations are made from Funston's Kalahari surveys. This may be a mathematical trend or merely a function of lower spoor delectability in the Serengeti substrate.
- The need for a technique for closed area mode.
- Use of capture sites located on farms or in other areas for a given period of time to be able to compare number of captured cheetah to amount of spoor found to be used for calibration.
- Get estimate and indices of what is out there.
- Several designs to use and develop for different data collection
  - Fence line
  - Random sites
  - Known areas where cheetah presence is known
- Need calibration design for any spoor study?
- Need to find people who can use formulas necessary for data analysis.
- Calibration can only be done through direct counts for accurate estimates of true density.

- Given facts of different designs, at the same time as doing direct counts, need to do a sampling of spoor to calibrate spoor count for that area.
- Use either random or stratified design.

Two designs

Fenced-closed
Open areas-no fences

Roads

Identify road network and define into known transects.
Sample each transect at a consistent and known time frame.
Not too often but not so far you do not get enough kilometres covered so sample weekly or monthly.

Stratified random design based on tracks should be implemented.

# WORKING DOGS FOR CONSERVATION

**Group members:** Amy Dickman (Cheetah Conservation Fund, Namibia) Steve Bircher (St. Louis Zoo, USA), Megan Parker (Working Dogs Conservation, USA, Botswana).

### 1. SURVEY DESIGN

The Ngorongoro Conservation Area is used as an example of a survey design as the technique is area specific.

Aims of the study could include diet, demographic information, endocrine examination, etc. For higher resolution, the number of animals in the group would require intensive sampling over a small area to try to capture the entire population. To determine presence or absence, one transect through a very large area may be appropriate. Scale of the area and objectives will determine the study design. Cost estimates are given here for the most expensive means of estimating population size, which is individual identification through DNA analysis (mark recapture analyses). One must remember that these costs could be considerably reduced if there is a reliable means to relate scat density to population size.

Estimates of a dog / handler team working 20 – 50 km transects / week were based on information from Tanzania. If a resident male cheetah's territory is approximately 35 $km^2$, transects may be setup approximately 8 km apart. Transects can run perpendicular to roads if road / spoor count data are to be compared. Scat encounter rates will determine the time and relative effort of the teams. Based on a captive feeding trial using a Gemsbok fed to a coalition of 3 male cheetah, scat production rates = 5.8 scats / individual over 1.5 days. NB. The Serengeti Cheetah Project has noted a much lower scat production rate of close to an average of 1 scat per day.

Transect length 5 – 10 km.
Distance between transects – 8 km? - looking to cover a single territory.
Teams work 5 days / week.
Area covered / week = 50 – 100 $km^2$
One month trial should be done for four areas within a region (to be re-sampled again next month).
800 $km^2$ covered in two months.

Transect width (effort as well as area actually covered by the olfactory range) is dependent on environmental conditions at the time e.g. wind, substrate and vegetation. In theory, a dog working in a two kilometer transect may be sampling 2 km upwind, sampling a 4 $km^2$ area. In contrast to a visual road survey of spoor count, the area is simply the width of the road or track.

Analyses: Variable line distant sampling, presence / absence, DNA extractions allow mark recapture statistics. Diet analysis can use Monte Carlo simulations to help estimate the number of scats necessary to determine diet and population size (Francesca Maruco, M.S. ms)

### 2. ACCURACY AND PRECISION

Is the index valid? Not proven on cheetah in Africa yet, although Smith *et al* have worked through demographic data using DNA on kit fox. Wasser *et al.* (2004) on bear, which were sampled in successive years. DNA would allow mark recapture estimates over time to detect change. Otherwise, would need to develop faecal counts for cheetah in a habitat with known population parameters. Megan Parker has tested dogs on cheetah in Montana to prove whether cheetah scat is appropriate for dog work and found the dogs responded quite well, working > 100 meters to source. Consumption of the scats by Coyotes (*Canis latrans*) was a problem in the training area.

The technique is able to estimate confidence intervals through controlled trials (captive or known scats which are placed blindly for the handler), or by testing in a known population, such as testing against other methods.

The relationship between the index and abundance can be determined in a known population or DNA can be used in a mark/recapture analysis. In the case of a scat count, you would assume it holds a relationship with abundance of individuals; however it would be necessary to assess the way in which the estimated age of scats and longevity of the scats can vary between different areas (validation trials in particular environments).

Whilst such relationships vary over time and space, as does detectability, it may be possible to compensate for thick vegetation, versus open savannah, or in wet seasons, by working the dog on trucks, narrowing distance between transect legs, etc. or increasing sampling intensity in tougher environments. It is important to know rates of faecal decay – wet season versus dry.

How sensitive? It depends on sampling efforts and whether the same areas are re-sampled over time. If faecal decay rates are very slow, animals that died from rabies epizootic for example 5 years ago may be found. DNA analysis compensates for some of these issues and hence is more sensitive.

Sampling errors can be determined by controlled trials showing differences between individual dogs / handlers. Environmental conditions can also contribute to sampling errors which is also measurable by 'observer bias' controls, by training and measuring in various winds, temperatures, habitats, etc.

Score – we thought 5 due to incredible sensitivity possible, but plenary felt 4

**Bias**
Bias should be measured during training and include both dogs and handlers, as mentioned above. Bias should be considered when testing against other census methods; such as capture bias, hair snags, bait stations, etc. Dogs have not proven to be sensitive to gender, age or status (except in wolves, when uncut male dogs may avoid alpha wolf scat), but it should be considered.

**3. SUITABILITY**
This method can be used across a wide variety of habitats and regions but may require modifications, i.e. working a dog / handler team from a vehicle, working the dog closer to the handler, using orienteers spotting for predators, etc. Dogs work well in most conditions ranging from desert to marine to mountainous environments.

Limitations to suitability may be political, in obtaining permits to work in protected areas, on private land, etc. Even the perception of a team of people with a dog may be problematic in national parks (Yellowstone for instance).

Calibrating the efficacy and accuracy of the dog in each region is important and can be tested using controlled trials. Feasibility of the method can be assessed in each region based on both the physical and political climate.

To increase the cost effectiveness and suitability of this technique, layering of more than one carnivore species per dog can be used in detection and location. By surveying for a suite of predators rather than a single species, the dog would be rewarded more often which helps to maintain motivation in areas of widely distributed animals, and there is likely to be increased buy-in from other researchers, government agencies and interested parties, as well as information on relative abundances (with prior trials to understand passage rates, decay rates, etc.)

**4. COST ISSUES**
**Capital Costs:**
Vehicle - US$10,000
Dog (trained with handler) - US$5,000
Kennel facility - US$400
Crate and misc. dog equipment - US$100
Freezer or drying racks for faecal samples - US$200 - 400?
Total capital costs = US$15,700

**Running Costs:**
Dedicated handler for two months - US$2,000
Orienteer - US$800
Petrol, maintenance for vehicle - US$200
Food, care, veterinary care, vaccines – US$100 (covering vaccinations for 2-3yrs)
DNA laboratory costs for microsatellite with shipping to U.K. US$60 – 200 / faecal sample thumb-suck estimate of 100 faecal samples = US$6,000-200,000.
Total running costs for two months = US$3,100, plus DNA analyses
Range = US$25,000 – 39,000.

Plenary thought our cost estimates were high, and scored this 3. Estimates ARE high, to buffer unforeseen expenses, like the fact we forgot to budget for a GPS.

**5. TRAINING / CAPACITY**

- Initial training requires international support but local capacity can be built for handling dogs and orienteering.
- The programme Mark or Capture would be used for statistical analyses and training can be done on-line or gathered within country.
- Genetic analyses can either be done in or out of country.
- Only infrastructure required is building a leopard-proof kennel.

# CAMERA TRAPS TECHNIQUE (Photographic capture-recapture)

**Group members:** Kelly Wilson (De Wildt Wild Cheetah Project, South Africa), Maurus Msuha (TAWIRI, Tanzania), Rebecca Klein (Cheetah Conservation Botswana, Botswana), Charles Foley (Wildlife Conservation Society, Tanzania), Ullas Karanth (Wildlife Conservation Society, India) and Samuel Antanje (Kenya Wildlife Services).

## 1. SURVEY DESIGN

This survey design can only be used to cover a relatively small area, not at a national or regional level. However an area of a particular habitat type could be surveyed and the results extrapolated to other similar habitats.

Three main criteria need to be considered when using this method:
1) Minimum home range size of animals being trapped.
2) How many traps one can afford.
3) Length of trapping period with the assumption of a closed population.

**Cheetah Home Ranges:**
Females with cubs are assumed to have the smallest home range, followed by territorial males, and then dispersing animals. The smallest female home range was estimated to be 150 $km^2$ – this in an area with a good prey base

**Number of traps:**
Two traps are needed per female range (every 150 $km^2$). Because female ranges overlap considerably by approximately 50%, assuming that one camera trap is required for every 75 $km^2$, thus 20 traps are needed to cover an area of 1500 $km^2$. One camera trap consists of two cameras and one tripping device.

**How long should trapping last?**
Assuming one is monitoring a closed population, if trapping occurs over too long a period, there will be turnover (mortality, emigration etc.) within the cheetah population. We assumed that a closed population period for cheetah is 60 days (a period of 40 days is generally used for Tigers).

**When should trapping occur?**
Throughout the year, though it may be limited during rainy season due to accessibility (and the possibility of rain triggering the camera traps)

**Trap spacing:**
Spacing should be based on smallest female range which (with overlap) has been identified as 75 $km^2$. The researcher should then identify the most promising areas for trapping cheetah within the study area. If there are 20 camera traps, 40 or 60 potential sites should be identified to give a range of choice for site placement. These site locations should be mapped out, to ensure that there is at least 1 trap in a 75 $km^2$ area. Traps can then be placed in those locations in the field.

There is a trade off between recapture time versus area covered. One can either keep all traps in one area for 60 days (the duration of a closed population), or one could move traps between three different areas and leave them in each area for 20 days. It is best to try to maximise the number of individuals rather than the number of re-captures.

## 2. ACCURACY AND PRECISION

This method estimates abundance directly rather than an index – assuming one obtains a sufficient sample size. If individuals cannot be recognised, then capture-recapture analysis cannot be used, and instead a less accurate trapping rate index is obtained.

In order to maximise capture probability, locations of traps should not be random, and should instead be selected based on knowledge of cheetah use of an area. This requires a lengthy period of familiarisation with the study area before trapping can begin. Where possible local expertise should be used to expedite this process.

**Where to put traps?**

- Waterholes (although may get many different animals photographed)
- Scent marking posts (can create male bias)
- Holes through fence-lines
- Roads
- Baiting (urine, scat, shiny objects)

Kelly's experience with camera trapping to date has delivered the best results from cameras placed at marking posts and in roads where cheetah tracks are frequently seen. Most photographs have been taken at dawn, dusk and after nightfall.

Positioning of the cameras is crucial. Cameras must be placed to maximise probability of photographing cheetah. Cameras need to be placed 3.5 to 5 meters away from path on either side. cheetah can be funnelled into the path by cutting and brush packing vegetation if necessary. It may be necessary to turn camera off during the peak traffic periods if the camera is placed on a road. However, this should be avoided as far as possible to avoid missing animals, e.g. females in Serengeti inclined to be more diurnal than territorial males. Another option for this method is to concentrate on males (e.g. trapping at scent marking posts) and then calculate population based on sex ratios. This is because males are generally easier to trap as they frequently use scent marking posts.

Obtaining pictures from tourists and tour operators in a protected area can be another form of capture / recapture. In very open areas such as the Serengeti, researcher or tourists photographing an area can be used instead of camera traps; this however would only be applicable in well visited areas where cheetah are habituated.

## 3. SUITABILITY OF METHOD

This is a research technique for key areas rather than country wide monitoring. It is useful for providing a benchmark for a country (or a large area) and also in presence / absence surveys. This method is more applicable in areas with higher density of bush so animals can be funnelled towards traps. In open areas such as the Serengeti, cheetah often move randomly over the landscape so it would be very difficult to find areas for setting traps. Temperature does not seem to be a factor influencing camera operation. However avoid the rainy season with certain traps.

Theft is a major issue on non-private land, or non-protected areas. If theft is a problem this technique should not be used. However one can try to reinforce the camera, hide the camera or lock camera to trees. There can be a problem with large animals destroying the camera but placing cameras in steel boxes can help prevent this.

Data from Kelly's surveys were analysed by Ullas after the workshop. Results were promising and statistically significant. With an increased number of camera traps and the improved survey design – as discussed at the workshop - the data will become richer, showing that this method is definitely feasible for cheetah.

## 4. TRAINING / CAPACITY

- Training needs are few; the most time consuming is finding the best locations to put cameras and this may take several weeks to several months.
- Learning to set camera traps takes one week.
- Learning to identify individuals from photos takes one week.
- Sample design takes 3-4 days.
- Statistical expertise: this can be done by the researcher following a cookbook of data analysis with some expert advice.
- The analysis software 'CAPTURE' is freely available from the internet.

## 5. COST ISSUES

**Equipment:**
Passive traps - US$400-$500
Active - US$750
In dry areas – active traps are better
In wet areas – passive traps are better
For 20 units between US$10,000 - US$15,000

Manpower required – 2 people for 10-15 cameras. (4 people needed for a study – US$500 to US$1000)
Vehicles 1 or 2
Fuel and maintenance US$4000
Film and processing costs US$15 per film (20 traps use 100 rolls for 2 months US$1500)
Researchers salary US$1000
GPS: US$250

If using capture-recapture from tourist or research photographs:
Can see 90 cheetah in 60 days – tapping into tourist sightings
Vehicle 3000km x 80cents = US$4000
Research salary US$1000
Camera US$2000
Computer US$1000
GPS US$250

# PHOTOGRAPHIC SURVEY TECHNIQUE

**Group Members:** Gus Mills (SANPARKS / EWT, South Africa), Victor Runyoro (Ngorongoro Conservation Area Authority, Tanzania), Henneke Louwman (Wassenaar Wildlife Breeding Center, Nertherlands), Jerome Kimaro (TAWIRI, Tanzania), Jack Grisham (Smithsonian National Zoo, USA) and Mary Wykstra (Conservation Cheetah Fund - Kenya)

### 1. SURVEY DESIGN

Develop a programme that can be replicated in different regions using a photographic survey and analysis of the cheetah population in a given region. This can include photos supplied by tourists, local people, guides and researchers, to get a rough idea of population dynamics, demography, and presence. If it were done as a census technique it would need to be done over a specific time; with concentrated efforts in certain areas over certain times and with proper analysis in place.

To be used as a capture / recapture technique there must be a specific goal and time period selected. It is best if these can be determined prior to the survey. Over very large areas the photo submissions taken over a longer time can be divided into those received at certain times (i.e. Kruger National Park survey taken over a year can be divided into segments in time and region).

1. Goals of this type of survey can include:
    a. Presence / absence
    b. Baseline population estimate and monitoring programme
    c. Demography
    d. Develop awareness / participation

2. Methods

a. This technique is most effective in places where tourism is practiced.
    i. Clear guidelines for submissions
    ii. Intensive short-term dates if goal is to use information for a number estimate.
    iii. Countrywide photo library – central location for collecting photo submissions

b. Select launching and closing dates for submissions.

c. Promotion of the programme
    i. Posters
    ii. Pamphlets
    iii. Media – radio, magazines
    iv. Internet
    v. Newsletters
    vi. Workshops to tour guides
    vii. Thank you for submissions
    viii. Competitions prizes

d. Specify data handling
    i. Submission
    ii. Data entry / handling – including thank-you letters.
    iii. Analyse / report writing

e. Tour operator training – if conducted in parks
    i. Conduct workshops to inform tour operators of the project and create excitement in their participation.

f. Rural community training if community involvement
    i. Conduct workshops for involved parties.

**How to implement the survey?**

a) Employ person / team.
b) Design the programme.
c) Promote the programme.
d) Collect and analyse.

**How to analyse the data?**
Rarefaction to determine adequate sample sizes and for the analysis of the data. Matching software for individual identification.

## 2. ACCURACY AND PRECISION

**Is the index valid?**

- With rarefaction will determine the saturation point.
- Matching software would be the key in identification usage in the tourism photo campaign.
- It depends on accessibility and ability of the photographers and habituated animals.

**Is there a means of confidence?**
Yes, through rarefaction (saturation point).

**Is there a reasonable and quantifiable means of detecting trends?**
Will depend on the approach and difficult to determine when a change is significant. It can be tested statistically, provided it meets the criteria for rarefaction.

**Is there a straightforward relationship between index and abundance?**
Yes, as we are aiming for total counts.

**Does your index-abundance relationship vary between areas and / or over time?**
No

**How sensitive is the index?**
High – real differences.

**Is the index sensitive to measurement error?**
When depending on tourists only yes due to accessibility to on road areas only. If combining with requests to other researcher or community submissions the error would probably be less.

## 3. SUITABILITY

This technique lends itself well to high tourist impact areas (areas of habituated cheetah) and open habitats. Should not be used as a means of counting in areas with low numbers of tourists such as outside protected areas (only useful for determine presence / absence).

Calibration is not essential as the model is the means of calibration – photo matching and rarefaction can be used.

Nationwide – not high
Regional - limited

## 4. COST ISSUES

(Every 3-5 years – initial costs are high, but can be used in multiple surveys.)

| | **START-UP** | **ONGOING** |
|---|---|---|
| Researcher salary | US$6000 | US$6000 |
| Vehicle | US$10000 | |
| Vehicle running costs | US$10000 | US$10000 |
| Accommodation for researcher | US$500 | US$500 |
| Computer facilities +digitalizing submissions | US$2500 | |
| Digital camera | US$1000 | |
| Printing posters / pamphlets | US$2000 | US$2000 |
| Promotion | US$1000 | US$1000 |
| Communications (phone / radio) | US$1000 | |
| GPS | US$1000 | |

TOTAL COST: US$34,000

ONGOING COST: US$20,000

If using this as a long-term project the vehicle costs would be higher. As an ongoing project the value of this method increases.

**5. TRAINING / CAPACITY**
**What training is needed?**

- Project manager would need some background in conservation / biology and computer skills.
- Driving skills and community relations needed if the survey extends beyond tourist surveys into distribution of cameras in rural areas for the presence / absence.
- Most of these skills would be available to in-country staff.
- Some external statistical advice would be needed if being used as a large-scale survey method - informal.
- Necessary infrastructure does exist.

**ADDITIONAL NOTES:**
Useful technique for actual population estimates (Park Surveys):
**Kenya** – All parks, reserves, major private sanctuaries.
**Tanzania** - Serengeti, Tarangire, Ngorongoro, Mikumi, Selous, Mkomazi
**South Africa** – Kruger, Kalahari, Hluhluwe Umfolozi
**Namibia** – Etosha
**Botswana** – Okavango, Chobe
**Zimbabwe** – Hwange, Mana Pools
**Zambia** – Luangwa, Kafue
**Uganda** – Northern region

- Nation wide presence / absence and to some degree demographics and trends – pilot project in Kenya "Snap-A-Cheetah" distributing 500 one time use cameras in rural communities.
- No one person can see all the cheetah, but many people can cover the whole park.
- Needs a good road network and good coverage.
- Gaps in tourist areas are filled by rangers / staff and other methods.
- Capture / recapture – fitting this into a sampling period can provide survival rates when repeated surveys are conducted.

# PLENARY SESSION COMMENTS AND DISCUSSION

Open plenary sessions were held in which working groups presented their discussions and conclusions to the entire group. A chart was developed which listed the techniques on the Y-axis and the criteria across the X-axis with the consensus-derived scores filling the blocks in the middle (technique prioritisation table below with 1 being least appropriate and 5 being most appropriate).

### Technique prioritisation table compiled by all workshop participants

| Techniques | Accuracy / Precision | Suitability | Cost | Training |
|---|---|---|---|---|
| Direct counts: | | | | |
| ▪ Visual counts | 5 | 1 | 3 | 1 |
| ▪ Tagging | 4 | 1 | 2 | 1 |
| Atlas / Questionnaire / GIS | 2 – 3 | 4 | 3 | 4 |
| Spoor Counts | 4 | 4 | 5 | 5 |
| Working Dogs | 4 | 3 | 3 | 2 |
| Camera Traps | 4 | 3 | 2 | 4 |
| Photographic Surveys | 4 | 3 | 4 | 5 |

In plenary, a discussion was then held to list the factors or criteria that will determine the circumstances under which a technique may be chosen. The list below represents the factors that would be taken into account in determining which technique best suits a particular situation:

Factors used to determine which technique is the best to use or should never be used:

A. Presence / absence and monitoring trends / determining numbers
   1. Presence / absence (detection / non-detection)
   2. Assessing numbers using indices
   3. Assessing population size / density
   4. Assessing vital rates

B. Human use
   1. Tourists
   2. Cheetah hunting
   3. Hunting of other species

C. Land-use
D. Habitat structure
E. Substrate
F. Fenced / unfenced
G. Legal status of land
H. Roads / infrastructure
I. Cheetah density / prior knowledge of cheetah in the area

Keeping these factors in mind, the techniques where then described in terms of their suitability to the conditions. They were rated according to when the technique would either never be used or would be best suited for use, according to the factors or criteria listed above.

Circumstances under which a particular technique would be the technique of choice:

### 1. Direct Counts / Visual Counts

Why use this technique?
To determine population size and assess vital rates

**When this technique will be most effective**
Where cheetah are more habituated
Open habitat
Small team of people is available

When the presence of cheetah is known

**When never to use this technique**
Do not see cheetah frequently (not sighted often)
Where the cheetah are persecuted
When researchers can not access certain areas or land

### Direct Counts / Tagging

Why use this technique?
To determine population size, assess vital rates and population using indices.

It should be noted that this technique needs clear objectives.

**When this technique will be most effective**
Reasonable chance of catching cheetah
Where permits will be granted or are not necessary
High recovery rate for previously captured cheetah
Prior knowledge of distributions is available

**When never to use this technique**
Where you cannot catch and release
When the area is difficult to access

### 2. Spoor Counts

Why use this technique?
When determining Presence / absence and monitoring trends / determining numbers.
1. Presence / absence (detection / non-detection).
2. Assessing numbers using indices.

In calibrating, you could include assessing population size / density

**When this technique will be most effective**
High “detectability” of tracks e.g. sandy environment

Suitable tracks
When direct visual counts are not possible
No prior knowledge is available

**When never to use this technique**
When off road driving is not feasible and/or when access to suitable areas for counting spoor is not available e.g. management regulations or rugged terrain

### 3. Working Dogs

Why use this technique?
When determining Presence / absence and monitoring trends / determining numbers.
1. Presence / absence (detection / non-detection).
2. Assessing numbers using indices.

And if DNA analysis is available
3. Assessing population size / density.
4. Assessing vital rates.

A pilot study is presently being undertaken in Kenya and usefulness of the technique will depend on the results of this pilot study.
Disease transmission must be mitigated, protocol *in prep*. Megan Parker.

**When this technique will be most effective**
In the dry season or dry area in relatively open areas

**When never to use this technique**
Permit problems

| | |
|---|---|
| Advantage in low density areas<br>Where cheetah are not habituated<br>No prior knowledge is available | Where there is no security for the handler and dog |

### 4. Atlas / Questionnaire / GIS data

This technique should be used as a baseline study and not as a study technique on its own – it should be used to indicate areas of needing further work.

Why use this technique?
When determining Presence / absence and monitoring trends / determining numbers.
1. Presence / absence (detection / non-detection).
2. Assessing numbers using indices on a local scale.

| **When this technique will be most effective** | **When never to use this technique** |
|---|---|
| No prior knowledge<br>Large spatial scale<br>Quick assessment required<br>Fragmented land-use areas with limited access for more detailed studies<br>Stakeholders with knowledge about cheetah<br>Should be within a GIS framework | Does not determine number of the population<br>No people present or area is not visited often |

### 5. Photographic Surveys

Why use this technique?
When determining Presence / absence and monitoring trends / determining numbers.
1. Presence / absence (detection / non-detection).
4. Assessing vital rates

Could be a by-product for
2. Assessing numbers using indices.
3. Assessing population size / density.

| **When this technique will be most effective** | **When never to use this technique** |
|---|---|
| High tourist presence<br>Good road network or open areas – good access to the area<br>Habituated cheetah | Low tourist presence |

### 6. Camera Traps

Why use this technique?
When determining Presence / absence and monitoring trends / determining numbers.
1. Presence / absence (detection / non-detection).
2. Assessing numbers using indices.
3. Assessing population size / density.
4. Assessing vital rates.

| **When this technique will be most effective** | **When never to use this technique** |
|---|---|
| Need areas of intensive use by cheetah to place traps or ability to "capture" cheetah<br>Need prior knowledge of cheetah movement<br>When cheetah are shy and not easily seen<br>Where theft and vandalism to equipment is absent<br>Where access is limited | Open / uniform is not recommended<br><br>In a wet habitat<br>Increased rate of theft and vandalism |

<u>Ullas Karanth recommendations:</u>

It should be noted that although each area may be assessed using different field techniques, the central statistical problem is the same as stated below.

Using different field techniques we try to estimate N, the true number of cheetah to the count statistic C we obtain in the field by estimating the detection probability P. This can be expressed as the general equation:

$N = C / P$

Two most powerful families of estimating P (and hence N) reliably are: distance sampling and capture recapture sampling.

I believe several of the field techniques detailed in this workshop can be modified analytically to suit these two sampling approaches, thus increasing the reliability and rigor of the estimates.

<u>Prey-cheetah density relationship discussion:</u>

Data collected in Namibia indicate a positive correlation between prey and cheetah density. Extrapolation of cheetah densities from prey densities could be biased in areas where cheetah are persecuted. This could result in a lower cheetah density than would be expected from the observed prey density. It is suspected that in areas of larger prey densities that conflict with humans would be decreased.

# GLOBAL CHEETAH MONITORING WORKSHOP 2004

## 1 – 4 June 2004

**Ndutu Safari Lodge, Ngorongoro Conservation Area**

## WORKSHOP REPORT

## SECTION 5

## REGIONAL REPORTS – TASK 2

# Regional Working Groups

The entire group convened for an open discussion in which the countries represented were listed and split into working groups, namely: Namibia, Tanzania, Kenya, Botswana, Zimbabwe and South Africa.

Participants then re-grouped according to their regions, with Zimbabwe and Botswana being grouped together due to their similarities and low numbers of participants. In plenary, a discussion was held to determine a set of questions which each regional group should answer, taking into account the recommendations and information yielded over the previous two days, and which will assist in determining the census methodology/ies of choice for that region.

The following questions were posed which were answered in working groups:

1. Assess which areas in your region / country **ARE** being covered in a monitoring programme.
2. What methods / technique(s) are being used?
3. Are the methods the most appropriate and if not, would you change them?
4. What would you change them to?
5. Actions: Please consider:
   - What obstacles do you foresee implementing a new technique?
   - What needs do you have in implementing a new technique?
   - Who would be responsible for / able to implement the new technique?
   - Timelines
6. Should the methodology of the current technique, if chosen to stay, change and how?
7. If different techniques must be used, can they be calibrated?
8. Assess areas in your region / country which **ARE NOT** covered by any monitoring programme.
9. Prioritise the “new” areas to be covered and list them in this order.
10. What technique(s) would be best (use guidelines of 6 techniques) to implement in these new areas?
11. Actions: Please consider:
    - What obstacles do you foresee implementing a new technique?
    - What needs do you have in implementing new technique?
    - Who would be responsible for / able to implement the new technique?
    - Timelines
12. If different techniques must be used, can they be calibrated?

# Namibia Regional Report

**Group Members:** Arthur Bagot-Smith, Amy Dickman, Laurie Marker, Harald Forster, Ullas Karanth

**1. Areas being covered**

Split into Protected Areas (PAs), commercial / freehold land and communal land for consideration:

1. Protected Areas
   Etosha – radio-tracking ~1994-1996 and tourist sightings, ongoing – analysed 2003 for the Atlas.
   Now – tourist sightings continuing
   Other Protected Areas – Skeleton Coast - sightings from Ministry, incorporated into Atlas
   All Parks with officials should have reported to Atlas
2. Commercial
   Central / north-central region – intensive studies
3. Communal
   All regions – sightings into Atlas but no intensive studies

**2. Techniques being used**

- Interviews, mainly in north / north-central regions.
- Atlas – sightings report data (spatial distribution) across country.
- Radio-tracking in Etosha, also mainly in north / north-central regions. There is a potential of using radio telemetry data in some areas for calibrating spoor counting data.
- Mark-recapture (tagging and release, also genetic analysis) in north / north-central regions.
- Spoor counts in north / north-central regions.

**3. Appropriate methods / changing**

- Interviews are a good start to obtain baseline data.
- Sightings are good to continue monitoring the broader picture but not for density estimates.
- Radio tracking appropriate for collecting intensive information but has now ceased in some areas. Could have used tourist photos in Etosha.
- Tag and release appropriate for ongoing monitoring, demographic parameters, and lots of additional information, education and outreach.
- Spoor tracking has the potential for trends but needs to be calibrated.

**4. Changing techniques**

Etosha – potential for tourist photos
North-central farmlands – aim to use long-term intensive data to calibrate less intensive methods to be used on regional, national and international scales however may need calibration in other areas as well. Expanding spoor counts, trialling use of working dogs and use of camera traps.

**5. Actions**

<u>Etosha</u>
**Obstacles:** No obvious obstacles.
**Needs:** Collaboration between Large Carnivore Management Association of Namibia (LCMAN), Namibia Professional Hunting Association (NAPHA) and Ministry of Environment and Tourism (MET) to initiate.
**Implementation:** Co-operation needed – implemented by Ministry and LCMAN.
**Timeline:** start 2005.

<u>Commercial farmlands, especially north-central regions</u>

(a) Spoor counts – Cheetah Conservation Fund (CCF) and Okatumba Wildlife Research: calibrate with existing data and expand further into region
**Obstacles:** Survey design to be developed
**Needs:** Statistical and analytical support
**Implementation:** CCF and Okatumba responsible and able
**Timeline:** later 2004

(b) Use of working dogs - CCF
**Obstacles:** Getting good dog / handler teams and funding.
**Needs:** Pilot study and study design, statistical and analytical support
**Implementation:** CCF with Working Dogs for Conservation
**Timeline:** early 2005 (begin process end 2004)

(c) Camera traps - CCF
**Obstacles:** Survey design. Aim to use information gathered from dogs and other sources to determine where traps should be placed
**Needs:** include funding, camera traps, statistical and analytical support
**Implementation:** CCF
**Timeline:** start late 2005

<u>Communal areas</u>
Pool and analyse information
**Obstacles:** Lack of existing communication network
**Needs:** Effective communication
**Implementation:** LCMAN, NGOs, MET
**Timeline:** begin 2004

**6. Changing existing methodologies**
Radio-tracking is expanding to incorporate GPS collars, with the aim of gathering more intensive information about spatial ecology, daily movements and range use. This information could then be used to assist decisions on where to place camera traps or conduct other survey techniques.

Spoor tracking – change study design from transects on single farms to across multiple farms, and also possibly use dogs to detect spoor. More work is also planned on correlating existing cheetah spoor data with results from long-term population monitoring, as well as spoor counts for prey and other species.

**7. Use of different techniques**
New techniques can be calibrated, especially with the data available from the north-central region.

**8. Areas not covered by monitoring**
Aside from Atlas reports:
1. Southern half of country, although cheetah density probably is low.
2. North-eastern areas, including communal areas and protected areas, e.g. Bushmanland, and protected areas such as Khaudom and Caprivi reserves.
3. North-west e.g. Damaraland, also resettled areas.

Both in the NE and NW regions the cheetah density are low or unknown – possibly increasing in NW region.

**9. Priority areas**
1. North-west  2. North-east  3. Southern

**10. Best technique for use in new areas**
Use of questionnaires
Spoor counts / use of working dogs

**11. Actions for new techniques**
Obstacles: lack of existing resources, infrastructure, communication network
**Needs:** Funding, collaboration
**Implementation:** LCMAN
**Timeline:** 2005

**12. Calibration**
As above, techniques can be calibrated from existing data or from planned pilot studies, although it will be difficult to calibrate in a particular area without good knowledge of the cheetah population size in that area.

# Tanzania Regional Report

**Group Members:** Sarah Durant, Maurus Msuha (rapporteur), Karen Laurenson, Alex Lobora, Jerome Kimaro, Steve Bircher, Jack Grisham, Charles Foley
Sultana Bashir (Facilitator & rapporteur)

**Areas being covered**

1. Local Scale – Serengeti National Park
2. National Scale

**Techniques used**

1. Local Scale – Serengeti National Park.

a) Direct visual count.
b) Photographic surveys through the Cheetah Watch Campaign, which was piloted in Serengeti.

2. National Scale

a) Extension of Serengeti Cheetah Watch Campaign to all other national parks where cheetah may occur and Ngorongoro Conservation Area (NCA). No cheetah in Gombe, Rubondo and Udzungwa.
b) Requests for interested individual's sighting records (through questionnaires) through the Tanzania Carnivore Atlas Programme.

**Appropriate methods / changing**

1. <u>Local Scale – Serengeti National Park</u>

Direct visual counts (total counts) remain appropriate so long as we are seeking to gather more information than numbers from the Serengeti plains population. However, if at any point objectives were scaled down to just monitoring, then photographic surveys may be more appropriate as they are less costly than doing direct visual counts. Photographic surveys are likely to be more appropriate than any other technique for the Serengeti receives a high number of tourists. The Tanzania Cheetah Conservation Programme through the Tanzania Carnivore Centre could implement these. Timeline: to be determined.

**Obstacles / Needs:** None for the direct visual count. See below for the photographic surveys.

**Calibration:** Techniques can easily be calibrated in Serengeti. A photographic survey was piloted here to test its effectiveness given that there are reliable estimates of the cheetah population on the plains from direct visual counts.

2. <u>National Scale - Extension of Serengeti Cheetah Watch Campaign to national parks and Ngorongoro Conservation Area (NCA)</u>

**Appropriateness, Obstacles / Needs:**
This technique is useful on a national scale to compile a baseline dataset and in areas with high tourist numbers. The technique is therefore probably likely to be most effective in northern parks and the NCA. The Tanzania programme is running a National Cheetah Watch Campaign that seeks to gather photos from tourists across Tanzania. This scheme was piloted in Serengeti where, after an initial good response rate in the first two years, the response rate has dropped radically. The response rate from the rest of the country is pretty low. We are not entirely sure why this is the case, but we think it may be because we need someone on the ground to promote and motivate visitors and tour guides. This, however, is costly and time-consuming. In the first two years of the pilot in Serengeti, the Serengeti Cheetah Project had a Tanzanian Msc student (and Park Warden) who was regularly talking to visitors and tour guides at the Visitor Centre and the main park entrance gate. This was probably helping to motivate visitors and their guides to send in photos. Other potential obstacles have been the delay in setting up and expanding a website to provide feedback on cheetah sightings to contributors.

**Obstacles:**
Improving the response rate and motivating people to send in their photographs of cheetah sightings. The method is not appropriate for areas where tourist numbers are low and / or where it is difficult to see cheetah.

**Improvements:**

- Learn from the South African experience of conducting photographic surveys in Kruger and Kalahari National Parks.
- Currently developing posters to increase awareness about the campaign.
- Increased targeting of tour companies and tour guides by staff from the Tanzania Carnivore Centre
- Improving website and reducing delay in posting information on the website

2. National Scale - Requests for interested individual's sighting records (through questionnaires) through the Tanzania Carnivore Atlas Programme.

**Appropriateness, Obstacles / Needs:**
Probably too limited on its own in the long-term but could help build up baseline in the absence of any information and could supplement photographic surveys and other methods. However, there is a need to review this in future as too little time to assess its effectiveness. Takes time to build up network of contributors and sightings

**Improvements:**
As with photographic surveys, to improve and develop links with potential contributors, both within national institutions, (e.g. Tanzania National Parks (TANAPA), the Wildlife Division and Universities), tour companies and known wildlife enthusiasts.

**Alternative Techniques / Calibration on National Scale:**
We agreed that surveys and questionnaires have great potential in the absence of any information to develop some baseline information, but we would need to overcome existing obstacles regarding response rate. Also in some areas such methods are limited by poor visibility and / or shy cheetah and / or limited tourism. There is the perennial problem that such methods can only confirm presence, while lack of reports from an area doesn't confirm absence. Therefore such methods would probably have to be complemented by other techniques. The method can potentially be calibrated for plains habitat using the Serengeti Cheetah Project's long-term direct monitoring data.

**Priority areas:**
The group first agreed on the following objectives:

1. To establish baseline information on the distribution and abundance of cheetah in different habitats.
2. To set up systems of monitoring threats and abundance in areas with potentially viable cheetah populations.
3. To determine what, if any, conservation action is required in areas with potentially viable cheetah populations.

The group agreed to first prioritise areas outside national parks partly based on the assumption that cheetah populations in such areas are likely to be safe in the immediate term (although this might not be a valid assumption in all areas) and also because even less is know about cheetah outside the parks. Agreement was then reached to target areas neighbouring national parks where cheetah may be moving between parks and adjacent areas, which currently may have cheetah-compatible land-uses (i.e. pastoralism), but which may require increased protection or other strategies to ensure the long-term survival of cheetah in such areas (these areas also have the potential for the development of ecotourism). The group also considered the different habitat types within which cheetah occur in Tanzania. Finally, the group acknowledged an inherent bias in all our discussions due to increased knowledge of northern Tanzania within the group and lack of representation from southern Tanzania. Three priorities for surveys were identified by the group as follows:

**Priority No. 1 – Miombo Woodland**
The group agreed, that the top priority was to survey cheetah in miombo woodland habitat as some 50% of Tanzania's cheetah are reported to occur in such habitat, but little is know. Two potential sites

were identified, one in lowland miombo, such as in the Selous Game Reserve, and one in highland miombo, as in the Ugalla-Katavi Game Reserves.

Best technique: Spoor count survey or the use of sniffer dogs depending on the outcome of the imminent trials in Kenya of the latter technique.

**Obstacles:** Access-related issues (permission from Wildlife Division could be problematic especially for dogs; a good network of tracks is required for spoor surveys, etc). The technique is logistically difficult and costly to implement in terms of equipment, travel, trained manpower and time. It was estimated that at least US$10,000-15,000 is required for spoor survey assuming a vehicle is available. A sniffer dog survey would be even more costly.
**Needs:** Training in use of both techniques will be required.
**Implementation:** Under oversight of the Tanzania Carnivore Centre – possibly Amy Dickman as part of her PhD work.
**Timeline:** At least 18 months to start of survey and some 3-5 months to conduct survey.

**Calibration:** Could possibly calibrate spoor surveys and photographic surveys in Ruaha National Park which is also Miombo, which has similar habitat to the Selous, but would be difficult. Historical data are available for Selous but mainly for other carnivores.

**Priority No. 2 – the Masai Steppe**
The Masai Steppe was identified as a potentially key area for cheetah (and other wildlife) in national parks in northern Tanzania. Many species, including cheetah, currently move between parks and neighbouring pastoralist areas. For example, much of the recruitment in the Serengeti plains cheetah population in recent years has been from the neighbouring Ngorongoro Conservation Area. While there are many reports of cheetah from the Masai Steppe, comprehensive information is lacking on the status of cheetah in this area including current and future threats.

Three discrete areas for survey within the Masai Steppe were identified as follows in order of highest importance:

1. The Simanjiro Plateau neighbouring Tarangire National Park. This area was considered top priority because it is the most threatened part of the Masai Steppe due to agricultural expansion and other changes in land-use.
2. West Kilimanjaro.
3. The area between Longido and Natron

Best techniques:

a) Spoor survey
b) Sniffer dogs, again, depending on outcome of Kenya's trials.
c) Potentially photographic surveys targeting tourists and hunters, providing the cheetah in these areas are not shy.

**Obstacles / Needs:** Largely the same as for surveying miombo woodland (i.e. access, finance and capacity) but logistically much easier and therefore likely to be cheaper. For example the Simanjiro Plateau could easily be surveyed within six weeks once money was raised and permissions obtained.
Implementation: To be overseen by the Tanzania Carnivore Centre. The Serengeti Cheetah Project would probably be closely involved.

**Timeline:** About 18 months to start of survey.

**Calibration:** Assume comparable to the Serengeti plains as similar habitat. Spoor surveys and photographic surveys are being calibrated in Serengeti.

**Priority No. 3 - Moyowosi-Kigosi Game Reserves**
Cheetah are known to occur in this swampy grassland habitat but we know nothing about them. Terrain is difficult and logistically this would be a very difficult area to survey. The group decided there was no point in discussing techniques and other aspects yet as it would be best to wait until the first two priority areas had been surveyed. It was not feasible to organize a survey for this area within the next two years in any case.

# Zimbabwe and Botswana Regional Report

**Group Members:** Rebecca Klein (U.K., Botswana), Ann Marie Houser (U.S., Botswana), Nettie Purchase (Zambia, Zimbabwe), Megan Parker (U.S., Botswana) Megan Parker scribe.

For Botswana, current research lies in the following areas:

| **Area:** | **Assessment:** | **Methods:** |
|---|---|---|
| Area 1 – Jwaneng | 20 K ha game<br>Resource and tribal lands<br>Communal cattle farms | Spoor counts along fence lines<br>Tagging and radio collaring<br>Questionnaires<br>PAC records |
| Area 2 - Ghanzi | Game and cattle farms<br>Commercial farms | Questionnaires<br>PAC records |
| Area 3 – Tuli Block | Game, cattle and commercial farms | Questionnaire<br>PAC records |

<u>Botswana Jwanang Park</u>
Areas for improvement: Researchers feel that the techniques are applicable but spoor counts should be calibrated. Air support is necessary for their radio collaring efforts. They need local community officers for tribal lands in place

**New methods:**
- Spoor counts, especially calibrated against other methods and known populations.
- Working dogs for presence / absence and demographic data, dogs would work best to identify initial survey areas, and then obtain further demographic information.
- Camera traps
- Direct counts

**Obstacles:**
- Costs associated with implementing current and new methods.
- Costs for camera traps
- Would prefer longer-term volunteers – reduce training time and observer bias, consistency, etc. This project relies heavily on volunteer effort.
- Manpower – this project is adding new methods and adding assistants and longer-term volunteers.

<u>Area 2 and 3 Ghanzi and Tuli Block</u>
Questionnaires are appropriate for presence / absence data.

**New Methods:**
- Will start radio collaring this year, tagging
- Other 'new' methods will be implemented after testing in area 1 (Jwaneng).
- Pilot studies with spoor and dogs may be trialled for presence / absence data.

**Obstacles:**
- Return rates, credibility of some information for questionnaires
- Lack of GIS expertise
- Costs for aerial support, radio collars, dogs, training, infrastructure

In Zimbabwe, research is being conducted in these areas:

| Area: | Assessment: | Methods: |
|---|---|---|
| Area 1 - Southern low veldt | Commercial farms<br>Conservancy<br>Resettlement<br>Communal | Questionnaires, both direct and indirect<br>Hunting returns and applications for pelt export<br>PAC records |
| Area 2 – Hwange | | Radio collaring<br>Tourist sightings |
| Area 3 – Matusadona | | Radio collars<br>Tourist sightings<br>Spoor counts |

<u>Zimbabwe area 1</u>
Questionnaires are appropriate for presence / absence data but no density nor demographic data.

New methods are needed for any additional data:

- Working dogs for presence / absence and density, demographic data
- Radio collars (GPS / satellite)
- Predictive mapping of distribution (feedback from methodology)

**Obstacles:**

- Changing access due to land tenure and cultural issues.

**Areas not covered by monitoring**

**Botswana:**
Protected areas have never been studied. Kgalagadi was surveyed in late 1990's by spoor count (Paul Funston).

**Zimbabwe:**
No current bias toward land-use by studies, as commercial, communal and protected area lands are being surveyed.

Both of these projects were started due to conflict issues on farmlands.

Prioritization for future areas:

**Botswana:**
Okavango Delta and northern Botswana – different habitats, land-use. Recommended would be two studies for comparisons of protected areas (Moremi, Chobe, Magkadigkadi, to livestock, tribal areas and game farms). Predator competition, viable populations, behaviour, demographics, etc.

Another priority area is along the Zimbabwe / South African border, where cheetah move across border areas with unknown implications, population size, conflict issues, etc. Reports from Kelly Wilson are that cheetah are being trapped along the South African border and sold for zoo and private collections. Botswana may be providing a source population in this area, drawing from central Kalahari, Tuli Block, and cattle ranching areas in eastern Botswana.

Protected area methods:

- Radio collaring – 3rd effort
- Spoor – 1st effort
- Tourist surveys – 2nd effort
- Camera traps – 2nd effort

Outside protected areas:

- Similar techniques to southern Botswana
- Questionnaires / atlas / GIS – 1st effort
- Apply best practices after testing in southern Botswana

**Zimbabwe:**

Protected areas need more work:

- Mana Pools
- Gonarezhou
- Tuli area, including non-protected lands contiguous to Tuli Block in Botswana.

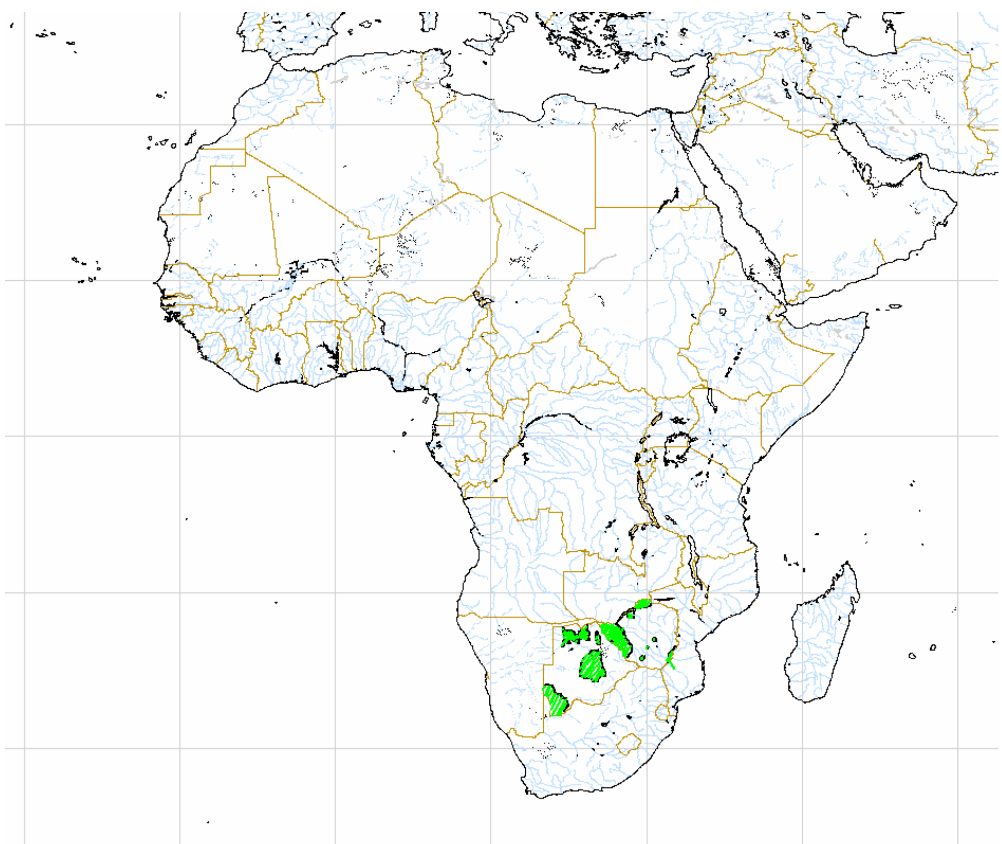
Methods:

- Spoor counts (calibration would be difficult but for p/a and trends) – 1st effort
- Camera traps – 2nd effort

We don't foresee any problems working in these areas. Endangered predators are a priority with governments. Implementing new techniques require calibrating, which is possible.

Manpower and funding are eternal issues for implementation. Ideally studies would run for 5 years, but a minimum of 2 years.

Different techniques for spoor counts, camera trapping and detection dogs can be calibrated for all areas between countries. Funding might be shared in this way also.



**Graphic 1:** The map shows protected areas in Zimbabwe and Botswana

# Kenya Regional Report

**Group Members:** Hadley Becha, Samuel Andanje and Mary Wykstra

**1. Areas being covered**
Nakuru, Mara, Machakos, Laikipia, Tsavo, Marsabit, Kajiado, Samburu, Taita

Background: 1989-90 Paule Gros (report 1998)

Take Note:
* A nationwide search of Kenya Wildlife Services (KWS) incident / occurrence and information system is being conducted. Reports are kept by KWS Game Stations (District), Ranger Outposts (Division, Location – need based), and Headquarters (Park Locations). The goal of this operation is to look at presence / absence and level of cheetah / human conflict.

* A nationwide campaign requesting photo submissions from tourists has also been launched. This was originally targeted as a presence / absence campaign, but can possibly be used in future capture / recapture methods.

**2. Techniques used**

a) Baseline using #2 Atlas / Questionnaire method: Nakuru (CCF / KWS), Mara (KWS), Machakos (CCF [underway] / KWS), Laikipia (CCF [underway] / KWS), Tsavo (KWS-report pending), Marsabit (KWS), Kajiado (KWS).
b) Direct Count Visual (Photo ID): Mara (KWS), Samburu (under-way), Taita (under-way).
c) Photo Survey: Mara (launched in 2002), Nation wide (launching soon).

**3. Appropriate methods**
The technique is appropriate, as data needed is for presence / absence data and the best approach is through questionnaires, data searches and photo campaigns.

**4. Changing techniques**
What would you change? - More posts are needed for identifying presence / absence data in the estimated range areas and focused demographics could be launched in areas of known populations / core areas.

**5. Actions**
**Obstacles:** Resources in terms of finances and equipment.
**Needs:** Resources
**Implementation:** Data Resource Centre – easily accessible.
**Timelines:** Undetermined

**6. Changing existing methodologies**
As baseline presence / absence data is needed in some areas, the Atlas / questionnaire method is necessary. In other areas, presence / absence data have been collected and in these areas more focused studies should be undertaken.

**7. Use of different techniques**
Yes, use of past info and other regions.

**8. Areas not covered by monitoring**
As cheetah populations exist throughout Kenya it is necessary to cover the majority of Kenya by determining presence / absence and density. Cheetah have been seen from the Indian Ocean beach to the main runway at Jomo Kenyatta Airport. Pockets of cheetah population occur in human populated regions, the issues are not the absence of cheetah, but identifying areas worth targeting for future research and awareness / education campaigns

Areas of non-essential research would be eliminated from the study: Kisumu, Kakammega, Nandi Hills.

**9. Priority areas**
Method #2 – Atlas / Questionnaire / GIS

**Priority 1**: Presence / absence / baseline estimates – use to fill in the gaps where focused studies have already been done.

- Amboseli, Lake Magadi, Nairobi, Kajiado
- Mara, Nairobi, Nakuru (gap areas)
- Marsabit, Maralel

**Priority 2**: Less infrastructure, but still a high need for data – Presence / absence / baseline estimates.

- Tana river, Ijara, Lamu, Garissa and Garissa District
- Turkana,
- Nasolot, South Turkana, Kamnarok, Baringo, Bagoria
- Wajir, Mandera
- Meru Conservation Area, Kora, Rahole

**Priority 3**: Less likelihood of sustainable cheetah populations, high human numbers.

- Ruma (from Masai Mara)
- Shimba Hills (South of Tsavo)

General comment: Sampling representative areas.
Seeking trends: Especially changes in land-use.

**10. Best technique for use in new areas**
Method #6 and #1: Detailed demographics needed based on baseline surveys already done.

]* Incorporate spoor counts to predict trends in decline of cheetah. Useful tool for international predictions in land-use changes and park distribution areas where pastoral usage still exists.

- Mara – In process (KWS – photo ID and tagging, CCF Tourism campaign).
- Samburu – In process (Save the Elephant – only in Samburu / Buffalo Springs and nearby ranches).
- Tsavo, Kitui, Chyulu (Proposed need).
- Machakos (Proposed tagging / collaring).
- Taita / Rukinga (near Tsavo an individual volunteer has started photo ID).

Proposals are being developed for further GIS and telemetry tracking – the idea is to look at Park dispersal cheetah and problem animals.

There are implications for capture / recapture (#5) and tagging (#1) in certain areas.
- Machakos / Nairobi / Kitengela,
- Laikipia,
- Tsavo / Amboseli [Masai area].

**11. Actions for new techniques**
**a. Obstacles:**
- Finances and equipment: Vehicles, running costs, Equipment purchase.
- Regional disparities (tribal, political issues, safety).
- Human land-use – (differs in each region identified – overcome in different way.
- Extensive areas of coverage.
- Infrastructure, accessibility, communication
- Language barrier

**b. Needs:**
- Personnel

- Funding – Transport, Equipment
- Plan – Way forward

**c. Who would be responsible?:**

- Coalition – KWS, EAWLS, CCF
- Need for central data base with easy accessibility
- Need for coordinating party – KWS?

**d. Timelines:** Need for plan and funding to set the timelines. Personnel available to start immediately with new areas. Current studies should have reports by 2004 -2005.

**12. Calibration**

Yes it can be done.

# South Africa Regional Report

**Group Members:** Paul Funston, Gus Mills, Deon Cilliers and Kelly Wilson

| Areas being covered | Techniques used |
| --- | --- |
| Kruger National Park | (Photo survey) |
| Kgalagadi Transfrontier Park | (Photo survey and spoor counts) |
| Reintroduced populations on small reserves | (Direct counts) |
| Limpopo Province | (Atlassing, telemetry, camera traps) |

**Appropriate methods / changing**

Generally YES, but need to focus more on following:

- Atlassing project for whole country
- More cameras for camera trapping
- Incorporate spoor counts into camera trapping design

**Areas not covered by monitoring (Ranked)**

1. Limpopo Province
2. Northern Kwa-Zulu Natal
3. North-West Province
4. Northern part of Northern Cape

Note: regions in these provinces where cheetah are free-roaming.

**Proposed Action Plan**

Phase 1: Research Programme

A current investigation is underway to compare and investigate appropriateness of the following techniques for surveying cheetah on ranch land in Limpopo:

- Camera trapping
- Telemetry
- Questionnaire survey
- Spoor counts (to be initiated)

Phase 2: National Monitoring Programme

This phase will consist of two initiatives to be conducted over a ten-year period.

- National atlassing programme.
- Extensive camera trapping survey, incorporating a sample design with one yearly sampled area to determine population size and survival rates, and nine sample areas that will be surveyed every third year. It is estimated that it will take a total of three months to survey each area.

**OBSTACLES**

Phase 1:

- Financial resources for purchasing of equipment are limited.
- Man power, could be overcome with improved financial resources.

Phase 2:

- Most capital outlay in the form of equipment would be done during phase 1.

**SYNOPSIS**

It would seem that in South Africa cheetah are well conserved within two large national parks as well as several smaller game reserves and conservancies. In the last decade there has been a marked increase in the number of smaller areas that conserve cheetah, often accepting cheetah that are removed from ranches as so-called problem animals. There is also a large but undetermined population of cheetah that still persists in commercial ranching areas. Although large strides have been made in creating awareness and tolerance of cheetah in certain areas, several intolerances still persist. In terms of assessing population trends these perceptions have not been overtly helpful in determining either abundance or trend information.

# GLOBAL CHEETAH MONITORING WORKSHOP 2004

## 1 – 4 June 2004

### Ndutu Safari Lodge, Ngorongoro Conservation Area

## WORKSHOP REPORT

### SECTION 6

### REGIONAL GROUPS DISCUSSIONS – TASK 3

# Gap Analysis and Priority Area Survey

Countries known to contain cheetah but which are not represented on the Global Mammal Map of Africa include:

Algeria
Angola
Benin
Botswana
Burkina Faso
Cameroon
Central Africa
Chad
Congo Democratic Republic
Egypt
Ethiopia
Iran
Kenya
Malawi
Mali
Mauritania
Mozambique
Namibia
Niger
Senegal
South Africa
Sudan
Tanzania
Uganda
Zambia
Zimbabwe

Data indicates that West African countries may have small, isolated populations of cheetah but no accurate information exists on how many or where exactly these are.

Many North and Central African countries are at war therefore there is a lack of data on these regions.

Countries with no data include Mozambique, Angola, Zambia, Malawi, Uganda, Central Africa Republic, Congo Democratic Republic of the Congo, Chad, Sudan and Benin.

Data extracted from Marker, L. 1998. The current status of the cheetah (*Acinonyx jubatus*) In: Penzhorn, B.L. (Ed) 1998. Proceedings of a Symposium on cheetahs as Game Ranch Animals, Wildlife Group of the South African Veterinary Association, Onderstepoort, 23-24 October 1998. (Appendix 2)

The group decided that due to the vast areas of unknown cheetah distribution in Africa, there is a need to prioritise countries that have the potential to sustain large populations of cheetah as well as countries with active cheetah conservation projects.

**Priority Areas with the potential to sustain large populations of cheetah:**

***Action:*** Contacts will be identified in these areas and contacted to join the Global Cheetah Forum list server and increase communication (Global Cheetah Monitoring Workshop Report and CDs).

The following countries were identified and set as priority areas:

1. **Zambia** – most cheetah populations enjoy some level of protection in formally protected areas and therefore the focus should be on protected areas (e.g. Kafue, Laungwa north and south, Luwa). Determine population estimates for larger parks.

***Action:*** Make contact with Lusaka and work with them to set goals and objectives

2. **Mozambique** – Cross border data could be collected between Mozambique and Tanzania. Information is needed on start-up projects within Mozambique on other species and further progress should follow on from this. Population was estimated at 100 individuals (1988).

***Action:*** EWT / Fórum para a Natureza em Perigo (FNP) Antonio Reina to facilitate making contact and collection of info in this area.

3. **Chad, Ethiopia and Sudan** - Need to determine baseline distribution patterns and population numbers, taking into account the lack of infrastructure and ongoing political unrest.

***Action:*** Contact Sahelo-Saharan Interest Group (SSIG) so determine presence and absence of cheetah within the countries.

4. **Algeria** – Two people doing research in that area, an amateur naturalist that lives in the area and an Antelope Biologist who has been doing research in the area.

***Action:*** Laurie Marker to contact the local Forestry Department. Possible survey in future

5. **Iran –** Have presence / absence data. Need population size and habitat data.

***Action:*** Gus Mills, Laurie Marker to contact WCS and Sultana to contact Iranian Cheetah Society.

# GLOBAL CHEETAH MONITORING WORKSHOP 2004

## 1 – 4 June 2004

### Ndutu Safari Lodge, Ngorongoro Conservation Area

## WORKSHOP REPORT

## SECTION 7

## APPENDICES

# Appendix 1

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# Appendix 2: The Endangered Wildlife Trust and CBSG Southern Africa

Endangered Wildlife Trust

The Endangered Wildlife Trust (EWT) is one of the largest non-governmental conservation organisations in southern Africa and was established in 1973. Widely recognised by its prominent red cheetah spoor logo, the EWT conserves biodiversity through the hands-on conservation of threatened species and their habitats, in a sustainable and responsible manner. Coordinating more than 90 field-based conservation projects and with 18 specialist Working Groups operating throughout Southern Africa, Endangered Wildlife Trust programmes cover a wide variety of species and eco-systems and play a pivotal role in conserving southern African biodiversity and natural resources.

The Endangered Wildlife Trust with its access to a rich and diverse range of conservation expertise established CBSG Southern Africa in partnership with the CBSG, SSC / IUCN in 2000. Nine CBSG regional networks exist worldwide, including CBSG Indonesia, India, Japan, Mesoamerica, Mexico, Sri Lanka, Europe and South Asia. Regional CBSG networks are developed in regions requiring intensive conservation action and each network operates in a manner best suited to the region and local species. CBSG tools are adapted according to the needs and requirements of regional stakeholders and species and local expertise is utilised to best effect. Each regional network has developed its own unique conservation identity.

CBSG Southern Africa's mission is: *To catalyse conservation action in southern Africa by assisting in the development of integrated and scientifically sound conservation programmes for species and ecosystems, building capacity in the regional conservation community and incorporating practical and globally endorsed tools and processes into current and future conservation programmes*.

CBSG Southern Africa, operating under the banner of the Endangered Wildlife Trust is a non-profit, non-governmental organisation, serving the needs of the *in situ* and *ex situ* conservation community in southern Africa through the provision of capacity building courses, species and organisational Action Planning, Population and Habitat Viability Assessment (PHVA) and Conservation Assessment and Management Planning (CAMP) workshops, communication networks, species assessments and a host of other CBSG processes for species and ecosystem conservation. CBSG Southern Africa works with all stakeholders in the pursuit of effective biodiversity conservation throughout southern Africa.

Contact CBSG Southern Africa on +27 (0)11 486 1102 / cbsgsa@ewt.org.za / www.ewt.org.za/cbsg

CONSERVATION BREEDING SPECIALIST GROUP
SOUTHERN AFRICA

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# Appendix 4: Current Status of the cheetah

Cheetah as Game Ranch Animal Symposium – South Africa Veterinary Association, Onderstepoort Faculty of Veterinary Science, 1998

Laurie Marker, Director, Cheetah Conservation Fund, August 1998 (global captive population updated 2004)

ABSTRACT

The status of the cheetah, (*Acinonyx jubatus*), varies widely in the 32 countries listed in this report. All populations are classified as vulnerable or endangered by the World Conservation Union (IUCN) and are regulated by the Convention for International Trade in Endangered Species of Wild Fauna and Flora (CITES) as Appendix I. There are 13 countries listed in this report where the cheetah has become extinct during the past forty years. The wild cheetah is nearly extinct in Asia, with approximately 100 cheetah surviving in small-pocketed areas through Iran.

Free-ranging cheetah inhabit a broad section of Africa including areas of North Africa, Sahel, eastern, and southern Africa. The two strongholds remain in Kenya and Tanzania in East Africa and Namibia and Botswana in southern Africa. Although there has not been a comprehensive survey of African cheetah since 1975, there is a consensus that the cheetah population is declining throughout Africa. Since 1991, and up-dated regularly, Cheetah Conservation Fund has made contact with researchers in cheetah range countries and has tried to keep communication open about cheetah populations in those countries. From the information gathered, it is approximated that less than 15,000 cheetah are found throughout their range, with a low estimate of 9,000 animals and an optimistic estimate of 12,000 animals.

Perhaps for the cheetah, though, individual numbers of animals may not be the important point, but the numbers of viable populations still existing. Viable populations may be found in only half or less of the countries where cheetah still exist. The cheetah has suffered a devastating decline of available habitat and prey, both necessary for its survival. In addition, the species does not do well in protected game reserves due to competition with other large predators, and the captive population is not self-sustaining but is maintained through imports of cheetah from the wild population.

CURRENT STATUS

The status of the cheetah, (*Acinonyx jubatus*), varies widely in the 32 countries listed in this report. All populations are classified as vulnerable or endangered by the World Conservation Union (IUCN) and are regulated by the Convention for International Trade in Endangered Species of Wild Fauna and Flora (CITES) as Appendix I [16], which bans international commerce and sporting trophies. There are 13 countries listed in this report where the cheetah has become extinct during the past forty years. Only in two or three countries are cheetah populations considered only threatened and are killed legally if found to be in conflict with human interests. In 1992, at the CITES meeting, quotas were set for export of 150 animals from Namibia, 50 animals from Zimbabwe, and 5 animals from Botswana, as live animals or as trophies[16].

Five subspecies are considered valid by most taxonomists [80]. But this should be changed or condensed in the future, as the validity of the existence of sub-species is questionable. Genetic research has shown the genetic distance between two subspecies *A. j. jubatus* and *A. j. raineyi*, is trivial, 10 to 100 times less, for example, than the genetic distance between human racial groups [69].

The recognized subspecies are as follows:

NORTH AFRICA AND ASIA:

*Acinonyx jubatus venaticus* (Griffith, 1821): Algeria, Djibouti, Egypt, Mali (northern), Mauritania (northern), Morocco, Niger (northern), Tunisa, Western Sahara.
On the Asian continent: Afghanistan, India, Iran, Iraq, Israel, Jordan, Oman, Pakistan, Saudi Arabia, Syria, Russia and the Commonwealth of Independent States.

WEST AFRICA
*Acinonyx jubatus hecki* (Hilzheimer, 1913): Benin (northern), Bukina Faso, Ghana, Mali (southern), Mauritania (southern), Niger, and Senegal.

CENTRAL AFRICA
*Acinonyx jubatus soemmeringii* (Fitzinger, 1855): Cameroon (northern), Chad, Central African Republic (northern), Ethiopia, Nigeria (northern), Niger (southern), and Sudan.

EAST AFRICA
*Acinonyx jubatus raineyii*: (Heller, 1913) Kenya, Somalia, Tanzania (northern), and Uganda.

SOUTHERN AFRICA
*Acinonyx jubatus jubatus*: (Schreber, 1976): Angola, Botswana, Democratic Republic of Congo (southern), Mocambique, Malawi, South Africa, Tanzania (southern), Zambia, Zimbabwe.

HISTORIC DISTRIBUTION
The cheetah was widely distributed throughout Africa and Asia. Cheetah were originally found in all suitable habitats from the Cape of Good Hope to the Mediterranean, throughout the Arabian Peninsula, and the Middle East, from Israel to India and Pakistan, and through the southern provinces of the Russia and the former Commonwealth of Independent States.
Cheetah have become extinct in at least 13 countries over the past 50 years. These countries and the year of extinction are as follows:

1. Djibouti: Believed to be extinct (not a party to CITES). Although in 1990 private people could still buy cheetah skins and live cheetah cubs in the market place. These skins and live cheetah are thought to be coming from Somalia and possibly eastern Ethiopia [81]. Skins are still available in large numbers.
2. Ghana: Believed to be extinct. The Mole National Park had a small population in the reserve as of 1975 [93].
3. India: Extinct in 1952. Last known cheetah found in Hyderadad in 1951 and Chitoor in 1952. Indians were importing cheetah from Africa to be used as hunting leopards in 1929 due to the rarity of local cheetah [29, 93, 18]. There has been talk of reintroducing cheetah back to India, but availability of prey species and unsuitable habitat are limiting factors. A captive breeding effort may be launched.
4. Iraq: Extinct (not a party to CITES). Last sighting in 1950.
5. Israel: Extinct. Last report of cheetah was in 1956 [47, 57]. There have been thoughts of re-introduction of cheetah into the Biblical Wildlife Reserve of the Negev Desert [47, 57].
6. Jordan: Extinct. In 1935 many skins were still sold in Be'er Sheva'. May still have been found in Negev Desert, the Palestine Mountains, Sinai Desert, and Trans Jordan until the late 1940's[29].
7. Morocco: Extinct. Were still found up to 40 years ago in the mountainous regions of the country bordering the Sahara [93].
8. Nigeria: Extinct [20]. Skins are found for sale in the public market in Lagos which are probably coming from the countries north of Nigeria [87].
9. Oman: Extinct (not a party to CITES). Last sighting in 1968 [93], probably lived on until the early 1970's on the Jiddat al Harasis Plateau, Dhofar province [71].
10. Russia and the former Commonwealth of Independent States: Considered extinct as of 1989. No confirmed sightings in the past few years, a small expedition looked for cheetah during the summer of 1989 but no animals or tracks were seen [22]. Cheetah existed in many areas until the 1940's and 1950's when their prey, the goitered gazelle, was reduced drastically from over-hunting. Some cheetah were believed to have moved down into Afghanistan when the goitered

gazelles conducted a permanent move southward. In the 1960's and 1970's the last cheetah existed in parts of Turkmenia and Uzbekistan (east and west of Murgab, east of the Caspian sea, and in the Badkhyz Preserve). In these areas they lived mostly on remnant populations of goitered gazelle and arkhar sheep, saiga antelope, kopet-dag sheep and hares [43, 73, 34, 22, 84, 17, 83]. In 1972 it was suggested that the cheetah be listed as a living monument and very strict international laws be proposed to save the last of the Asian Cheetah. The Commonwealth would like to reintroduce cheetah into areas with sufficient prey populations such as the Ustyurt Plateau of Uzbekistan. We have suggested that before they introduce African Cheetah they wait until the genetics have been run on the Asian Cheetah in Iran.

11. Saudi Arabia: Extinct (not a party to CITES). Four cheetah shot in 1950 near Saudi, Jordan, Iraq border intersection [29], last cheetah in the country probably lived on until the 1970's in the remote parts of Rubrquote Al Khali desert [71].
12. Syria: Extinct (not a party to CITES). Oil pipeline worker killed one of the last cheetah in the Syrian Desert in 1950 [29], the last cheetah lived on until the 1960's in the eastern temperate Syrian steppe (Badiyat ash sham) near Khabur river [71].
13. Tunisia: Believed to be extinct. Formerly found in the region of Chott el Djerid and the desert south of Tatahoume [93]. Last cheetah sighted and killed was in 1968 near Bordj Bourguiba in the extreme south [19]. Last Tunisian Cheetah lived until the 1970's in the Alfalfa-endash Acacia steppes at the North of the Hammada El Homra, near the Libyan border [71]. Re-introduction of cheetah back into Tunisia may occur in the next few years in Bou Hedma National Park, which has good prey diversity [71]. According to Koen (19, 2004) these last 2 sentences are not correct – The possible return of cheetah to Tunisia may occur from Algeria from the Erg Oriental area, once dune gazelle populations increase in both countries [19] (2004). This will be very close to the future Senghar National Park – which is being gazetted in 2004.

CURRENT DISTRIBUTION

Reports on the status of cheetah in the following countries are included in this document.
In Africa, Algeria, Angola, Benin, Bukina Faso, Botswana, Cameroon, Central African Republic, Democratic Republic of Congo, Egypt, Ethiopia, Gambia, Kenya, Libya, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Senegal, Somalia, South Africa, Sudan, Tanzania, Tunisia, Uganda, Western Sahara, Zambia, and Zimbabwe. On the Asian continent, Iran and possibly Pakistan.

POPULATION-CENSUS

Censusing such an elusive species as the cheetah is very difficult, particularly since it is largely diurnal and widely roaming. Current information about the status of the cheetah in many countries, especially countries that have been engaged in long civil wars, is lacking. The following material is taken from recent literature, and where noted, from recent communications originating from researchers in the field.

From the information gathered, it is estimated that there are less than 15,000 cheetah throughout their range, with a low estimate of 9,000 animals and an optimistic estimate of 12,000 animals. Perhaps for the cheetah, though, individual numbers of animals may not be the important point, but the numbers of viable populations still existing. Viable populations may be found in only half or less of the countries where cheetah still exist.

ASIA

The wild cheetah is nearly extinct in Asia. Once widely distributed throughout Asia, the cheetah has suffered a devastating decline of available habitat and prey. A small number of Asian Cheetah still survive in small pocketed areas through Iran, and possibly in the boarding areas of Pakistan.

AFRICA

Free-ranging cheetah inhabit a broad section of Africa including areas of North Africa, Sahel, eastern, and southern Africa. The two remaining strong-holds are Kenya and Tanzania in East Africa, and Namibia and Botswana in southern Africa.
There has not been a comprehensive survey of African Cheetah since 1975, when Norman Myers calculated the African population of cheetah to be between 7,000 and 23,000 animals in 25

countries.  The population of cheetah in Africa had decreased by half since the 1960's [62].  On the basis of his research, he estimated that there would be less than 10,000 cheetah by 1980.  No new information is available to validate or refute this prediction, although there is a consensus that the cheetah population is declining throughout Africa.

Since 1991, and up-dated regularly, cheetah Conservation Fund has made contact with researchers in range countries and has tried to keep communication open about cheetah populations in those countries [42, 71].

Until more recently, the cheetah has been generally considered to be an animal of open country and grasslands.  This impression is probably due to the ease of sighting the cheetah in the shorter grass, and the long-term studies conducted on cheetah in East Africa [14].  However, cheetah use a wider variety of habitats and are often found in dense vegetation, ie. The Kora Reserve in Kenya, Botswana's Okavango Delta, and the Namibian farmlands [54].

As reported throughout Africa, cheetah are not doing well in protected wildlife reserves due to increased competition from other, larger predators such as lion and hyenas [44, 61, 59, 54, 67].  Therefore, a large percentage of the remaining, free-ranging cheetah populations are outside of protected reserves or conservation areas.

There has been limited information from North or West Africa in the form of personal correspondence with field researchers and the cheetah's future in these areas is questionable [76, 19, 64, 26, and 71].  Cheetah continue to survive in small, pocketed groups in isolated areas throughout the Sahel.  Most of these populations though can not be considered viable for long-term survival. Controlling factors are small populations, restricted habitats with a limited prey base, conflict with nomadic herders and wars that have supplied guns and ammunition's to the populace, which then poach all forms of wildlife for food and profit.

A few regional studies do exist:  David Burney reported on cheetah in Kenya in 1980;  P.H. Hamilton did a survey on the cheetah in Kenya in 1981;  Norman Myers reported on the status of cheetah in Africa, 1981; Dieter Morsbach reported on the cheetah in Namibia,  1986; Marker Kraus *et al*, followed up on the Namibian cheetah in 1996;  Vivian Wilson on the status of cheetah in Zimbabwe, 1985;  and Christopher Stuart and Vivian Wilson on the status of cheetah in southern Africa, 1988, and Paula Gross conducted surveys in several African countries from 1989-1996.

In East Africa both Burney and Hamilton found the cheetah adapting in the agriculture land in the Masai Mara region outside the national parks and were co-existing with the Narok Masai, whose stock they left alone [12, 30].  In Southern Africa, it has been reported that cheetah are killed regularly in farming areas due to their raiding of livestock and the attitudes of the farmers [61,91, 82, 11, 45, 53, 54].

Hamilton predicted that cheetah prospects in Kenya in the 1981-2000 period looked reasonable in the vast arid and semi-arid rangelands (primarily in the north) which would be the last areas to be developed.  Hamilton's premise seems to be that the cheetah is a "remarkably successful predator...supremely adapted to surviving at low densities over large expanses of often waterless arid and semi-arid lands.  Elsewhere the spread of commercial and group ranching is likely to bring the cheetah into greater conflicts with man.  The spread of illegal and legal firearms is also likely to pose a threat so long as the cheetah's skin has any value [30].

Myers believes the cheetah is less adaptable.  He says, "if its ecological circumstances start to experience persistent perturbation, the specialized nature of the species ecology and behaviour, and its genetic make-up, could leave it little able to adapt to the disruptive conditions imposed by human communities in emergent Africa" [62].

In fact, the ability of the cheetah to adapt to a changing ecological system brought about principally by conversion of its preferred habitat to farmland is perhaps the critical question in estimating the population's survivability in Africa.  In several studies over the last decade, the cheetah was reported to suffer declining numbers as land was developed and suitable habitat converted to farmland [93, 30, 62, 13, 91, 61, 52, 54]. In Namibia, the population of cheetah was halved by farmers from 1975-1987 [61], and conflict with the farming community continues [54]. In 1996, the Cheetah Conservation Fund hosted a Population and Habitat Viability Analysis Workshop (PHVA), for Namibian cheetah, in co-operation with the IUCN's Conservation and Breeding Specialist Group (CBSG), the Ministry of Environment and Tourism (MET) and local Namibia farmers. A working strategy was developed and formed the basis for MET's conservation strategy for cheetah [66]. In 1997, a working group of MET and Namibian NGO's formed the Large Carnivore Management Forum. In 1998, a country-wide census for cheetah will commence.

Wild cheetah in Africa need help. Suitable prey is becoming scarce and habitat is disappearing. They are suffering from the consequences of human encroachment, from competition with other large predators in game reserves, and not least, from the complication of a limited genetic make-up. The wild population continues to sustain the captive population [49].

HISTORY OF THE CAPTIVE CHEETAH

The similar experiences of the world's zoos have reaffirmed the traditional difficulties of breeding cheetah in captivity. Despite the capturing, rearing and public display of cheetah for thousands of years, one litter was reported in the 16th century by the son of Akbar the Great, an Indian mogul. The next documented captive reproduction did not occur until 1956 [55].

The history of the captive population of cheetah as of 1955, when it became one of the major animals exhibited throughout the world, is presented in Table 1. From 1955 to 1994, the number of world zoos holding cheetah increased from 29 to 211, and the number of animals during this 40-year period increased from 33 to 1218. Since 1955, 1763 cheetah have been imported from the wild and there have been 3512 births and 4422 deaths [49, 55].

Table A1.1 History of the Captive Cheetah Population [49]

| | **1955-64** | **1965-74** | **1975-84** | **1985-94** | **1995-2002** | **Total** |
|---|---|---|---|---|---|---|
| No. Facilities | 29-92 | 87-80 | 87-150 | 152-211 | 223-241 | 272 |
| No. Cheetah | 33-206 | 215-401 | 423-848 | 856-1218 | 1224-1340 | 1340 |
| No. Imports | 142 | 548 | 419 | 388 | 266 | 1763 |
| No. Births | 16 | 178 | 967 | 1360 | 991 | 3512 |
| No. Deaths | 121 | 382 | 1244 | 1689 | 986 | 4422 |

The captive population on 31 December 2002 was 1340 (695.644.1) animals in 241 facilities in 51 countries. Of the 1340 animals, 69% or 926 (497.429.0) were captive-born and 28% or 372 (179.193.0) were wild born. There has been a decrease of 42 animals in the number of captive-born animals in the population compared to 2001. The number of wild-born animals also decreased by 36 animals compared to the population of wild-born animals 2001 [49].

The captive population is currently maintained by a combination of imports and captive breeding [49].

The breeding programmes of our world's zoos, though, are not self-sustaining. Data indicates that a high proportion of cheetah propagation has occurred in a handful of the zoos with a majority of these facilities having only limited success; and half of the successful breeding facilities have had only a single breeding pair, or a single male or female. The captive population has had a low effective breeding size (Ne), 5% in 2002 [49], versus that of 17% in 1994 [55].

STATUS OF THE CAPTIVE SOUTH AFRICAN CHEETAH POPULATION

As of 31 December 1996, the southern African cheetah population represented 30% of the captive world population51. South Africa has the only recognized breeding facilities in Africa. The progress achieved in acquisitions and breeding, as well as the incidence of mortality and sales for the South African captive cheetah population from 1970 to 1996 are presented in Table A1.2.

Table A1: 2 History of the South African captive cheetah population [51].

| | 1970-975 | 1976-1980 | 1981-1985 | 1986-1990 | 1991-1996 | Total |
|---|---|---|---|---|---|---|
| No. Imported | 29 | 26 | 31 | 82 | 76 | 244 |
| No. Births | 37 | 184 | 127 | 133 | 291 | 772 |
| No. Deaths | 23 | 88 | 78 | 111 | 197 | 497 |
| No. Exports | 0 | 29 | 49 | 83 | 116 | 277 |
| No. Sales | 0 | 5 | 16 | 17 | 57 | 95 |
| No. Facilities | 4 | 5 | 9 | 12 | 11 | |
| No. Alive at end of Period | 46 | 143 | 204 | 166 | 221 | |

The number of facilities holding cheetah has varied between 4 in 1970 to 11 in 1996. A summary of the numbers of imports and captive births from 1970 to 1996 is presented in Table A1.2. In total, 244 animals have been imported from the wild into South Africa, 29% have come from South Africa and 71% have come from Namibia. There have been 772 captive births in 254 litters, 497 deaths occurred and 277 animals were exported out of the country's recognized South African population. Within South Africa, 95 animals were transferred, primarily due to the creation of the new Hoedspruit cheetah breeding facility [51].

Examination of Table A1.2 shows that the majority of the increase in the captive population prior to 1985, when the population reached 204 animals, can be attributed to captive births. Prior to 1985, deaths and exports remained relatively low in comparison to births. From 1986 to 1996 deaths and exports increased to off set the population growth from births during those same years. Therefore, from 1986 to 1996 the captive population increased primarily due to imports, as during this time 65% of the total wild-caught animals (primarily from Namibia) were imported into South African facilities. As of 31 December 1996, the population was 262 (124.138) animals in 12 facilities, of which 30% were wild caught and 70% were captive born [51].

REGIONAL BREEDING PROGRAMMES AND GLOBAL CAPTIVE MANAGEMENT

Regional breeding success is important to monitor as the need for co-operation increases in order to facilitate movement of animals within the regions. The success of the individual regions is important in relation to the number of animals actually living in the population. In 2002, 36% of the world's captive population was in southern Africa. By comparison, 18% was in North America and 2% of these were wild-caught animals. A larger percentage of the North American facilities were reproductively successful in part due to the American Zoo Association's (AZA) Species Survival Plan (SSP) cooperative management programme, which was developed in 1984.

As of 1996, internationally, fourteen facilities (15%) have had continuous breeding success and have produced 63% of all cubs born in captivity [55]. Thus, a relatively small number of cheetah have made a disproportionately large contribution to the captive population gene pool, for example 8 males have sired 21% of all cubs born and 12 females have produced 24% of all cubs born [55]. Several of these breeding animals are from breeding facilities in South Africa and they have produced 28% of the captive births in the world [55].

There is a substantial need to continue enhancing captive management to ensure optimal captive breeding. The implementation of management programmes such as the African Preservation Programme (APP) within the Pan African Association of Zoos, Aquariums, and Botanical Gardens (PAAZAB) are designed to facilitate cooperative management to the benefit of the population as a whole. As free-ranging populations of cheetah continue to decline, and a large amount of genetic diversity of the wild population is lost, the captive and wild populations should be managed in co-operation. In the future, in the absence of further imports from the wild, the size of the world's captive population could be expected to decline, unless there is continued improvement in captive breeding efficiency. This trend, coupled with the continuing decline of the wild population, leaves the species extremely vulnerable.

CONSERVATION

No one knows what constitutes a minimum viable population for wild cheetah. Unquestionably, the larger the population and the more broadly it is dispersed, the better placed it will be to avoid genetic failings and to endure localized epidemic mortality or widespread episodic catastrophe.

An important factor that must be taken into account, when considering the long-term conservation of the cheetah, is its lack of genetic variation. In 1981 an extensive genetic and physiological analysis of captive and free-ranging cheetah revealed that the cheetah appears to be unique among felids and other mammals in having an extreme paucity of genetic variation68. The combined genetic, reproductive, and morphological data places the cheetah in a status similar to deliberately inbred mice or livestock, and prompted the hypothesis, that in its recent natural history (perhaps dating back 10,000 years), the species had probably suffered a demographic contraction or population bottleneck necessarily followed by inbreeding [69, 70, 88, 55]. The consequences of this lack of genetic variation include reproductive abnormalities [89, 90], high infant mortality, morphological abnormalities, and a weakened immune system69, [48, 56, 32, 38], making the species more susceptible to ecological and environmental changes.

Although the species tolerates a broad range of habitat types, its essential requirements for long-term survival is for suitable prey and the reduction of conflict with humans and other large predators. These components are essential to its conservation.

CURRENT STATUS-COUNTRY BY COUNTRY

1. Afghanistan: Population. No information at this time. Possibly still a few animals in the south-west above Baluchistan, Pakistan and the Iranian border region. There is no protection for cheetah.
2. Algeria: Population. Still to be found in a few areas of south-east Algeria, between 3 1/2 E to the Libyan border and between 27 1/2 N to 20 1/2 N, with possible concentrations in Tassili N'Ajjer Range, Tassili Ahaggar, and Tassili Teffedest. Females with two to three cubs are seen regularly by tribesman. Tribesman sometimes complain when cheetah attack their camels. Rainfall was good most years from 1987-2004 in these areas, and there were increasing populations of Dorcas gazelle and Barbary sheep for cheetah to prey upon and more and more feral donkeys [19]. Because there are more vehicle use, donkeys are used less for transport, therefore, these donkeys are feral. With the good rains, the donkey numbers have increased, and may be supporting the cheetah population by providing an easy prey that is not protected [19]. It is thought that the majority of the remaining Algerian cheetah are living in the southern Algerian National Parks of Tassili and Ahaggar. Because these mountains are far more rich in water and vegetation [71]. It is difficult to see the last Algerian cheetah, native people know their presence only through their spoor / tracks [71]. This country could be a very important area for saving the North African cheetah. Principal Threats. Habitat quality, effects of drought on prey, illegal sport hunting, and conflict with nomadic herders.
3. Angola (Not a party to CITES): Population. No recent information due to the long-standing civil war. Estimate of 500 with a range of 200- 1000 animals [62]. Range was confined to the drier, arid areas in the central and southern parts of the country. In 1975 cheetah were reported in the following parks and protected areas: Iona National Park (14,500 $Km^2$), Bicuar National Park (7,900 $Km^2$), Cameia National Park (14,450$km^2$), Luando National Park (8,280 $km^2$), Quicama National Park [93]. The cheetah was declared protected game in 1957, but legislation is difficult to enforce, and the military community is exempt from these provisions of the law [62]. Principal Threats. Large scale poaching, which has helped support the long, civil war, cultivation and over grazing of cattle in the arid areas will contribute to the elimination of cheetah habitat.
4. Benin: Population. Thought to be extinct outside of the tri-country national park in the north of Benin, the Park Nationale du W, which adjoins Niger, Burkina Faso and Benin. In this park, a very small population of 2 or 3 pairs may exist [26, 23]. A few cheetah exist in and around the Pendjari complex of protected areas in northwestern Benin [23]. Principal Threat. Insufficient numbers of cheetah to sustain a viable population and lack of habitat.

5. Botswana: Population. Estimates vary between 1,000 and 1,500 [11, 52, 27, 53]. Cheetah have a wide distribution throughout Botswana, but are absent from areas of dense human settlement in the extreme south. In the northern districts of Ngami West, Ngami East, and Tutume areas, the cheetah is found throughout and is often in conflict with communal farmers who graze livestock and the commercial farmers of the Botswana Livestock Development Corporation [11]. Freehold lands make up a small percentage of the overall land base in Botswana, but appear to harbour relatively large cheetah populations [53]. This is especially true in the commercial farming areas of Ghanzi district and the Tuli Block and communal livestock areas in the south central Ghanzi district [45, 53]. Cheetah have been reported in the following protected parks and reserves: Chobe National Park (11,000 $km^2$), Moremi Wildlife Reserve (3,880 $km^2$), Nxai Pan National Park (2,100 $km^2$), Makgadikgadi Pans Game Reserve (3,900 $km^2$), Kalahari Game Reserve (24,800 $km^2$). Cheetah have been protected game since 1968 but can be shot for livestock defense even before any damage has been noted. Recent quotas set by CITES in 1992 allows for 5 animals for export. Principal Threats. Livestock farming and poaching.
6. Burkina Faso: Population. Extremely low. Estimated at 100 [62]. Perhaps only found, now, in the complex of national parks and protected areas and the tri-country national park in the eastern point of the country that borders Niger and Benin where 2 or 3 pairs exist [26, 23]. A few cheetah exist in the Singou Fauna Reserve and the adjacent proposed Arlin National Park [23]. Cheetah may now be extinct in the vicinity of Kabore Tambi National Park and the Natinga Game Ranch in southern Burkina Faso [23]. The cheetah is totally protected but enforcement is likely to be inadequate. Principal Threats. The country is under growing invasion by large numbers of nomads from the north, which has increased the pressure on the cheetah's range. Loss of habitat, poaching and insufficient numbers of cheetah to sustain a viable population.
7. Cameroon: Population. Population very small. In 1975, small populations of cheetah were still found in Benoue National Park [93, 62]. Between 1974 and 1976, a census was carried out in Bouba Nr'dijida National Park, which resulted in finding no cheetah [62]. Principal Threats. Decline of prey species, poaching and environmental degradation [62].
8. Central African Republic: Population. Still found in the south-eastern area of the country, bordering Sudan and in the southern middle of the country, bordering Democratic Republic of Congo [85, 71]. A small population still existed in Saint Floris National Park boarding Chad and the hunting domains in the north [93, 9, 71]. Principal Threats. Extensive poaching and limited prey species. Taxonomy. North Central African Republic listed as A.j. soemmeringii, there is no listing for southern Central African Republic.
9. Chad: Population. Possibly a small population still exists in the Tibesti Highlands where prey species still are abundant, and there may also be a small population in Ennedi mountains [71]. As of 1975, there was a small population of cheetah in the Zakouma National Park [93]. Principal Threats. Changing climate conditions have reduced the carrying capacity of the land and have over-burdened the sensitive environment [62]. Currently, the many years of war have armed the general population, which puts all wildlife in danger of poaching for food and profit.
10. Democratic Republic of the Congo (Zaire): Population. No current information. Estimated at 300 and could decline below 100 by 1980 [62]. Small populations found in parts of Shaba, Kasai and Kwango Provinces in the southern and southeastern part of country [62]. Kundelungu National Park (7,600 $km^2$) and Upemba National Park (10,000 $km^2$) did contain a few cheetah [62]. Principal Threats. Agricultural development, poaching and loss of habitat. Taxonomy. There is no listing for the Northern Congo population.
11. Egypt: Population. Cheetah tracks have been seen and at least 5 animals were seen around the Sitra water source in the Qattara Depression in the western and northwest parts of the country, and north of Qara Oasis. It is believed there is still a small population that remains there [24, 3, 78]. In 1994, tourism was banned in Marsa Matruh Province (where the Qattara depresion is situated) for five years to protect wildlife from poaching [71]. A proposed cheetah-gazelle sanctuary in northwest Qattara has been prepared [78]. The cheetah is totally protected, although enforcement is likely to be inadequate. Principal Threats.

Restricted habitat, possible conflict with nomadic herdsmen, and insufficient numbers of cheetah to sustain a population.

12. Ethiopia: Population. In 1975 the population was estimated to be 1000 animals and it was believed that the populations could decline to 300 animals by 1980 [62]. The cheetah was widely distributed from Addes to Djibouti in eastern Ethiopia. Also widely distributed through the southern parts of the country, between 200-1500m elevation, absent from the low lands of the Ogaden in the east, and no sightings in the north since 1937 [94]. A small population was known to be in the Danakil Reserve [62]. In 1995, cheetah were sited near Dolo [40]. Two cheetah were seen in the dry desert scrub, 100km from Dolo, by American oil company employees. The cheetah were seen on a rocky plateau. This area has a fairly large antelope prey population [40]. Other cheetah sightings have recently been in the Afder Zone, in and around the CherriHi/El Kere area, and in the Dolo region skins and live cheetah are offered for sale [40]. One cheetah from the Dolo region is in captivity at the Royal Palace as of 1996 [40]. Cheetah are protected against hunting and capture although legislation is difficult to enforce. Principal Threats. Civil war, habitat loss, extensive poaching, decline of prey, and fur trade.
13. Gambia: Population. Reported that cheetah may wander into Gambia from Senegal [6].
14. Iran: Population. Estimates of 100-200 [39] and less than 1007. Under the rein of the Shah of Iran the population was estimated at 400-450 [28, 37, 7]. As of 1998 cheetah are still to be found in very small groups in a variety of areas of this large country. A recent survey has been conducted by Hormoz Asadi showing 6 areas in the country where cheetah still exist.

a) Evidence indicates definite dispersal of cheetah from the Koshe-Yeilagh and Miandasht protected areas towards the southern Khorasan. The survey indicates that there are at least 15 to 20 cheetah in southern Khorasan and groups of 5-8 cheetah have been reported to be hunting wild sheep.
b) Cheetah are surviving in the unprotected areas in Bafgh region of Yazd province. Much of this region consists of arid mountains and population estimates are still 10 to 15 animals including the Kalmand protected area.
c) A population is in the unprotected area of eastern Isfahan where the terrain consists of vast expanses of desert, unpopulated except for herdsmen grazing goats and camels. Here livestock numbers have increased and the past gazelle population has decreased, but this region may still support 5 10 cheetah that are widely scattered.
d) A population is found in Kavir National Park and reports are frequent in this vast desert with arid mountains. The population corresponds with a gazelle population and there may still be 10 to 15 cheetah here.
e) A population exists in the Garmsar, Damghan and Semnan unprotected areas in the northern part of the plateau. Here, 5 to 10 cheetah are in conflict with growing agriculture and human populations.
f) A population is found in the Khar Touran National Park and protected area, which may possess the highest cheetah density in Iran. Cheetah reports are frequent in this vast expanse of desert where there may be 15 to 20 cheetah still alive [7]. Principal Threats. Loss of habitat, poaching, limited numbers of prey species. Direct persecution by humans, either shepherds or local hunters. They are easy targets for people in four-wheel drive vehicles and motorbike riders who chase cheetah if they see them, causing them to die of exhaustion or leave the area.

15. Kenya: Population. Estimation of 1,200 animals [30]. Species still occurs throughout the country, except in forests, montane moorland, swamps, and areas of dense human settlement and cultivation. Cheetah are absent in western Kenya, the more densely populated parts of Central Province, and most parts of the coastal strip. Its distribution coincides with the distribution of Thompson's gazelle, Grant's gazelle, and gerenuk. Cheetah occur throughout most of the arid northern and northeastern parts of Kenya. Although this area is vast and mostly unpatrolled and poaching is on the increase [30]. Populations of cheetah are found in the following national parks and reserves; Nairobi National Park (114 $km^2$), Tsavo National Park (20,821 $km^2$), Amboseli National Park (329

km$^2$), Meru National Park (870 km$^2$), Samburu-Isiolo Reserve (504 km$^2$), Kora Reserve (1500 km$^2$), Masai Mara Reserve (1510 km2), Marsabit Reserve (2088 km$^2$), Tana River Reserve (165 km$^2$). All hunting of cheetah is completely banned. Exports of live cheetah stopped in the 1960's. Principal Threats. Poaching, habitat loss, competition with agriculture and farming development.

16. Libya (Not a party to CITES): Population. Cheetah may still live around Fezzan oasis, SE of the country [71]. Little information is available. Formerly found across the south of the country, but last seen in 1980. Few cheetah have been sighted in the south west corner, in the Akakus Mountains (photo on Web Site get from Koen***), where the country borders Algeria, in the Tassili National Park [19]. Until 1969 still found sparsely throughout the country except for the south and southeast79. Principal Threats. Unknown, lack of information, presumed lack of prey species and habitat loss.
17. Mali (Not a party to CITES): Population. Estimated to be 200 to 500 [62], believed to be much less than this currently [71]. Probably a small population still exists in the north west of the country bordering Mauritania and in the south part of Adghagh nrquote Ifoga chain, where cheetah have been reported in late 1970's [71]. In 1990 skins were found for sale in Tibuta, north Mali [46]. There were a few cheetah in Gurma National Park in the 1970's [71]. Principal Threats. Decline of prey, poaching, environmental desiccation and reduction of habitat due to drought conditions.
18. Malawi: Population. Estimated at 50 [62]. Absent in southern part of the country. A small population still exists in the western parks and a few individuals around Chiperi area south of Kasurgu Park. Animals seen to be coming and going from Zambia into parks with very few resident individuals in Malawi parks. There have been sightings of individual cheetah in Nyika National Park (3134 km$^2$), Vwaza Marsh Game Reserve (986 km$^2$), and Kasunga National Park (2316 km$^2$) [27]. Principal Threats. Human population growth, loss of habitat and poaching. Morocco – unconfirmed stighting in the south east of the country in boarder area between Morocco and Algeria – by hunting guides and Algerian foresters.
19. Mauritania (not a party to CITES): Population. Estimated at 100 to 500 [62]. Possible small population and isolated individuals still exists in Aouker Plateau, Mauritania Adghagh, at the NE of Banc drquote Arguim National Park, in the northwest of the country (thought to be extinct due to the disappearance of their main prey, the Mhorr gazelle and decrease of dorcus gazelle) and Tidjika. No cheetah exist in conservation areas [71]. Principal Threats. Decline of prey, poaching, environmental desiccation and reduction of habitat. Taxonomy. Northern Mauritania are *A.j. venaticus* and in the south, *A.j. hecki.*
20. Mozambique: Population. Estimated at 100 [82]. Once widely distributed, now relic populations perhaps survive in parts of Gaza and Inhambane Provinces and south of the Zambezi River, and in the southern regions of Tete Province [93]. The Tete Region is believed to be absent of cheetah now [82]. The Gorongoza National Park (3,770 km$^2$) had a small population of cheetah [93]. Principal Threats. Poaching due to civil war situation, lack of enforced protection.
21. Namibia: Population. Estimated at 2,000-3,000 animals [61, 54]. Still widely spread throughout the country, although only small populations are found in the southern part of the country due to smallstock farming, jackal-proof fences and eradication of predators. Ninety-five percent of the population is on commercial farmlands to the north of the Tropic of Capricorn. Apart from farmlands, very small numbers of animals still occur in communal farming areas of Damaraland, Hereroland, Bushmanland, and Kaokaland. Individual animals are seen in Kavango and Caprivi. Only two conservation areas have populations of cheetah Etosha and the Namib/Naukluft, but only 1.4 to 4% of the population lives in proclaimed conservation areas [61, 52, 82]. Possibly less than 100 animals live in the 2 conservation areas, Etosha National Park (22,270 km$^2$) because high predator competition, and Namib/Naukluft National Park (49,768 km$^2$), because of low prey density. Although protected game, cheetah can be killed if livestock is threatened. In January 1992, at the CITES meeting a quota of 150 animals was given to Namibia for live export and trophy hunting [16]. Principal Threats. Live capture and shooting by livestock farmers and game farmers. Cheetah are easily trapped, in large numbers, on farms that have "cheetah play trees". The trapping is indiscriminate. These animals are then shot as there is little export

market for live animals. The majority of the current world's captive population of cheetah has originated from Namibia [53].

22. Niger: new spoor and individuals – and individuals – ask Tim, Ed, John Newby – 2003 2004 – Francoise Claro). Population. Estimated at 50 to 40 [62]. Still found in the Niger Sahel running from Mali to Chad with concentrations of 10 to 15 pairs in the L'Air Tenere Reserve in the northwest central park of the country. A few remain in the Termit Area. In Niger's Park W (the entire tri-country park is over 11,000 $km^2$ of which Nigerrquote s protion is about 2,200 $km^2$) in the extreme south west of the country bordering Benin and Burkina Faso there are still cheetah [64, 26, 65, 25]. In a study between 1993 and 1995, 22 cheetah were seen in this park in eight sightings with an estimation of at least nine cheetah living in the park [86]. Small populations of cheetah have been recorded in Reserve Naturelle Nationale de L'Air et du Tenere (20 or 30 animals) (77,360 $km^2$). Principal Threats. Poaching, lack of prey species, conflict with livestock. Taxonomy. *A.j. venaticus* in northern Niger and *A.j. hecki* in southern Niger.
23. Pakistan (Possibly (probably) Extinct): Population. Information collected suggests that there are no more cheetah in northern Baluchistan from Quetta westward. This was thought to be the last area-claiming cheetah in Pakistan [2]. Possibly some still exist in southwest Baluchistan on the Iranian border. It is very difficult for Pakistan officials to get information from these semi-autonomous areas. Specimens of hides were collected in the early 1970's [2, 58, 1, 8]. There is a current proposal to conduct a survey in Baluchistan and the Nushki desert region close to Iran for the potential occurrence of the cheetah [67]. Principal Threats. Loss of habitat, competition with livestock and poaching.
24. Senegal: - Some might still exisit in the Ferlo region in the northern part of the country, but no firm proof recently – Col. Gueye, National Parks Breakfast. Population. No current information. Possibly still a few animals in Parc National Du Niokolo-Koba (8,000$km^2$) [26]. Principal Threats. Lack of habitat.
25. Somalia: Population. Only proof of existence is from cubs being sold by locals in the Kismajo area [33]. The situation for cheetah in the country is at a critical point. They have been on the decline since the 1970's, in the north the records are old and not current and in the south of the country the civil war has caused an impact on the species [4]. Estimated at 300 [62]. A traveler reported seeing eight animals in one days travel in the south of the country along the main road from Kenya, suggesting some numbers still occur in this region [10]. Formerly found throughout the entire country, reduced by half to two thirds as of 1975 [62]. Previously found along the Ethiopian border in the north-west and central areas of Somalia [94]. Live cheetah and skins for sale in Djibouti market place and thought to come from Somalia81. Principal Threats. Civil war, agriculture expansion caused reduction of prey, and poaching for skins and live trade. Due to Shifta bandits and civil war, enforcement is inadequate.
26. South Africa: Population. Estimated at 500-800 [52, 27]. Individuals occur sporadically in the northern parts of the Cape Province. In the Kalahari Gemsbok National Park there is a small population of approximately 50 animals. A small population is found on the extensive commercial farmlands in the north western, northern and eastern Transvaal, to the southern border of the Kruger National Park and along the Zimbabwe and Botswana borders. They were exterminated in Natal by the 1930's. Since 1965, 64 animals from Namibia were reintroduced to Hluhluwe/Umflozi, 33 into Mkuzi Game Reserves, 18 into Eastern Shores, 13 into Itala, and 14 into Ndumu [79, 77] and over 10 into Phinda. Other reserves contain isolated groups too small to be considered as viable populations. The population in the Kruger National Park is approximately 250 animals. Many cheetah are imported to South Africa from Namibia for zoos, parks and private facilities, as well as for trophy hunting in small camps. South Africa does have several successful captive breeding facilities [51]. Only two parks hold large enough populations: Kruger National Park (19,485 $km^2$) and the Kalahari Gemsbok National Park (9,591 $km^2$). The cheetah was taken off the South African endangered species list in 1989. Permits are issued to control problem animals through shooting and live capture. Trophy hunting is allowed, but there is no legal export of the trophy. Principal Threats. Livestock farming, small populations in unconnected conservation areas, and the believed success of captive breeding

programmes in South Africa, which has eliminated the need to put much effort into the conservation of the remaining wild populations.

27. Sudan: Population. Recent reports indicate that cheetah are mainly distributed in southern Sudan [31]. Estimates of 1,200 animals, which could have declined by half by 1980 [62]. Recent information in the north indicates that cheetah skins are used to make slippers and these are in great demand by rich Sudanese [76, 46]. Populations may still be present where adequate prey and livestock exist in semi-arid areas below the true desert in the central middle of the country [76]. Widely distributed throughout the south, as of 1982 [35]. Recent information is lacking from the south of the country due to the long civil war. The population there could be greatly affected by the eight years of war. All wildlife has been severely affected by the availability of guns and ammunition [76]. Were very rare or non-existent in all parks and reserves [62]. Sightings of 10 animals in the southern reserve,*Southern National Park (23,000 $km^2$), sightings also seen in *Boma National Park (22,800 $km^2$), *Boro Game Reserve (1,500 $km^2$), *Meshra Game Reserve (4,500 $km^2$), *Badingile Game Reserve (8,400 $km^2$), Ashana Game Reserve (900 $km^2$), Chelkou Game Reserve (5,500 $km^2$), Kidepo Game Reserve (1,400$km^2$), Numatina Game Reserve (2,100 $km^2$), and Shambe Game Reserve (620 $km^2$) (Hillman,1982). The cheetah has been a protected species since 1972. Effective 1 January 1989 Wildlife Conservation and National Park forces of Sudan issued a 3-year notice banning the hunting and capture of mammals, birds and reptiles in the Republic of Sudan. Principal Threats. Poaching, loss of prey, indirect affects of the long civil war in the south of the country.
 *Proposed not yet gazetted (1988).
28. Tanzania: Population. Estimated at 1000, with a range of 500-1500 [62]. Found in the grasslands of Masailand and a few localized areas of woodlands. Populations do exist in the Serengeti/ Ngorongoro Conservation Area (25,000 $km^2$), possibly as many as 50044, 14, however, the population suffers due to competition with lion and hyena. There have been sightings in Mikumi National Park (3,230 $km^2$), Tarangire National Park (2,600 $km^2$), Katavi National Park (2,250 $km^2$), and Ruaha National Park (10,200 $km^2$) [15, 27]. Principal Threats. Poaching, predation and competition with other large predators.
29. Uganda: Population. Estimated less than 200 [62]. No current information available. Small numbers are thought to be found in the north east sector of the country and a few may still found in Kidepo National Park (1,400 $km^2$) [93]. Principal Threats. Poaching and loss of habitat.
30. Western Sahara (Possibly (Probably) Extinct) (Not a party to CITES): Population. Presumed extinct. Last individual caught in 1976 and given to the zoo of Algiers, Beni Abbes Scientific Research Center, by the Algerian Army Comander of Tindouf who received the animals from Polisario fighters in Western Sahara [71, 19]. A possible population may still live in the upper lands of East Tiris (south east of the country), a region of abundant vegetation [71].
31. Zambia: Population. Although cheetah records are very scant, the species distribution in the last three decades is encouraging [75]. The species is uncommon in many areas, however, as of 1969 cheetah were still widely distributed in various parts of the country, but in low densities [5]. Populations were concentrated in the flood plains and along dry riverbeds. It was thought that the majority of the suitable habitats would disappear by the 1980's [62, 5]. Recently cheetah occur in relatively low numbers in Kufe National Park (22,400 $km^2$), South Luangwa National Park and Sioma Ngwezi National Park. In Lower Zambezi National Park, one or two have been sighted by tour operators at Jeki plain since 1990 [75]. Experimental re-introduction of three male cheetah into the Lower Zambezi took place in 1994 [75]. Principal Threats. Poaching, loss of habitat, and expanding human population.
32. Zimbabwe: Population. Estimated at 500-1000 [91, 82, 52]. A 1991 Department of National Parks and Wildlife Management (DNPWLM) report estimated cheetah numbers using a computer model. This model predicted there were over 600 cheetah within the Parks and Wildlife Estates, nearly 200 in communal lands, 400 on alienated land and nearly 200 on other state land, resulting in a total of 1,391 cheetah throughout Zimbabwe. These estimates should however, be treated with caution as they are not based on actual data95. Farmers on private and commercial land in southern Zimbabwe have indicated an increase

in the cheetah population and are concerned over the loss of valuable game and livestock to cheetah. According to a 1997 report from the Ministry of Environment and Tourism DNPWLM, the amount of commercial ranchland with permanently resident cheetah populations has more than doubled in the last decade, with an estimate of 5,000 animals.

Cheetah are largely absent from the northeast part of the country. Two main populations are found in the southern commercial farming areas and in the northwest conservation areas. These two areas account for about 400 animals. The remainder of about 100 animals is distributed over the middle Zambezi Valley, the Midlands and Gonarezhou91. Over 50% of the population occurs on privately owned farmland [95]. Less than 200 animals are thought to be in the conservation areas including Hwange National Park (14,650 $km^2$), Matetsi Safari Area (2,920 $km^2$), Kazuma National Park (313 $km^2$) and Zambezi National Park (564 $km^2$). Occasional sightings are reported in Matobo National Park (432 $km^2$) and 10-20 animals are in the National Park and Safari area around Lake Kariba Valley. Small numbers occur in the Mana Pools National Park (2,196 $km^2$) and the lower Zambezi area, unknown number in the Gonarezhou National Park (5,053 $km^2$) [91]. Cheetah are on the sixth schedule of the Parks and Wildlife Act and are also specially protected, which means that it is illegal to kill a cheetah under any circumstance without a Section 37 permit. This includes trophy hunting a cheetah, killing one as a problem animal or live capture. The Government opened trophy hunting on the cheetah in 1990, which is monitored by "hunting returns". Quota's set at the January 1992 CITES meeting allows for the export of 50 animals [16]. Principal Threats. Conflict with farmers and livestock and illegal killing of cheetah.

## CONCLUSION

During the past 25 years, the world’s cheetah population has declined by over 50%, from approximately 30,000 animals, to less than 15,000, whereas the human population has doubled during this time. The majority of the remaining cheetah populations are found outside protected reserves and are increasingly in conflict with humans. This is due to conflict experienced with lion and hyaena, by cheetah in game reserves. As human populations increase, the reduction of prey species available to cheetah and the loss of habitat are the biggest threats facing the cheetah today. Another major problem facing the species is its lack of success in captivity, as the captive population is not self-sustaining but maintained by the wild population of cheetah, which is under increasing pressure.

In order for the cheetah to survive into the 21st century, some simple and yet economically hard decisions will have to be made. The survival of the cheetah depends on the ability of range countries discussed in this paper to develop a Global Master Plan for the cheetah in its remaining ranges of Africa. A Global Master Plan will hopefully be developed with the assistance of the IUCN SSC’s Conservation and Breeding Strategy Group (CBSG) during the next year.

Having been revered by humans for over 5,000 years, the cheetah is now facing extinction caused by human factors. In order to ensure this species’ survival, we have to look critically at the political, social and economic issues facing wildlife conservation in Africa today. Countries like Namibia, Botswana and Zimbabwe, which have key remaining populations, urgently need to set the example with integrated conservation management programmes to ensure the survival of the cheetah.

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