Population and Habitat Viability Assessment For the Blue Crane

(Anthropoides Paradiseus)

Final Report

1-4 October 2002
Villiersdorp
SOUTH AFRICA

EDITED BY :
K. McCann, K. Morrison, A. Byers, P. Miller and Y. Friedman

Mazda Wildlife Fund
Consol. Speciality Glass
M - PRINT
WWF The Green Trust Die Groen Trust
Endangered Wildlife Trust South African Crane Working Group
Species Survival Commission
Conservation Breeding Specialist Group South Africa
IUCN The World Conservation Union
Endangered Wildlife Trust

BLUE CRANE

Anthropoides Paradiseus

Population and Habitat Viability Assessment Workshop

1 – 4 October 2001

Villiersdorp, South Africa

FINAL REPORT

Sponsored by:

The South African Crane Working Group
Endangered Wildlife Trust
The Mazda Wildlife Fund
The Nedbank Green Trust
Consol Speciality Glass

In collaboration with

The Overberg Crane Group
The Conservation Breeding Specialist Group IUCN/SSC

and

CBSG South Africa

K. McCann, K. Morrison, A. Byers, P. Miller and Y. Friedmann editors. 2001. *Blue Crane (Anthropoides Paradiseus). A Population and Habitat Viability Assessment Workshop. Final Workshop Report.* Conservation Breeding Specialist Group (SSC/IUCN)., Apple Valley, MN.

A contribution of the IUCN/SSC Conservation Breeding Specialist Group in collaboration with the South African Crane Working Group of the Endangered Wildlife Trust, the Overberg Crane Group and CBSG South Africa.

Sponsored by Endangered Wildlife Trust, the Mazda Wildlife Fund, the Nedbank Green Trust and Consol Speciality Glass.

Cover art courtesy of Wicus Leeuwner, Warwick Tarboton, Shawn Catterall, Jon Smallie.

The CBSG Conservation Council

These generous contributors make the work of CBSG possible

Benefactors ($20,000 and above)

Columbus Zoological Gardens
Minnesota Zoological Gardens
Omaha's Henry Doorly Zoo
SeaWorld, Inc.
Toronto Zoo
White Oak Conservation Center
Zoological Society of San Diego

Conservators ($15,000 -$19,999)
Saint Louis Zoo
Walt Disney's Animal Kingdom
Wildlife Conservation Society - NYZS
World Zoo Organization (WZO)
Zoological Society of London

Guardians ($7,000-$14,999)
Chicago Zoological Society
Cincinnati Zoo
Cleveland Zoological Society
Nan Schaffer
Toledo Zoological Society

Protectors ($1,000-$6,999)
ARAZPA
Albuquerque Biological Park
Allwetter Zoo Munster
Audubon Zoological Gardens
Bristol Zoo
Caldwell Zoo
Calgary Zoo
Chester Zoo
Copenhagen Zoo
Denver Zoological Gardens
Detroit Zoological Park
Durrell Wildlife Conservation Trust
El Paso Zoo
Everland Zoo
Federation of Zoological Gardens of Great Britain and Ireland
Fort Wayne Zoological Society
Fort Worth Zoo
Fossil Rim Wildlife Center
Gladys Porter Zoo
Greater Los Angeles Zoo Association
Houston Zoological Garden
Japanese Association of Zoological Parks & Aquariums
Little Rock Zoo
Living Desert
Loro Parque
Marwell Zoological Park
Milwaukee County Zoo
National Tropical Botanical Garden
North Carolina Zoological Park
Oklahoma City Zoo
Oregon Zoo
Paignton Zool. & Botanical Gardens
Parco Natura Viva Garda Zool. Park
Perth Zoo
Philadelphia Zoological Garden
Phoenix Zoo
Pittsburgh Zoo
Rotterdam Zoo
Royal Zoological Society of Antwerp
Royal Zoological Society of Scotland
Royal Zoological Society of S Australia
San Antonio Zoo
San Francisco Zoo
Schonbrunner Tiergarten
Sedgwick County Zoo
Sunset Zoo (10 year commitment)
Taipei Zoo
The WILDS
Thrigby Hall Wildlife Gardens
Twycross Zoo
Union of German Zoo Directors
Urban Services Dept. of Hong Kong
Wassenaar Wildlife Breeding Centre
Wilhelma Zoological Garden
Woodland Park Zoo
Zoo Atlanta
Zoological Parks Board of New South Wales
Zoological Parks & Gardens Board Of Victoria
Zoologischer Garten Koln
Zoologischer Garten Zurich

Stewards ($500-$999)
Aalborg Zoo
Alameda Park Zoo
Arizona-Sonora Desert Museum
Banham Zoo & Sanctuary
Bee Barksdale
Cotswold Wildlife Park
Dickerson Park Zoo
Dutch Federation of Zoological Gardens
Fota Wildlife Park
Givskud Zoo
Granby Zoo
Great Plains Zoo
Knoxville Zoo
Lowry Park
National Aviary in Pittsburgh
National Zoological Gardens of Pretoria
Odense Zoo
Ouwehands Dierenpark
Prudence P. Perry
Riverbanks Zoological Park
Rolling Hills Refuge Conservation Center
Staten Island Zoo
Tierpark Rheine
Wellington Zoo
Welsh Mountain Zoo
World Parrot Trust
Zoologischer Garten Rostock

Curators ($250-$499)
Ellen Dierenfield
Emporia Zoo
Lee Richardson Zoo
Lincoln Park Zoo
Dr. Edward & Marie Plotka
Racine Zoological Society
Roger Williams Park Zoo
Tokyo Zoological Park Society
Topeka Zoo, Friends of
Zoo de la Casa de Campo

Sponsors ($50-$249)
African Safari
Alice Springs Desert Park
American Loriinae Conservancy
Apenheul Zoo
Arbeitskreis Natur-u Artenschutz in den
Belize Zoo
Bighorn Institute
Brandywine Zoo
Darmstadt Zoo
Folsom Children's Zoo & Botanical Garden
Nigel Hewston
Jardin aux Oiseaux
Marvin Jones
Kew Royal Botanic Gardens
Lisbon Zoo
Memphis Zoo
Miller Park Zoo
National Birds of Prey Centre
Steven J. Olson
Palm Beach Zoo at Dreher Park
Parc Zoologique de Thoiry
Pearcedale Conservation Park
Potter Park Zoo
Safari Parc de Peaugres
Teruko Shimizu
Steinhart Aquarium
Tautphaus Park Zoo
Touro Parc-France
Jackson Zee

Supporters ($25-$49)
Beardsby Zoological Gardens
Erie Zoological Gardens
Franklin Park Zoo/Zoo New England
Oglebay's Good Children's Zoo
Celia Sanchez Sanchez
Warren D. Thomas

Thank You!
January 2002

BLUE CRANE

Anthropoides Paradiseus

Population and Habitat Viability Assessment Workshop

1- 4 October 2001, Villiersdorp South Africa

CONTENTS

BLUE CRANE

Anthropoides Paradiseus

Population and Habitat Viability Assessment Workshop

Held 1 – 4 October 2001, Villiersdorp, South Africa

January 2002

Edited by

K. McCann, K. Morrison, A. Byers, P. Miller and Y. Friedmann

SECTION 1

EXECUTIVE SUMMARY AND RECOMMENDATIONS

Executive Summary

The Blue Crane occurs predominantly in South Africa, with the only other small populations being located in Etosha Pans (northern Namibia) and the western parts of Swaziland (Brown 1992). While locally abundant in limited parts of its range, it is now rare in most parts. Its population may be divided into three subpopulations, with one portion of the population centred in the Mpumalanga, north-eastern Free State, and KwaZulu-Natal regions into the northern parts of the Eastern Cape. A second occurs in the central Karoo situated within the Northern Cape extending into the Karoo regions of the southern Free State and Eastern cape, and the last in the south Western Cape (Overberg / Swartland regions), where it is a relatively recent colonizer of agricultural areas (Allan 1993). The species range has diminished from the “old” Transkei region, and occurs as an occasional vagrant in Lesotho and Botswana (Allan 1993). Although this species is still found throughout much of its historic range, it has experienced significant and rapid local declines over the last twenty years. The most recent estimate puts the population at between 20 000 and 21 000 individuals.

The Blue Crane is a bird of dry short grasslands, and together with the Demoiselle Crane (*A. virgo*), the least dependent on wetland habitats for breeding. Within the grasslands, the species is more abundant and evenly distributed in the eastern “sour” grasslands (where natural grazing of livestock is the predominant land use). In the arid Karoo, the species is found in areas where perennial grasslands are dominant over the more typical scrub Karoo vegetation of the region. In the Fynbos, the species is restricted almost exclusively to intensively cultivated habitats (mainly cereal crops and small livestock farming). Blue Cranes are summer breeders, nesting from late September through to February. Preferred nesting sites are secluded open grasslands with full view around the nest for predator evasion. A clutch of 2 eggs is laid, generally in a shallow grassy depression or simply on the bare ground. Occasionally, Blue Cranes may nest in shallow seasonal wetlands, particularly where livestock numbers are high and risk of nest trampling is increased. In agricultural areas, they nest in pastures, in fallow fields and in crop fields as stubble becomes available after harvest. The Blue Crane is termed a partial migrant, gathering in large flocks during the winter months having moved out of their breeding territories. The understanding of the movement patterns are limited but are currently being assessed using satellite telemetry and colour ringing. Movements appear to be more localized than previously expected, with flocks moving in large groups within their subpopulations (e.g. the subpopulation in the Karoo biome) and not mixing throughout the country.

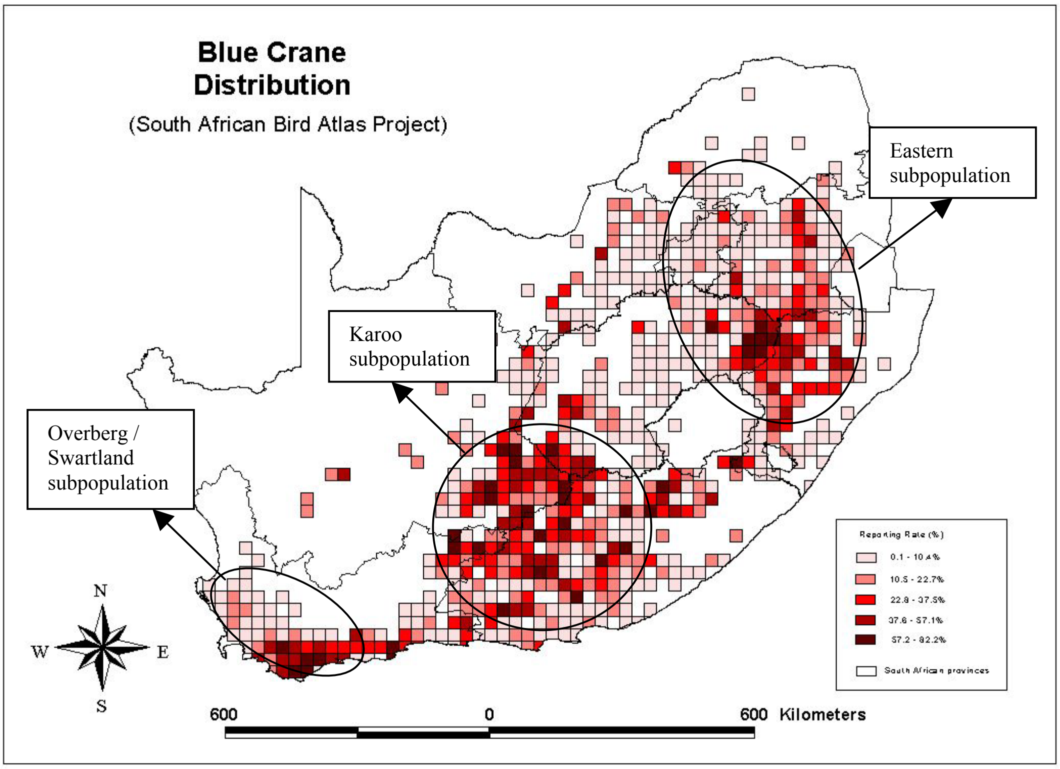


Figure 1 : The distribution of the Blue Crane according to the South African Bird Atlas project, showing the location of the three core subpopulations in South Africa.

Status

Van Ee (1981) investigated the conservation status of the Blue Crane during the mid-1970's and concluded that is was not in the least threatened. This species was therefore not included in either the South African Red Data Book (Brooke 1984) or the African Avian Red Data Book (Stuart & Collar 1985). Although this species is still found throughout much of its historic range, it has experienced significant and rapid local declines over the last thirty years. Concern was expressed for both the KwaZulu-Natal population where an 80% decline was reported (Johnson 1992), as well as the Eastern Cape population, which was reported to have declined from 7800 birds to between 1000 – 2000 individuals within the 1980's.

For this reason the Blue Crane has been included in the latest Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Barnes 2000) as "Vulnerable". It is reported to have declined by more then 20% over the past three generations, essentially between 1978 and 1998.

Threats

A combination of grassland habitat loss through land use alteration and agrochemical poisoning has led to the most significant declines in Blue Crane populations. The alteration of large tracts of natural grasslands to commercial afforestation, particularly pine and eucalyptus plantations for paper pulp and timber production, reduce the suitable open grassland habitats required for successful breeding (Johnson 1992, Tarboton 1992). Approximately 1,5 million hectares have already been afforested in South Africa, mainly in the eastern parts of Mpumalanga where the greatest impact has been experienced, with the likelihood of this increasing dramatically in the future, particularly in KwaZulu-Natal and the

Eastern Cape Provinces. It is estimated that 58% of this biome has been transformed (Low and Rebelo 1996). This was once the stronghold of the species and it is understandable that with the loss of this habitat, Blue Crane numbers have declined dramatically.

The documented decline of Blue Cranes has coincided with many reported cases of poisonings from all parts of the country (Scott & Scott 1996, Tarboton 1992, Vernon *et al* 1992), although proportionally more from the Western and Eastern Cape Provinces (where large populations of Blue Crane are found and can be expected to occur in crop fields). Poisoning in the past has been through intentional and deliberate poisoning of cranes causing crop damage, the inadvertent poisoning aimed at killing other species causing crop damage, or accidentally through the normal application of agrochemicals to croplands (Filmer & Holtshausen 1992, Allan 1994). Currently, poisoning cases are as a result of farm workers either directly poisoning cranes, or inadvertently poisoning them when baiting grain for gamebirds, for extra food protein.

Another significant threat is the removal of young Blue Crane chicks, prior to fledging, from the wild to be kept as pets, for food, or to sell to bird breeders. In the Karoo, the greatest threat occurs through collisions with the conductors and earthwires of powerlines, both large transmission and smaller distribution powerlines. Other less significant threats occur through domestic dog predation, fences, and chicks drowning in water troughs.

Conservation Concerns

The Blue Crane, despite being our national bird, has experienced dramatic population declines during the past century. Siegfried (1992) reported that only between 100 – 500 Blue Cranes were located in nature reserves, and had been recorded in 75 nature reserves, but not necessarily breeding. The inadequacy of relying on reserves is obvious and must be stressed, as the majority of cranes occur on privately owned land, the area where cranes will win or loose the survival battle.

In addition, an important fact regarding the Blue Crane population is that significant population losses have taken place in the natural grassland areas of the country, with more than 50% of this species' current distribution now occurring outside the grassland biome, this in spite of the fact that this species is recognized as a grassland endemic.

Further concern has been expressed over the future of the Blue Crane population, particularly in light of the fact that more than half of the remaining global Blue Crane population occurs in transformed agricultural lands, a system with a high likelihood of land-use change in the near future. This species has become highly adapted to using the artificial agricultural wheat-lands in the Overberg and Swartland regions of the Western Cape province. However, these favourable conditions in this area may be short-lived, as economics may drive the agriculture in the Western Cape to a crop unsuitable for Blue Cranes. As more than 50% of South Africa's Blue Crane population inhabits this area, the stability of this population is therefore a lot more tentative than the figures show.

This therefore places this population at severe risk, causing the South African Crane Working Group (SACWG), in conjunction with the Endangered Wildlife Trust (EWT) and the Conservation Breeding Specialist Group (CBSG) South Africa to hold a Population and Habitat Viability Assessment (PHVA) for Blue Cranes in Villiersdorp, Western Cape from the 1st - 4th of October 2001.

The overall purpose of the workshop was to assess the change in the South African Blue Crane population over the past two decades, and to assess the extinction potential of this population under current population conditions. It was, therefore, to result in the development of a conservation management strategy / plan for the Blue Crane population which will allow it to survive over the long-term in its natural and man-modified habitats in South Africa, incorporating specific recommendations and priorities for research and management.

The PHVA Process

The Blue Crane PHVA was well attended with more than 30 participants from all around South Africa. The workshop coincided with the 10th anniversary of the Overberg Crane Group who generously hosted an ice-breaker for the participants as an opener to the workshop.

The primary aim of the Blue Crane PHVA was to assess the threats to Blue Cranes, and prioritise required actions in a cohesive conservation action plan in order to improve the survival of this species in South Africa. The PHVA ran over three and half days and comprised a series of plenary and working group sessions in which working groups worked through tasks designed to facilitate free thinking, brainstorming, discussion and debate, issue tackling and finally, consensus building. Six working groups were established after the first morning's group session in which issues facing Blue Crane conservation were brainstormed. These groups dealt with the following issues:

- Institutional Management and Policy
- Education and Awareness
- Habitat and Land Use
- Causes of Blue Crane Mortality
- Trade and Captive Breeding
- Population dynamics and modelling

In addition, all life history traits of the Blue Crane were discussed in plenary in order to develop a population model that best represented the current population. Various aspects identified by the Habitat / Land Use and Causes of Mortality groups were then modelled against this standard model using the VORTEX programme to assess : (1) those factors making the species vulnerable to extinction, i.e. determining the sensitivity of parameters; and (2) identifying which factors, if changed or manipulated, may have the greatest effect on preventing extinction.

Working groups tackled the issues facing their group, compiling problem statements, solutions and finally resolutions and action plans and steps that will result in achieving the goals developed. Plenary sessions enabled working groups to present the results of their discussions to the whole group and obtain the input of all participants, which often resulted in much debate and insight from members of other working groups. At the end of each day, each working group submitted a report on their discussions and results, which goes towards forming the bulk of the final workshop report.

Executive Summaries of the 5 working groups
Results and Recommendations

1. <u>The **INSTITUTIONAL MANAGEMENT AND POLICY WORKING GROUP**</u> focused on the overall national management aspects of Blue Crane conservation, identifying the need for national strategies, funding to implement conservation actions and the policies required from the legislative point of view.

   The priority actions identified by this working group include :

   - Lobbying for the adoption of appropriate legislation and policy, the implementation and the providing of resources:
   - Establish a National Committee consisting of provincial representation and all stakeholders:
     - National Committee to supply information and policies to the appropriate authorities.
     - Training personnel according to identified needs.
     - Development of a National Management Policy Document.
     - Promote Blue Crane and its natural habitat as a priority for conservation.
   - Promote general awareness and conservation policies to the public:
     - Promote Blue Crane and its natural habitat as a priority for conservation.
     - Promote improved liaison between local law enforcement officers and legal administrators in terms of conservation issues.
     - Issue appropriate rewards for reporting irregularities regarding Blue Cranes.
   - Acquire funding:
     - Develop a business plan to be used as a motivation tool to obtain funding from both Government and other NGOs.
     - Produce project budgets for funding applications.
   - Promote Blue Crane as an important tourist attraction.

2. <u>The **EDUCATION AND AWARENESS WORKING GROUP**</u> concentrated on determining the aspects relevant to increasing the awareness of all “communities” to Blue Crane conservation needs. The first aspect the working group focused on was in defining a “community” and all the relevant components. A “community” was defined as being rural (farming and schools), urban (suburban, schools and industrial) and institutions (farmers associations, NGO’s, SANCO, chambers of commerce).

   Fourteen different issues were identified for education and awareness, which were then grouped into three main categories :

   - Community – awareness / ignorance, attitude, involvement / apathy.
   - Economic factors – human socio-economic, industrial green attitude, economic value of the Blue Crane and tourism.
   - Other issues – national pride, language of communication, marketing and human responsibility.

   For each of the three main categories, the working group developed strategies and action-orientated solutions which would effectively increase the awareness of all communities. The following were the overall solutions in order of priority :

1. Identify the different and various communities with whom one wishes to interact, and the key role players within each community.
2. Develop and implement educational programmes, relevant to the various communities, and train educational personnel for implementation.
3. Develop a close working relationship with those farmers whose crops may be affected by BC activities and provide them with information and advice.
4. Identify those industries with a strong conservation ethic, and use to influence other organisations. Also identify persons within industry that can positively influence that industry's attitudes to the BC.
5. Identify industries that are potentially threatening to the environment and in particular, those in BC range areas.
6. Develop an education/ awareness programme directed specifically at exploiters of BC commercially.
7. Establish a "watch dog" organisation to ensure compliance by industry with the various environmental acts and regulations.
8. Establish links with other conservation groups, including official bodies, to promote BC conservation.
9. Prepare promotional material such as pamphlets, posters and information sheets; conduct workshops, arrange farmers days and other community activities to promote awareness; make use of media as and when opportunity arises.
10. Develop tourist packages that can be used by travel agents, tourism groups and that advocate sound eco-ethical practices; develop controlled BC crane routes; publicise these packages with bird clubs to promote eco-tourism.
11. Determine the cultural uses of crane parts, the cultural differences that may exist, and hence the substitution of BC parts by alternative products.

3. The aim of the **HABITAT AND LAND USE WORKING GROUP** was to identify those habitat factors influencing the Blue Crane population and to assess the impacts of land use change. The working group identified all the different issues affecting Blue Crane habitats, and grouped them into the following categories:

- Lack of information on crane habitat and preferences
- Human influence on crane habitat (e.g. agricultural intensification, change in land use, human settlement)
- Historical factors involved in population trends
- Lack of knowledge regarding the interaction between cranes and their environment
- Lack of protection for key crane areas
- Natural environmental factors (e.g. climate changes, food availability)

A common thread throughout the discussions of the Habitat and Land Use Working Group was the lack of information and knowledge on habitat preferences, requirements and influences of land use change. Therefore, the solutions and recommendations that received priority were those of a research nature, allowing more detailed knowledge to be gained in understanding Blue Cranes in their relevant habitats. The working group developed an extensive list of possible strategies and solutions, from which the group selected the actions of highest priority. The top five solutions identified by this working group were as follows :

i. Determine and monitor the effects of various land uses and farming practices on Blue Cranes.
ii. Identify and quantify crop damage / stock feed loss by Blue Cranes and associated species.

iii. Obtain accurate data on habitat requirements (e.g. for feeding, breeding, etc) and preferences of Blue Cranes in the three core areas.
iv. Encourage land managers to adopt an appropriate conservation option to secure critically important Blue Crane habitats.
v. Attempt to identify the historical factors involved in population changes in the 3 core areas (long-term population trends).

4. The **CAUSES OF MORTALITY WORKING GROUP** identified two types of mortalities – human-induced mortality factors and natural forms of mortality. The human-induced mortality factors include poisoning, both indirect and direct, collision and electrocution with overhead cables, fences, direct persecution and hunting, drowning in water troughs, entanglement with baling twin, disturbance, domestic dogs, and fires. Natural forms of mortality include old age, natural depredation, natural disasters and disease. Each of these mortality factors were defined allowing a better understanding of each issue.

The working group agreed that currently, a lack of quantitative and qualitative data has probably resulted in certain mortality factors being under represented and others being over represented (i.e. information is not available on the different crane mortality factors and the impact (and relative importance) of each factor). A further problem is that a lack of age-specific mortality data means that long-term survival predictions are difficult to determine. In order to alleviate these problems, the working group discussed each threat and developed solutions to lessen the impacts of these threats. The solutions were prioritised as follows :

i. Make problem powerlines more visible using an effective marking device.
ii. Route new powerlines away from Blue Crane hotspots.
iii. Promote an awareness amongst farmers and farm labourers about the negative impacts and effects of poisons on non-target animals
iv. Encourage farmers to tolerate Blue Cranes.
v. Investigate and determine the relative impact of the different natural causes of mortality of Blue Crane populations.
vi. Modify existing domestic stock drinking troughs and/or design crane-friendly troughs.
vii. Reduce the amount of baling twine in the veldt.
viii. Improve the awareness of farmers about the effect of their activities on cranes while they are breeding.
ix. Make farmers aware of nesting cranes during the harvesting period and propose solutions.
x. Develop and promote alternative and selective problem animal control methods.
xi. Make farmers and farm labourers aware of the effect of their dogs on breeding cranes (& control dogs).
xii. Design methods to restrict access of Blue Cranes to feed troughs/lots.
xiii. Make land managers aware about the illegal hunting of cranes and the impact on their populations.
xiv. Promote alternative legal hunting methods to kill other animals.
xv. To investigate the impact of fences on Blue Cranes and to evaluate and develop solutions.
xvi. Provide an alternative food source and feeding method for Blue Cranes (and/or livestock).
xvii. Enforce legislation when Blue Cranes are illegally killed (poison, shooting & hunting)

xviii. Ensure that locust control poisons are crane friendly.
xix. Design a method to restrict access of Blue Cranes to agricultural lands.
xx. Make land managers aware of the impact of fires on cranes during the crane breeding season.

5. The **TRADE AND CAPTIVE BREEDING WORKING GROUP** focused specifically on the issue of trade in this species, in discussing how trade was affecting the Blue Crane, whether captive breeding was a relevant conservation technique for this species' recovery and how current breeding programmes were influencing the trade threat. The working group discussed extensively all the issues involved in trade and captive breeding in Blue Cranes and identified 5 main categories of concern : trade, both legal and illegal, law enforcement, crane husbandry and research needs.

The solutions identified and prioritised by this working group included the following:

i. Conduct research or gather information on the numbers of Blue Cranes being poached throughout the country, so that a baseline of data can be formed.
ii. Conduct research into natural diseases and contracted diseases in captive and wild stocks.
iii. Gain a better understanding of the DNA and Haematology of Blue Cranes.
iv. Develop adequate registration systems such as the studbook and permits through DNA, microchips and close-rings.
v. Organised training courses for law enforcement (ID Skills) and aviculturalists (trade issues).
vi. Create awareness and co-operation amongst stakeholders with regards to SA legislation and cultural taboos.
vii. Organise workshops to improve co-operation; provide regular feedback / contact sessions; respond to requests for information and co-operation.
viii. Research into feedlot modifications.
ix. Improve communication between captive facilities and the Studbook Keeper to facilitate proper genetic representation.
x. Strategic media drives with regard to legislation, conservation and compliance – specifically with regard to the general public.

This working group coordinated with the Institutional Management and Policy group, which had developed actions steps relating to the creation of awareness of applicable legislation to the general public (including aviculturalists) for the Blue Crane.

6. The **POPULATION DYNAMICS AND MODELLING WORKING GROUP** was tasked with developing a baseline model which best approximates the current population dynamics of the three Blue Crane subpopulation in South Africa (namely the Eastern, Karoo and Western Cape subpopulations), taking into account knowledge of the current population parameters, genetic structure and carrying capacity. The model was then used to predict the outcome of different scenarios on the population so as to improve decision-making in respect of management / objectives needed to maintain a viable Blue Crane population.

The baseline models show the current trend of the wild Blue Crane subpopulations in South Africa, using the most current information on population demographic parameters. These models show that the Eastern subpopulation is in moderate decline, the Karoo subpopulation is in severe decline while the Western Cape subpopulation maintains a highly positive growth rate, reaching carrying capacity within 10 years.

Therefore, the modelling scenarios show the overall result of several questions posed at the beginning of this chapter, as well as several hypothetical management actions. The resulting outcomes and interpretations are as follows :

- What effect do basic population parameters (such as age of first breeding and age of breeding senescence) have on the population outcome ?

  Age of first breeding and age of reproductive senescence both have a significant influence on the outcome of a population. Group discussions have shown that this information is not yet accurately known. Therefore, it is recommended that a comprehensive colour-ringing programme is maintained so as to ascertain these important population parameters more accurately.

- What level of juvenile, subadult and adult mortality rates allows for a positive growth rate in the Eastern and Karoo subpopulations ?

  The sensitivity analysis of the age-specific mortality rates has shown that varying the mortality rates for each of the age classes individually for the Eastern subpopulation results in severely different population outcomes. In the Karoo subpopulation, different combinations were analysed, with the combination of reducing the subadult and adult mortality rates to 5% each, as well as reducing the juvenile rate to only 50% had the largest impact on the population, the only scenario showing a positive growth rate.

- What level of subadult and adult mortality rates causes a negative growth rate in the Western Cape subpopulation ?

  The sensitivity analysis showed that in order for the Western Cape Blue Crane population to survive into the long-term, subadult mortality rates must be kept below 10%, combined with an adult mortality rate of below 7.5%. Any age-specific mortality rates greater that these shown above will cause the population to decline.

- How does a potentially inaccurate initial population size of the Karoo subpopulation affect the populations' long-term viability ?

  Much emphasis in the past has been placed on accurately determining the populations sizes of crane species. The analysis of vastly different initial population sizes for the Karoo subpopulation showed negligible differences in the final population outcomes. The most significant influence on the population, irrespective of the initial population size was the mortality rates of the different age classes. This is where emphasis must be placed for the Karoo subpopulation.

- How does the potential habitat loss / change affect the Eastern and Western Cape subpopulations, shown as a change in carrying capacity ?

Any changes or losses of habitats in the Eastern subpopulation appear to have very little influence on the population. In spite of even a 7.5% decline in habitat carrying capacity over a five year period had a very similar population outcome to that with only a 2.5% carrying capacity decline. The emphasis for this subpopulation again appears to be on the age-specific mortality rates.

Changes in the Western Cape subpopulation's carrying capacity had a significant influence on the population. In order to maintain the subpopulation with a positive growth rate, no more than 2% of the currently available habitat can be lost each year over the next 10 years. Any more loss than this could have catastrophic consequences for the population.

Therefore, the long-term survival of the wild population of Blue Cranes in South Africa relies on the implementation of several research projects, assessment programmes as well as management actions, as indicated by the Vortex modelling. Future emphasis must be placed on gaining more accurate age-specific mortality data, determining age of first reproduction and breeding lifespan, as well as addressing the potential habitat change / loss in the Western Cape subpopulation.

BLUE CRANE

(Anthropoides Paradiseus)

Population and Habitat Viability Assessment Workshop

Held 1 – 4 October 2001, Villiersdorp, South Africa

January 2002

Edited by

K. McCann, K. Morrison, A. Byers, P. Miller and Y. Friedmann

SECTION 2

INTRODUCTION AND OVERVIEW

Introduction and Overview

The Blue Crane is endemic to southern Africa, has the most restricted global range of all crane species and is South Africa's National Bird. Due to it having such a restricted range and the fact that it has declined rapidly over large areas of its range during the last two decades, the Blue Crane is listed as "Vulnerable" in the Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Barnes 2000).

Background

The Blue Crane occurs predominantly in South Africa, with the only other small populations being located in Etosha Pans (northern Namibia) and the western parts of Swaziland (Brown 1992). While locally abundant in limited parts of its range, it is now rare in most parts. Its population may be divided into three subpopulations, with one portion of the population centred in the Mpumalanga, north-eastern Free State, and KwaZulu-Natal regions into the northern parts of the Eastern Cape. A second occurs in the central Karoo situated within the Northern Cape extending into the Karoo regions of the southern Free State and Eastern cape, and the last in the south Western Cape (Overberg / Swartland regions), where it is a relatively recent colonizer of agricultural areas (Allan 1993). The species range has diminished from the "old" Transkei region, and occurs as an occasional vagrant in Lesotho and Botswana (Allan 1993). Although this species is still found throughout much of its historic range, it has experienced significant and rapid local declines over the last twenty years. The most recent estimate puts the population at between 20 000 and 21 000 individuals.

The Blue Crane is a bird of dry short grasslands, and together with the Demoiselle Crane (*A. virgo*), the least dependent on wetland habitats for breeding. Within the grasslands, the species is more abundant and evenly distributed in the eastern "sour" grasslands (where natural grazing of livestock is the predominant land use). In the arid Karoo, the species is found in areas where perennial grasslands are dominant over the more typical scrub Karoo vegetation of the region. In the Fynbos, the species is restricted almost exclusively to intensively cultivated habitats (mainly cereal crops and small livestock farming). Blue Cranes are summer breeders, nesting from late September through to February. Preferred nesting sites are secluded open grasslands with full view around the nest for predator evasion. A clutch of 2 eggs is laid, generally in a shallow grassy depression or simply on the bare ground. Occasionally, Blue Cranes may nest in shallow seasonal wetlands, particularly where livestock numbers are high and risk of nest trampling is increased. In agricultural areas, they nest in pastures, in fallow fields and in crop fields as stubble becomes available after harvest. The Blue Crane is termed a partial migrant, gathering in large flocks during the winter months having moved out of their breeding territories. The understanding of the movement patterns are limited but are currently being assessed using satellite telemetry and colour ringing. Movements appear to be more localized than previously expected, with flocks moving in large groups within their subpopulations (e.g. the subpopulation in the Karoo biome) and not mixing throughout the country.

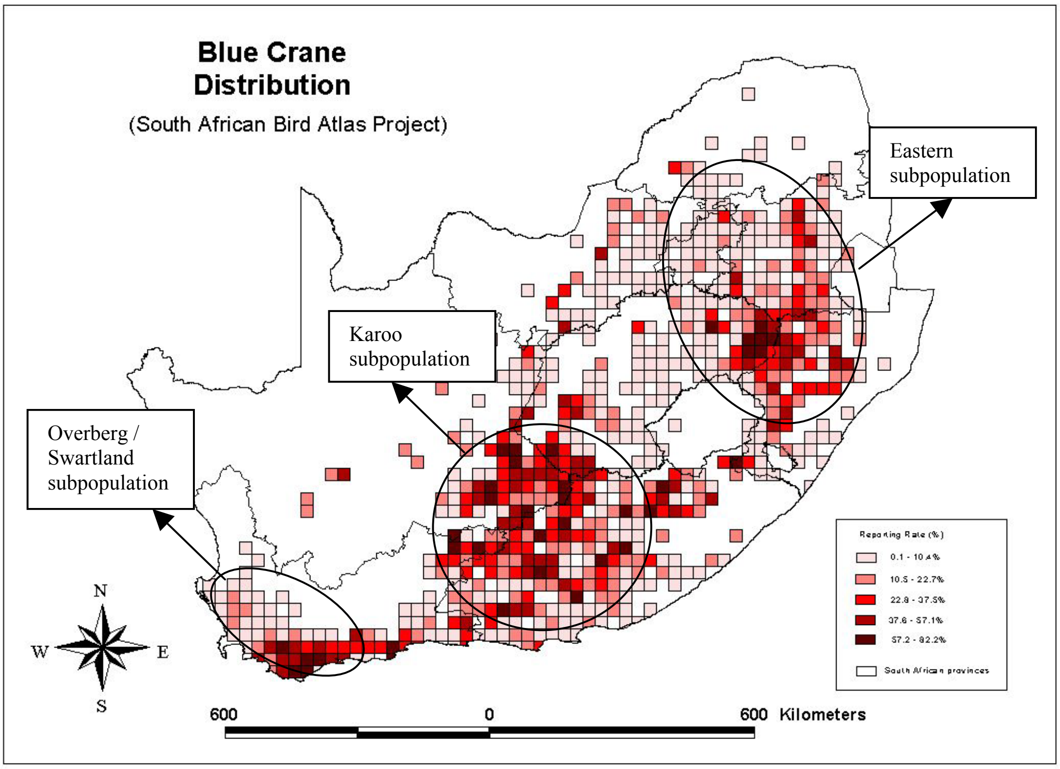


Figure 1 : The distribution of the Blue Crane according to the South African Bird Atlas project, showing the location of the three core subpopulations in South Africa.

Status

Van Ee (1981) investigated the conservation status of the Blue Crane during the mid-1970's and concluded that is was not in the least threatened. This species was therefore not included in either the South African Red Data Book (Brooke 1984) or the African Avian Red Data Book (Stuart & Collar 1985). Although this species is still found throughout much of its historic range, it has experienced significant and rapid local declines over the last thirty years. Concern was expressed for both the KwaZulu-Natal population where an 80% decline was reported (Johnson 1992), as well as the Eastern Cape population, which was reported to have declined from 7800 birds to between 1000 – 2000 individuals within the 1980's.

For this reason the Blue Crane has been included in the latest Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Barnes 2000) as "Vulnerable". It is reported to have declined by more then 20% over the past three generations, essentially between 1978 and 1998.

Threats

A combination of grassland habitat loss through land use alteration and agrochemical poisoning has led to the most significant declines in Blue Crane populations. The alteration of large tracts of natural grasslands to commercial afforestation, particularly pine and eucalyptus plantations for paper pulp and timber production, reduce the suitable open grassland habitats required for successful breeding (Johnson 1992, Tarboton 1992). Approximately 1,5 million hectares have already been afforested in South Africa, mainly in the eastern parts of Mpumalanga where the greatest impact has been experienced, with the likelihood of this increasing dramatically in the future, particularly in KwaZulu-Natal and the

Eastern Cape Provinces. It is estimated that 58% of this biome has been transformed (Low and Rebelo 1996). This was once the stronghold of the species and it is understandable that with the loss of this habitat, Blue Crane numbers have declined dramatically.

The documented decline of Blue Cranes has coincided with many reported cases of poisonings from all parts of the country (Scott & Scott 1996, Tarboton 1992, Vernon *et al* 1992), although proportionally more from the Western and Eastern Cape Provinces (where large populations of Blue Crane are found and can be expected to occur in crop fields). Poisoning in the past has been through intentional and deliberate poisoning of cranes causing crop damage, the inadvertent poisoning aimed at killing other species causing crop damage, or accidentally through the normal application of agrochemicals to croplands (Filmer & Holtshausen 1992, Allan 1994). Currently, poisoning cases are as a result of farm workers either directly poisoning cranes, or inadvertently poisoning them when baiting grain for gamebirds, for extra food protein.

Another significant threat is the removal of young Blue Crane chicks, prior to fledging, from the wild to be kept as pets, for food, or to sell to bird breeders. In the Karoo, the greatest threat occurs through collisions with the conductors and earthwires of powerlines, both large transmission and smaller distribution powerlines. Other less significant threats occur through domestic dog predation, fences, and chicks drowning in water troughs.

Conservation Concerns

The Blue Crane, despite being our national bird, has experienced dramatic population declines during the past century. Siegfried (1992) reported that only between 100 – 500 Blue Cranes were located in nature reserves, and had been recorded in 75 nature reserves, but not necessarily breeding. The inadequacy of relying on reserves is obvious and must be stressed, as the majority of cranes occur on privately owned land, the area where cranes will win or loose the survival battle.

In addition, an important fact regarding the Blue Crane population is that significant population losses have taken place in the natural grassland areas of the country, with more than 50% of this species' current distribution now occurring outside the grassland biome, this in spite of the fact that this species is recognized as a grassland endemic.

Further concern has been expressed over the future of the Blue Crane population, particularly in light of the fact that more than half of the remaining global Blue Crane population occurs in transformed agricultural lands, a system with a high likelihood of land-use change in the near future. This species has become highly adapted to using the artificial agricultural wheat-lands in the Overberg and Swartland regions of the Western Cape province. However, these favourable conditions in this area may be short-lived, as economics may drive the agriculture in the Western Cape to a crop unsuitable for Blue Cranes. As more than 50% of South Africa's Blue Crane population inhabits this area, the stability of this population is therefore a lot more tentative than the figures show.

This therefore places this population at severe risk, causing the South African Crane Working Group (SACWG), in conjunction with the Endangered Wildlife Trust (EWT) and the Conservation Breeding Specialist Group (CBSG) South Africa to hold a Population and Habitat Viability Assessment (PHVA) for Blue Cranes in Villiersdorp, Western Cape from the 1^{st} - 4^{th} of October 2001.

The overall purpose of the workshop was to assess the change in the South African Blue Crane population over the past two decades, and to assess the extinction potential of this population under current population conditions. It was, therefore, to result in the development of a conservation management strategy / plan for the Blue Crane population which will allow it to survive over the long-term in its natural and man-modified habitats in South Africa, incorporating specific recommendations and priorities for research and management.

The PHVA Process

The Blue Crane PHVA was well attended with more than 30 participants from all around South Africa. The workshop coincided with the 10th anniversary of the Overberg Crane Group who generously hosted an ice-breaker for the participants as an opener to the workshop.

The primary aim of the Blue Crane PHVA was to assess the threats to Blue Cranes, and prioritise required actions in a cohesive conservation action plan in order to improve the survival of this species in South Africa. The PHVA ran over three and half days and comprised a series of plenary and working group sessions in which working groups worked through tasks designed to facilitate free thinking, brainstorming, discussion and debate, issue tackling and finally, consensus building. Six working groups were established after the first morning's group session in which issues facing Blue Crane conservation were brainstormed. These groups dealt with the following issues:

- Institutional Management and Policy
- Education and Awareness
- Habitat and Land Use
- Causes of Blue Crane Mortality
- Trade and Captive Breeding
- Population dynamics and modelling

In addition, all life history traits of the Blue Crane were discussed in plenary in order to develop a population model that best represented the current population. Various aspects identified by the Habitat / Land Use and Causes of Mortality groups were then modelled against this standard model using the *VORTEX* programme to assess : (1) those factors making the species vulnerable to extinction, i.e. determining the sensitivity of parameters; and (2) identifying which factors, if changed or manipulated, may have the greatest effect on preventing extinction.

Working groups tackled the issues facing their group, compiling problem statements, solutions and finally resolutions and action plans and steps that will result in achieving the goals developed. Plenary sessions enabled working groups to present the results of their discussions to the whole group and obtain the input of all participants, which often resulted in much debate and insight from members of other working groups. At the end of each day, each working group submitted a report on their discussions and results, which goes towards forming the bulk of the final workshop report.

BLUE CRANE

(Anthropoides Paradiseus)

Population and Habitat Viability Assessment Workshop

Held 1 – 4 October 2001, Villiersdorp, South Africa

January 2002

Edited by

K. McCann, K. Morrison, A. Byers, P. Miller and Y. Friedmann

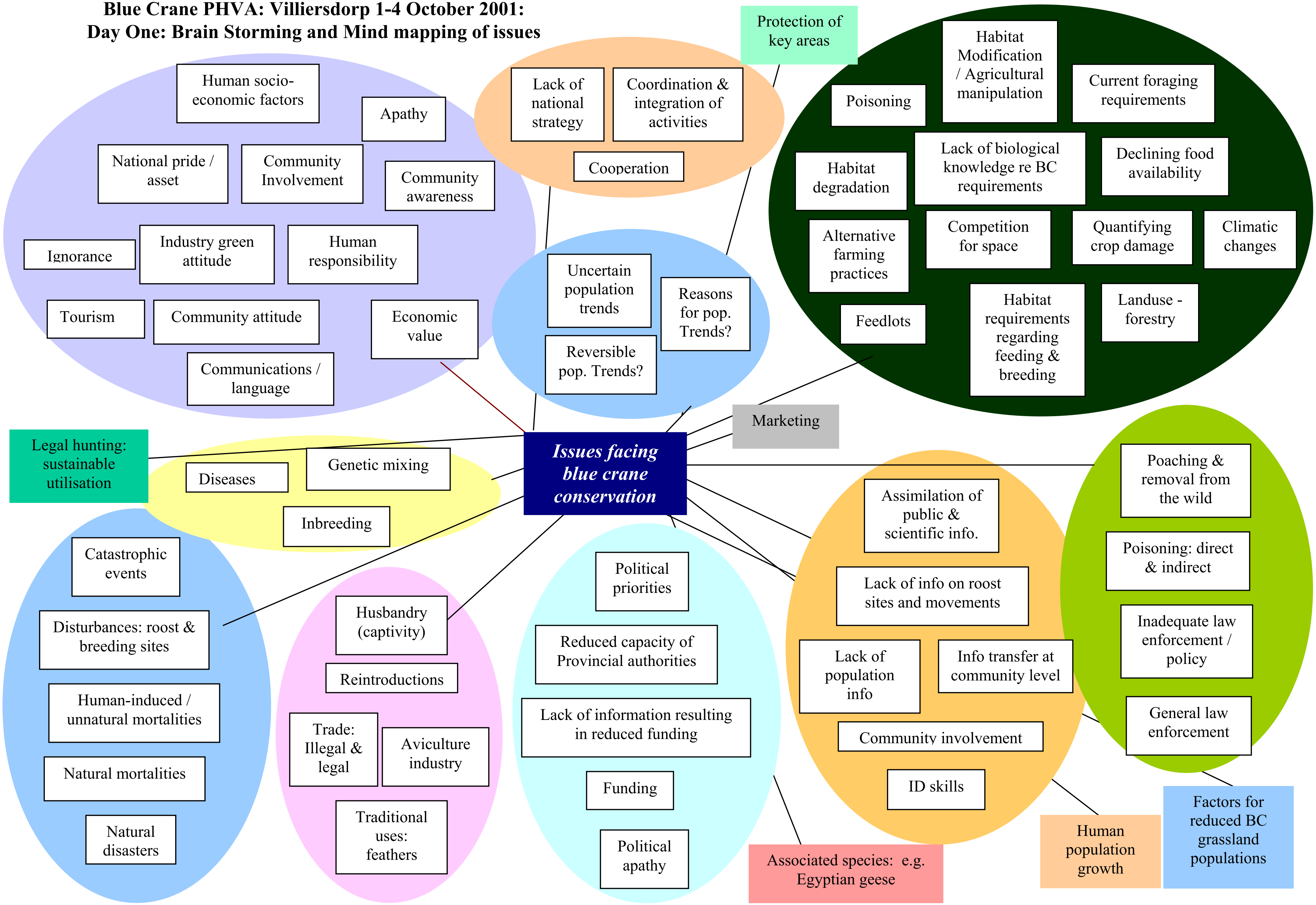
SECTION 3

WORKING GROUP REPORTS

Group Mind-Mapping Issues and Working Group Selection

Refer to diagram overleaf

Blue Crane PHVA: Villiersdorp 1-4 October 2001:
Day One: Brain Storming and Mind mapping of issues



Causes of Blue Crane Mortality

PARTICIPANTS: Chris van Rooyen, Brent Coverdale, Mark Anderson, Mike Scott, Vicky Hudson and Jon Smallie

The causes of Blue Crane mortalities were divided into “Human-induced” and “Natural” causes.

HUMAN-INDUCED CAUSES OF MORTALITY

ISSUE 1:
DIRECT POISONING
Cranes are poisoned because they are perceived to compete directly with domestic livestock for supplementary food, resulting in economic losses to certain farmers (as a result they are poisoned). Cranes are also poisoned when they are perceived to cause crop damage. Certain farmers retaliate because of the supposed economic losses caused by cranes.

ISSUE 2:
INDIRECT POISONING
Cranes are inadvertently poisoned when poisoned grain is placed to kill problem animals (rodents) or in order to kill animals for food (such as Egyptian Geese, Helmeted Guineafowl). Certain locust control chemicals may kill non-target species, such as Blue Cranes.

ISSUE 3:
OVERHEAD CABLES
Cranes fly into overhead cables when commuting between roosting and feeding grounds, especially in poor light conditions. This happens because of their flight characteristics (high wing loading, limited manoeuvrability and gregarious nature)

ISSUE 4:
FENCES
Blue Cranes become entangled in fences (probably exacerbated by disturbance and in an attempt to escape predators).

ISSUE 5:
SHOOTING
Certain farmers shoot Blue Cranes which are perceived to be causing damage to agricultural lands and which feed from domestic livestock feedlots. These farmers retaliate because of the supposed economic losses caused by cranes.

ISSUE 6:
DROWNING IN TROUGHS
Chicks become trapped and drown in domestic stock drinking troughs when attempting to drink.

ISSUE 7:
BALING TWINE
The legs and feet of Blue Cranes become entangled in discarded baling twine, either causing permanent injury to their limbs or resulting in then becoming entangled in fences.

ISSUE 8:
DISTURBANCE
Disturbance by dogs and people can result in nest desertion and then breeding failure (death of embryo or depredation of eggs and chicks). Agricultural operations can also kill eggs and chicks.

ISSUE 9:
DOGS:
Blue Crane chicks are preyed on my domestic and feral dogs.

ISSUE 10:
FIRES
Eggs and chicks can be killed by intentional and unintentional fires.

ISSUE 11:
HUNTING
Blue Crane chicks are killed for food (mainly in eastern areas).

NATURAL CAUSES OF MORTALITY

ISSUE 1:
OLD AGE
Birds die of old age.

ISSUE 2:
NATURAL PREDATION
Adults may be preyed on by carnivorous mammals (caracal, black-backed jackal) and chicks and eggs may be eaten by raptors (e.g. Martial Eagle and Jackal Buzzards) and medium- and large-sized mammals (such as baboons).

ISSUE 3:
CATASTROPHIC EVENTS
Extreme weather conditions could result in the death of adult Blue Cranes (for example, hailstorms at roost sites) or chicks (extreme cold).

ISSUE 4:
DISEASES

Avian diseases could potentially result in the death of Blue Cranes. The relative impact of the different natural causes of mortality of Blue Cranes is not fully understood.

Research of mortality factors

A lack of quantitative and qualitative data probably results in certain mortality factors being under-represented and others being over-represented (i.e. information is not available on the different crane mortality factors and the impact (and relative importance) of each factor). A further problem is that a lack of age-specific mortality data means that long-term survival predictions are difficult to determine.

Additional discussion points:

- Mortality factors are area specific; e.g. poisons are more important in Overberg; powerlines are more important in eastern Karoo.
- Mass site specific mortality events may result in a mortality factor being over-represented
- Cannot rank because of insufficient data
- Research is required to determine the significance of other mortality factors
- Poverty relief funding will not resolve many of the problems – farmers labourers are already employed, short-term solution (poverty relief funding may not be available indefinitely).
- The prioritisation of solutions is area specific (some problems will be ranked as a higher priority in some areas; for example, locust control impacts on cranes are important in the Karoo, but not necessarily in other regions)

- When it came to the prioritisation of solutions, certain overlaps were detected and thus subsequently combined into the table below. (see appendix for original table)

The group drafted a list of solutions for all their issues and problem statements and then pair-ranked the entire list of solutions. They came out with a list in order of priority which addresses all the solutions which reads as follows:

CAUSES OF BLUE CRANE MORTALITY

Paired ranking of solutions

No	Solution	Member's rank						Total	Order
10	Make problem powerlines visible using an effective marking device.	19	18	16	12	18	17	100	**1**
11	Route new powerlines away from Blue Crane hotspots.	11	14	14	10	17	16	82	**2**
6	Promote an awareness amongst farmers and farm labourers about the negative impacts and effects of poisons on non-target animals	15	13	11	11	11	17	78	**3**
5	Encourage farmers to tolerate Blue Cranes.	8	17	15	9	4	14	67	**4**
20	Investigate and determine the relative impact of the different natural and unnatural causes of mortality of Blue Crane populations (especially looking at age specific differences).	16	15	15	13	7	1	67	**5**
13	Modify existing domestic stock drinking troughs and/or design crane-friendly troughs.	11	7	15	12	8	10	63	**6**
14	Reduce the amount of baling twine in the veldt.	8	12	8	10	7	17	62	**7**
15	Improve the awareness of farmers about the effect of their activities on cranes while they are breeding.	9	8	17	9	11	8	62	**8**
17	Make farmers aware of nesting cranes during the harvesting period and propose solutions.	8	5	16	12	18	3	62	**9**
8	Develop and promote alternative and selective problem animal control methods.	17	7	8	8	10	8	58	**10**
16	Make farmers and farm labourers aware of the effect of their dogs on breeding cranes (& control dogs).	14	10	2	8	8	10	52	**11**
1	Design methods to restrict access of Blue Cranes to feed troughs/lots.	3	7	11	11	9	10	51	**12**
19	Make land managers aware about the illegal hunting of cranes and the impact on their populations.	3	18	1	12	12	4	50	**13**
7	Promote alternative legal hunting methods to kill other animals.	10	4	2	5	14	8	43	**14**
12	To investigate the impact of fences on Blue Cranes and to evaluate and develop solutions.	16	12	5	3	1	5	42	**15**
2	Provide an alternative food source and feeding method for Blue Cranes (and/or livestock).	4	4	10	10	5	7	40	**16**
4	Enforce legislation when Blue Cranes are illegally killed (poison, shooting & hunting))	1	14	5	3	6	11	40	**17**
9	Ensure that locust control poisons are crane friendly.	18	3	4	1	1	8	35	**18**
3	Design a method to restrict access of Blue Cranes to vulnerable agricultural lands.	2	0	11	8	1	10	32	**19**
18	Make land managers aware of the impact of fires on cranes during the crane breeding season.	1	3	1	9	0	0	14	**20**

SOLUTIONS:

SOLUTION 1: MAKE PROBLEM POWERLINES VISIBLE USING AN EFFECTIVE MARKING DEVICE.

ACTION STEP 1:
Continue to create awareness about Blue Crane powerline collisions

RESPONSIBILITY:
Eskom-EWT Strategic Partnership
TIMELINE:
Ongoing
RESOURCES REQUIRED:
Eskom-EWT Strategic Partnership; Blue Crane field workers, regional and local media.
COLLABORATORS:
SACWG, KZNCF, OCG, HCG, nature conservation agencies, Eskom
MEASURABLE OUTCOMES:
Increased reporting.
IMPACT:
Increased reporting resulted in more lines being marked.
OBSTACLES:
Limited resources (time), general apathy (Eskom, landowners)

ACTION STEP 2:
Conduct field investigations of reported incidents.

RESPONSIBILITY:
Eskom-EWT Strategic Partnership volunteer field investigators.
TIMELINE:
Field investigation within a month of reporting.
RESOURCES REQUIRED:
Suitably experienced person, transport, camera and film, digital camera, GPS, time.
COLLABORATORS:
SACWG, KZNCF, OCG, HCG, nature conservation agencies, Eskom field services staff, landowners.
MEASURABLE OUTCOMES:
Completed field investigation forms and a set of recommendations.
IMPACT:
If required, the marking of the specific powerline.
OBSTACLES:
Absence of field investigators in certain areas.

ACTION STEP 3:
Marking of powerline with an appropriate device.

RESPONSIBILITY:
Eskom.
TIMELINE:
From point of registration, within three months the powerline will be marked.
RESOURCES REQUIRED:
Qualified personnel, vehicle, mitigation devices, appropriate fitting equipment, time.
COLLABORATORS:
Eskom subcontractors.
MEASURABLE OUTCOMES:
Marked powerlines.
IMPACT:
Reduction in mortalities.
OBSTACLES:
Mechanical failure of mitigation devices, Eskom priorities, communication breakdowns, quality control, lack of funding.

ACTION STEP 4:
Monitoring the effectiveness of the mitigation measure.

RESPONSIBILITY:
Eskom-EWT Strategic Partnership.
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Transport, camera and film, digital camera, GPS, time.
COLLABORATORS:
Landowner, farm workers, SACWG and other field workers.
MEASURABLE OUTCOMES:
Feedback about recurrences of collisions and ineffective marking devices.
IMPACT:
Re-evaluation of marking method.
OBSTACLES:
Monitoring is neglected once the powerline is marked. If there is mechanical failure of a product, there is no replacement device.

ACTION STEP 5:
The identification of high risk collision areas.

RESPONSIBILITY:
Eskom-EWT Strategic Partnership.
TIMELINE:
Five years.
RESOURCES REQUIRED:
Suitably qualified personnel, transport, field equipment, funds, time,
COLLABORATORS:

Selected environmental NGO field workers, nature conservation agencies.
MEASURABLE OUTCOMES:
Risk assessment reports.
IMPACT:
High risk areas are identified and mitigation measures are implemented.
OBSTACLES:
Funding. Low priority for Eskom. Logistics (terrain). Time.

ACTION STEP 6:
Continue research to investigate the suitability and effectiveness of mitigation devices.

RESPONSIBILITY:
Eskom-EWT Strategic Partnership. Eskom Research & Development.
TIMELINE:
Before mid-2002.
RESOURCES REQUIRED:
Researchers, research facilities, suitable laboratories, suitable experimental sites, funding.
COLLABORATORS:
Eskom research personnel, manufacturers (e.g. PLP), biological researchers (universities and government agencies).
MEASURABLE OUTCOMES:
An effective mitigation device.
IMPACT:
Reduced collisions with problem lines; reduced cost; mechanically durable device.
OBSTACLES:
Eskom low priority and disinterest, availability of researchers, do not have luxury of long-term monitoring periods.

<u>SOLUTION 2:</u> ROUTE NEW POWERLINES AWAY FROM BLUE CRANE HOTSPOTS

ACTION STEP:
Provide input into EIA process.

RESPONSIBILITY:
Eskom-EWT Strategic Partnership, conservation authorities, environmental NGOs, members of the public (landowners).
TIMELINE:
Ongoing. As stipulated by individual EIA.
RESOURCES REQUIRED:
Time, transport.
COLLABORATORS:
Eskom-EWT Strategic Partnership, conservation authorities, environmental NGOs, members of the public (landowners).
MEASURABLE OUTCOMES:
Decision which reflects Blue Crane related input. Could possibly be a rerouted or a marked powerline.
IMPACT:

Fewer crane mortalities.
OBSTACLES:
Scoping Reports not being conducted by suitably qualified persons. Do not have opportunity to give input into all EIAs for developments in crane areas. Cost of mitigation measures leads to some lines not being marked (especially self build schemes). Cost of a longer line.

SOLUTION 3: PROMOTE AN AWARENESS AMONGST FARMERS AND FARM LABOURERS ABOUT THE NEGATIVE IMPACTS OF POISONS ON NON-TARGET ANIMALS

ACTION STEP 1:
In order to develop a coordinated and effective extension programme, it is necessary to identify problem areas and the poisons and agrochemicals used to kill problem animals (e.g. gerbils, Egyptian Geese) which impact the Blue Cranes.

RESPONSIBILITY:
Poison Working Group. OCG Field Worker
TIMELINE:
By end of 2002.
RESOURCES REQUIRED:
People with appropriate expertise. Coordinator Time.
COLLABORATORS:
SACWG and other field workers, landowners, chemical reps, AVCASA, ACDASA.
MEASURABLE OUTCOMES:
A document detailing a coordinated and effective extension programme which identifies problem areas and the means to deal with the problem.
IMPACT:
An effective extension programme which results in the responsible use of poisons.
OBSTACLES:
No coordinator. Reluctant landowners. Lack of knowledge about the poisons used and the distribution of the problem.

ACTION STEP 2:
To identify field workers in problem areas to conduct awareness programmes.

RESPONSIBILITY
SACWG and PWG coordinators.
TIMELINE
By end of 2002.
RESOURCES REQUIRED:
Vehicle. Time.
COLLABORATORS
Conservation authorities, other government departments, environmental NGOs, agricultural extension officers, cooperatives.
MEASURABLE OUTCOMES
New field workers in key areas.
IMPACT

Awareness programmes in problem areas.
OBSTACLES
Funds. Time. Lack of field workers in certain areas.

ACTION STEP 3:
Identification of appropriate resource materials and development of resource materials about poisons and their impact on Blue Cranes.

RESPONSIBILITY:
PWG and OCG Field worker.
TIMELINE:
End of 2003.
RESOURCES REQUIRED:
Funds. Time. Facilities to produce resources.
COLLABORATORS:
SACWG and other field workers.
MEASURABLE OUTCOMES:
Production of resource materials.
IMPACT:
Increased knowledge and awareness about poisons which impact on Blue Cranes.
OBSTACLES:
Funds. Time.

ACTION STEP 4:
Dissemination of information about poisons.

RESPONSIBILITY:
SACWG and other field workers.
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Field workers. Vehicle. Funds.
COLLABORATORS:
Conservation authorities, other government departments, environmental NGOs, agricultural extension officers, cooperatives.
MEASURABLE OUTCOMES:
Increased knowledge and awareness about poisons which impact on Blue Cranes. Increased reports about poisoning incidents.
IMPACT:
Fewer Blue Cranes poisoned.
OBSTACLES:
No (knowledgeable) field workers in some areas to disseminate information. No follow-up of awareness programme. General apathy.
<u>SOLUTION 4:</u> ENCOURAGE FARMERS TO TOLERATE BLUE CRANES

ACTION STEP 1:
To place (or identify) suitable field workers in certain Blue Crane areas (where there is conflict between farming and cranes).

RESPONSIBILITY:
SACWG Overberg Crane Group.
TIMELINE:
Mid-2002.
RESOURCES REQUIRED:
Funding, vehicle.
COLLABORATORS:
Conservation authorities (including district conservators and environmental educators), affiliated crane groups, other environmental NGOs.
MEASURABLE OUTCOMES:
Field workers in areas where there is a farming-crane conflict.
IMPACT:
Increased tolerance by farmers towards Blue Cranes.
OBSTACLES
Funding. Time. Suitable persons.

ACTION STEP 2:
To actively involve farmers in crane conservation.

RESPONSIBILITY:
Local/regional crane group and/or conservation authority.
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Time.
COLLABORATORS:
Conservation authorities (including district conservators and environmental educators), other government departments, environmental NGOs, agricultural extension officers, cooperatives.
MEASURABLE OUTCOMES:
Tolerance and appreciation of Blue Cranes.
IMPACT:
Reduction in the persecution of Blue Cranes.
OBSTACLES:
Disinterest. Economic factors.

SOLUTION 5: INVESTIGATE AND DETERMINE THE RELATIVE IMPACT OF DIFFERENT NATURAL AND UNNATURAL CAUSES OF MORTALITY OF BLUE CRANE POPULATIONS (ESPECIALLY LOOKING AT AGE SPECIFIC DIFFERENCES)

ACTION STEP 1:
Initiate studies to determine the relative impacts of the unnatural causes of mortality of Blue Cranes.

RESPONSIBILITY:
SACWG (Kevin McCann).
TIMELINE:

Datasheet (Feb 2002); project results (before end-2003).
RESOURCES REQUIRED:
Funding. Field workers. Vehicle.
COLLABORATORS:
Field workers, conservation authorities (including district conservators and environmental educators), landowners, Eskom.
MEASURABLE OUTCOMES:
An understanding of the relative importance of the different mortality factors.
IMPACT:
Information to prioritise crane conservation actions.
OBSTACLES:
Funding. Work-load of field workers.

ACTION STEP 2:
Initiate a study to determine the relative impacts of natural causes of mortality of Blue Cranes.

RESPONSIBILITY:
SACWG (Kevin McCann).
TIMELINE:
End 2005.
RESOURCES REQUIRED:
Funding.
COLLABORATORS:
Researcher at University.
MEASURABLE OUTCOMES:
An understanding of the relative importance of the different natural mortality factors.
IMPACT:
Information for increased understanding of Blue Crane biology (use in Vortex models, etc.)
OBSTACLES:
Funding. Project methodology. Difficulty in obtaining data.

ACTION STEP 3:
To initiate a research project to model survival using ringing and resighting data.

RESPONSIBILITY
SACWG.
TIMELINE:
End 2005.

RESOURCES REQUIRED:
Funding.
COLLABORATORS:
University researcher (Prof. Steven Piper?).
MEASURABLE OUTCOMES:
Information about survival.
IMPACT:
Increased knowledge about Blue Crane biology.
OBSTACLES:

Too few cranes ringed. Lack of ring colour combinations.

ACTION STEP 4:
Increased ringing and resighting effort in key crane areas.

RESPONSIBILITY:
SACWG (Kevin McCann).
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Rings and ringing equipment. Vehicles. Funds. Personnel. Time.
COLLABORATORS:
Field workers, conservation authorities (including district conservators and environmental educators), landowners, environmental NGOs.
MEASURABLE OUTCOMES:
Data about unnatural and natural mortalities of different Blue Crane age classes.
IMPACT:
Increased knowledge about Blue Crane biology.
OBSTACLES:
Difficulty in obtaining accurate resightings. Funds. Resightings.

SOLUTION 6: MODIFY EXISTING DOMESTIC STOCK DRINKING TROUGHS AND/OR DESIGN CRANE-FRIENDLY DRINKING TROUGHS.

ACTION STEP 1:
Encourage landowners to place rocks in corner of drinking troughs to enable chicks to escape.

RESPONSIBILITY:
SACWG OCG. conservation authorities.
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Rocks. Posters.
COLLABORATORS:
Agricultural extension officers, environmental NGOs, cooperatives.

MEASURABLE OUTCOMES:
More crane friendly domestic stock drinking troughs.
IMPACT:
Fewer crane chick drownings.
OBSTACLES:
Landowner apathy.

ACTION STEP 2:
Design a crane chick-friendly domestic stock drinking trough (which enables crane chicks to climb from troughs and to provide water for other livestock).

RESPONSIBILITY
SACWG, OCG
TIMELINE
End-2002.
RESOURCES REQUIRED:
Time.
COLLABORATORS
Manufactures.
MEASURABLE OUTCOMES
A crane chick-friendly domestic stock drinking trough
IMPACT
Fewer chick drownings.
OBSTACLES
Landowners already have existing troughs. Funds.

<u>SOLUTION 7:</u> REDUCE THE AMOUNT OF BALING TWINE IN THE VELDT

ACTION STEP 1:
Encourage landowners and labourers to collect baling twine in veldt.

RESPONSIBILITY:
Field workers.
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Time.
COLLABORATORS:
Landowners, farm workers, agricultural extension officers, conservation authorities (including district conservators and environmental educators).
MEASURABLE OUTCOMES:
Reduction of baling twine in veldt.
IMPACT:
Fewer entangled cranes, loss of limbs, and mortalities.
OBSTACLES:
Landowner apathy and disinterest. No suitable, cheap alternative.

<u>SOLUTION 8:</u> IMPROVE THE AWARENESS OF FARMERS ABOUT THE EFFECTS OF THEIR ACTIVITIES ON CRANES WHILE THEY ARE BREEDING

ACTION STEP 1:
Encourage farmers to reduce the activities in areas where cranes are breeding in order to prevent the death of embryo and chick (e.g. parents stop incubation and eggs exposed to the cold) and depredation of embryo and chick.

RESPONSIBILITY:

Crane field officers.
TIMELINE;
Ongoing.
RESOURCES REQUIRED:
Time.
COLLABORATORS:
Landowners, farm workers, agricultural extension officers, conservation authorities (including district conservators and environmental educators).
MEASURABLE OUTCOMES
Increased fledging success.
IMPACT:
Reduced mortality of embryos and chicks.
OBSTACLES:
Ignorance. Disregard.

<u>SOLUTION 9:</u> MAKE FARMERS AWARE OF NESTING CRANES DURING THE HARVESTING PERIOD AND PROPOSE SOLUTIONS

ACTION STEP 1:
Make farmers aware of the effect of their harvesting activities on breeding cranes and encourage crane friendly harvesting methods.

RESPONSIBILITY:
Crane field officers.
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Time. Rocks and markers to mark position of nests. Labour.
COLLABORATORS:
Landowners, farm workers, agricultural extension officers, conservation authorities (including district conservators and environmental educators).
MEASURABLE OUTCOMES:
Increased fledging success.
IMPACT:
Reduced mortality of embryos and chicks.
OBSTACLES:
Disinterest and disregard.
ACTION STEP 1:
To promote an awareness of the negative impact on cranes of certain indiscriminate problem animal control methods (rodents, Egyptian Geese).

RESPONSIBILITY:
Crane field workers.

TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Time. Resource materials.
COLLABORATORS:

Landowners, farm workers, agricultural extension officers, conservation authorities (including district conservators and environmental educators).
MEASURABLE OUTCOMES:
More selective problem animal control methods.
IMPACT:
Fewer crane mortalities.
OBSTACLES:
Lack of suitable alternatives. Reluctance to use alternatives. Resistance to change. Finances.

ACTION STEP 2:
To determine alternative problem animal control methods.

RESPONSIBILITY:
SACWG (Kevin McCann).
TIMELINE:
Mid-2005.
RESOURCES REQUIRED:
Funding. Time. Researchers.
COLLABORATORS:
Universities, conservation authorities (including district conservators and environmental educators).
MEASURABLE OUTCOMES:
More selective problem animal control methods.
IMPACT:
Fewer crane mortalities.
OBSTACLES:
Funds.

<u>SOLUTION 11:</u> MAKE FARMERS AND FARM LABOURERS AWARE OF THE EFFECTS OF THEIR DOGS ON BREEDING CRANES (AND CONTROL DOGS)

ACTION STEP 1:
For farmers and farm labourers to control their dogs and/or to restrict them to their homesteads.

RESPONSIBILITY:
Crane field officers, conservation authorities (including district conservators and environmental educators).
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Time.
COLLABORATORS:
Landowners, farm workers, agricultural extension officers.
MEASURABLE OUTCOMES:
Increased fledging success.
IMPACT:

Reduced mortality of embryos and chicks.
OBSTACLES:
Ignorance. Disregard. Lack of law enforcement. Repercussions of shooting dogs.

SOLUTION 12: DEVELOP METHODS TO RESTRICT ACCESS OF BLUE CRANES TO FEED TROUGHS / LOTS

ACTION STEP 1:
To develop and evaluate methods to restrict access of Blue Cranes to feed troughs/lots.

RESPONSIBILITY:
Overberg Crane Group.
TIMELINE:
December 2002.
RESOURCES REQUIRED:
Time, collaborators, equipment.
COLLABORATORS
Land managers, manufactures, agricultural colleges, agricultural extension officers.
MEASURABLE OUTCOMES:
An effective method to keep Blue Cranes away from feed troughs/lots.
IMPACT:
Reduced feeding by cranes at feed troughs/lots.
OBSTACLES:
Funds, practicality and suitability of method.

SOLUTION 13: MAKE LAND MANAGERS AWARE OF THE ILLEGAL HUNTING OF CRANES FOR FOOD AND THE IMPACT ON THEIR POPULATIONS

ACTION STEP 1:
Increase landowners awareness about the impact of illegal hunting of cranes on their properties on Blue Crane populations.
RESPONSIBILITY:
Crane field officers.
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Time, funds.
COLLABORATORS:
Landowners, farm workers, conservation authorities (including district conservators and environmental educators), agricultural extension officers.
MEASURABLE OUTCOMES:
Increased awareness about the negative effect of Blue Crane hunting.
IMPACT:
Increased crane populations.
OBSTACLES:
Difficult to control activities on farm. Farm worker ignorance. Socio-economic factors.

<u>SOLUTION 14:</u> PROMOTE ALTERNATIVE LEGAL HUNTING METHODS TO KILL OTHER ANIMALS
See solution 3.

<u>SOLUTION 15:</u> INVESTIGATE THE IMPACT OF FENCES ON BLUE CRANES AND TO EVALUATE AND DEVELOP SOLUTIONS.
See solution 5.

<u>SOLUTION 16:</u> PROVIDE AN ALTERNATIVE FOOD SOURCE AND FEEDING METHOD FOR BLUE CRANES (AND OR LIVESTOCK)

ACTION STEP 1:
To research possibilities of alternative food for livestock, which is unsuitable to cranes.

RESPONSIBILITY:
SACWG (Kevin McCann). OCG.
TIMELINE:
End-2003.
RESOURCES REQUIRED:
Funds, time, cooperation of feed companies.
COLLABORATORS
Feed companies, Overberg Crane Group, farmers.
MEASURABLE OUTCOMES:
A livestock food source or feeding method which is unsuitable to cranes.
IMPACT:
Reduced conflict between cranes and farmers.

OBSTACLES:
Economics. Unlikely to find a suitable method.

<u>SOLUTION 17:</u> ENFORCE LEGISLATION WHEN BLUE CRANES ARE ILLEGALLY KILLED (POISONING, SHOOTING AND HUNTING)

ACTION STEP 1:
Improved law enforcement by nature conservation authorities and SAPS.

RESPONSIBILITY:
Law enforcement agencies and SAPS.
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Time, resource materials (such as posters).
COLLABORATORS:

SACWG, crane field officers, agricultural extension officers, land managers.
MEASURABLE OUTCOMES:
Increased and appropriate enforcement.
IMPACT:
Reduce illegal killing of cranes.
OBSTACLES:
Lack of knowledge about legislation. Lack of manpower. Apathy.

<u>SOLUTION 18:</u> ENSURE THAT LOCUST CONTROL POISONS ARE CRANE-FRIENDLY

ACTION STEP 1:
Ensure that Department of Agriculture continue to use crane-friendly poisons.

RESPONSIBILITY:
SAWCG. PWG. Conservation agencies.
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Time.
COLLABORATORS:
Landowners.
MEASURABLE OUTCOMES:
Crane-friendly locust control poisons are used.
IMPACT:
Cranes are not poisoned.
OBSTACLES:
Economics. Ignorance. Incorrect implementation on ground.

ACTION STEP 2:
Promote non-chemical means to control locusts ("bossieslagter", funnels, natural predators).

RESPONSIBILITY:
SACWG, conservation authorities (including district conservators and environmental educators).
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Time, equipment, funds, labour.
COLLABORATORS:
Crane field workers, other environmental NGOS, land managers.
MEASURABLE OUTCOMES:
Non-poison methods used to control locusts.
IMPACT:
Cranes are not poisoned. Locust food available for cranes and other birds.
OBSTACLES:
Economics. Ignorance. Incorrect implementation on ground. Farmers not aware of alternatives and impact of poisons on cranes and other birds

<u>SOLUTION 19:</u> DESIGN A METHOD OF RESTRICTING BLUE CRANE ACCESS TO VULNERABLE AGRICULTURAL LANDS

ACTION STEP 1:
Design a cost-effective, practical and feasible methods to keep cranes off vulnerable agricultural lands.

RESPONSIBILITY:
Kwande East Cape Crane Project
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Funding, gas cannons, chevron tape, droppers, time, vehicle.
COLLABORATORS:
Crane field workers, landowners.
MEASURABLE OUTCOMES:
The development of a suitable method.
IMPACT:
Reduced presence of cranes on vulnerable crop lands.
OBSTACLES:
Funds, time, practicalities, acceptance by farmers.

<u>SOLUTION 20:</u> MAKE LAND MANAGERS AWARE OF THE IMPACT OF FIRES N CRANES DURING THE CRANE BREEDING SEASON

ACTION STEP 1:
Promote sound fire management practices (fire-breaks, fire control, burning outside breeding season).

RESPONSIBILITY:
Crane field officers.
TIMELINE:
Ongoing.
RESOURCES REQUIRED:
Time, funds, vehicle.
COLLABORATORS:
Other environmental NGOS, land managers, agricultural extension officers, conservation authorities (including district conservators and environmental educators).
MEASURABLE OUTCOMES:
Crane breeding areas not burnt.
IMPACT:
Increased reproductive success.
OBSTACLES:
Ignorance. Necessity to burn during breeding season. Wild and arson fires.

ADDENDUM:

It is recognised by this group that certain actions involving awareness amongst farmers have also been suggested by the group dealing with education and awareness. It is suggested that it is incumbent upon the National Co-ordinator to ensure that there is no duplication of effort.

Policy and Institutional Management

Participants: Steven Evans, Gustav Engelbrecht, Kobus Pienaar, Helen Gaynor, Sampie van der Merwe and Shaun Page.

ISSUES AND SOLUTIONS:

ISSUE 1
LACK OF A NATIONAL BLUE CRANE CONSERVATION STRATEGY
The lack of a national strategy, co-ordination, integration of activities and co-operation is due to the fact that the conservation of the blue crane has not been a priority.

Subsequently, there is:

- A lack of information and awareness
- A lack of resources, money, people etc.
- No previous lead agency
- Fragmentation between institutions, provinces, government organisations and NGO's
- No Inter-provincial management committees and coordinating structures
- No national legislation and policy
- A lack of communication structures

SOLUTION 1: National Committee - Provincial representation from all interested and affected parties. (Propose SACWG)

SOLUTION 2: National Management Policy Document

SOLUTION 3: Inter-provincial Conservation Committees

SOLUTION 4: Ensure that an Information and Awareness programme is launched (E & A Group). It should be a Government and a public project.

SOLUTION 5: Acquire funding (see issue 2)

SOLUTION 6: Promote the Blue Crane and its natural habitat as a conservation priority.

ISSUE 2
FUNDING
Inadequate funding has been identified as an inherent problem. The funding issue relates to both Government and NGOs. The problems can be identified by the economic climate, priorities and values, namely:

- Limited Government budget for conservation
- Current and future economic climate
- Priorities both politically and internally

- A general disinterest in conservation
- Competitive environment
- Value conflicts
- World economics
- Increase in human population
- Provincial and political apathy.
- Lack of knowledge
- Too many social issues
- People before nature
- Past political history of South Africa
- Other higher conservation priorities
- Economic values

SOLUTION 1: Business plan is used as a motivation tool to obtain funding. Divide into Government and NGO.

SOLUTION 2: Project budgets.

SOLUTION 3: Sponsorships.

SOLUTION 4: Promote Blue Crane and its natural habitat as a priority for conservation

SOLUTION 5: Partnerships

SOLUTION 6: Awareness of World and National economic trends and plan accordingly.

SOLUTION 7: Promote Blue Crane as an important tourist attraction.

ISSUE 3
INADEQUATE LAW ENFORCEMENT

Blue Cranes are being threatened due to a lack of adequate legislation and law enforcement due to:

- Lack of staff, resources, logistics, funds etc.
- Outdated policies: politicians' hesitancy to sign new legislation, fragmentation, and constant restructuring (causes confusion).
- Lack of HQ and political back-up, integration process has frustrated this process.
- Lack of commitment/inadequate training.
- Inadequate legislative process (court procedure).
- No mechanisms to involve general community
- Other priorities and commitment
- Fragmented law enforcement, no incentives.
- Inadequate communication channels.

SOLUTION 1: Lobby for adoption of appropriate legislation and policy and for implementation of policies through supply of adequate resources.

<u>SOLUTION 2</u>: National Committee to supply information and policy to the appropriate authorities.

<u>SOLUTION 3</u>: Train personnel according to identified needs.

<u>SOLUTION 4</u>: Promote improved liaison between local law enforcement officers and legal administrators in terms of conservation issues.

<u>SOLUTION 5</u>: Promote general awareness of Blue Crane conservation policies to the public.

<u>SOLUTION 6</u>: Issue appropriate rewards for reporting irregularities regarding Blue Cranes.

The above solutions were evaluated against the various filter guidelines, and there was consensus on the results.

<u>PRIORITISATION OF SOLUTIONS:</u>

The solutions were then grouped and ranked according to the paired ranking system. The following are the solutions in order of priority:

1. Lobby for adoption of appropriate legislation and policy, and for implementation of policies through supply of adequate resources.
2. National Committee - Provincial representation from all interested and affected parties. (Propose SACWG)
3. Promote general awareness of Blue Crane conservation policies to the public.
4. National Committee to supply information and policy to the appropriate authorities.
5. Train personnel according to identified needs.
6. National Management Policy Document
7. Acquire Funding
8. Promote Blue Crane and its natural habitat as a priority for conservation.
9. Ensure that Information and Awareness programme is launched (E & A Group). It should be a Government approach and a public approach.
10. Promote Blue Crane as an important tourist attraction.
11. Partnerships
12. Sponsorships.

13. Business Plan is used as a motivation tool to obtain funding. Divide into Government and NGO.

14. Promote improved liaison between local law enforcement officers and legal administrators in terms of conservation issues.

15. Inter-provincial Conservation Committees

16. Project budgets.

17. Issue appropriate rewards for reporting irregularities regarding Blue Cranes.

18. Awareness of World and National economic trends and plan accordingly.

ACTION STEP DEVELOPMENT:

From the list of solutions, five solutions with appropriate Action Steps were developed which incorporated the rest of the solutions, namely:

SOLUTION 1: LOBBY FOR THE ADOPTION OF APPROPRIATE LEGISLATION AND POLICY, ITS IMPLEMENTATION AND PROVISION OF RESOURCES

Covers:

- National Committee to supply information and policy to the appropriate authorities.
- Training personnel according to identified needs.
- National Management Policy Document.
- Promote Blue Crane and its natural habitat as a priority for conservation.

ACTION STEPS: (In order of importance)

a. Review existing legislation and policy for all relevant provinces. (Conservation organisations).
b. Document proposals to be incorporated into new National Management Policy with the input of all the affected and interested parties.
c. Identify appropriate individuals, organisations, and politicians to be lobbied.
d. Lobby for the adoption of the proposed new National Management Policy.
e. National Committee to supply information and policy to the authorities.
f. Lobby for the acceptance of principles contained in the new National Management Policy to be incorporated into existing and future National legislation. Promote Blue Crane as conservation priority.
g. Lobby for resources for the implementation of the National Management Policy and resulting legislation.
h. Training personnel according to identified needs.
i. Lobby for Inter-provincial Conservation Committees

RESPONSIBILITY: SACWG sub committee " Policy and Legislation " representatives from all Provincial organisations and appropriate stakeholders.
TIMELINE:
- Review of all legislation = 6 months
- Drafting of National Management Policy = 1 year.
- Lobbying to start within 12 months of Draft National Management Plan.
- Implementation = Unknown.

RESOURCES REQUIRED: People, money and time to be carried by the current budgets.
COLLABORATORS:
- Legal advisors can be co-opted when necessary.
- Other stakeholders can be co-opted when necessary.

MEASURABLE OUTCOMES:
- Consolidation of fragmented policy and legislation.
- General awareness.
- Approved co-operation and communication.

IMPACT:
- Improved regulation and control.
- Improved organisational capacity.
- More efficient crane conservation, by means of:
  - Reduction in threats to the cranes.
  - Reduced removal from the wild / trade.
  - Reduced poisonings.
  - Reduced hunting.
  - Reduced powerline collisions.

OBSTACLES:
- Government and political apathy, slow procedures, other current priorities and time-constraints.
- Lack of funds.
- Time constraints.

<u>SOLUTION 2:</u> A NATIONAL COMMITTEE CONSISTING OF PROVINCIAL REPRESENTATION AND ALL STAKEHOLDERS

Covers:
- Partnerships.

ACTION STEPS:

a Propose SACWG as the national representative committee for crane conservation in South Africa.
b Acceptance of SACWG as the national representative (mandated) committee for Blue Cranes in South Africa by the relevant authorities.
c Continued revision and improvement of representation by all stakeholders.
d Maintain and revise the existing prospectus (constitution).

RESPONSIBILITY: SACWG.
TIMELINE: Next SACWG meeting = 6 months
RESOURCES REQUIRED:
- Certain representation.

- Funding.
- Personnel time.

COLLABORATORS: Can be co-operated when necessary.
MEASURABLE OUTCOMES:

- Acceptance of a National Crane Committee by the relevant authorities.
- Improved representation, co-operation and communication.
- More effective and efficient Blue Crane conservation.

IMPACT: More effective and efficient Blue Crane conservation.
OBSTACLES:

- Lack of personnel.
- Limited funding.

<u>SOLUTION 3:</u> PROMOTE GENERAL AWARENESS AND CONSERVATION POLICIES TO THE PUBLIC

Covers:

- Promote Blue Crane and its natural habitat as a priority for conservation.
- Promote improved liaison between local law enforcement officers and legal administrators in terms of conservation issues.
- Issue appropriate rewards for reporting irregularities regarding Blue Cranes.

ACTION STEPS:

a. Identify the target groups.
b. Identify appropriate format of information for each target group.
c. Supply information to the National Networking Co-ordinator.
d. Proposed SACWG sub committee for Education and Awareness.
e. Promote Blue Crane as priority for conservation.
f. Promote improved liaison between local law enforcement officers and legal administrators in terms of conservation issues.

RESPONSIBILITY: Policy and legislation sub-committee and Education and Awareness sub-committee (proposed).
TIMELINE: After adoption of National Management policy = 6 months.
RESOURCES REQUIRED: Personnel and funding.
COLLABORATORS:

- Communication experts.
- Sponsors.

MEASURABLE OUTCOMES:

- Increased reporting of irregularities.
- More charges.

IMPACT:

- Improved Blue Crane conservation awareness.
- Reduced threats to cranes.
- More cases reported.
- Increase in crane populations.
- Less eggs and nestling removed from the wild.
- Reduced accidental and deliberate poisoning.

OBSTACLES:

- Inadequate monitoring across the full Blue Crane range.
- Economic climate.

<u>SOLUTION 4:</u> ACQUIRE FUNDING

Covers:

- Business Plan is used as a motivation tool to obtain funding. Divide into Government and NGO.
- Sponsorships.
- Project budgets.

ACTION STEPS:

a Identify funding needs.
b Identify funding agencies.
c Apply to funding agencies with a business plan.
d Receive funding.
e Maintain contact with sponsors via regular meetings and reports.
f Stay up to date with World and National economic trends and plan accordingly.
g Identify (e.g reporting irregularities etc.) and structure incentives for contributors (e.g. farm workers, volunteers etc.) to crane conservation.
h Allocate funding to rewards programme.

RESPONSIBILITY: SACWG National Co-ordinator and collaborators.
TIMELINE: Ongoing.
RESOURCES REQUIRED: Personnel and funding.
COLLABORATORS:

- Government.
- Other NGO's
- Funding agencies.
- Corporate sector.

MEASURABLE OUTCOMES:

- Able to implement projects.
- Improved contribution to Blue Crane conservation.

IMPACT:

- Increased numbers of Blue Cranes.
- Reduced threats to Blue Cranes.

OBSTACLES:

- Economy.
- Funding agencies priorities.

<u>SOLUTION 5:</u> PROMOTE BLUE CRANES AS AN IMPORTANT TOURIST ATTRACTION

ACTION STEPS:

a Identify target groups (tourists).
b Identify tourist destinations.
c Conduct tourism feasibility and impact assessments.
d Compile tourism action plans.
e Implement tourism action plans.

RESPONSIBILITY: SACWG Network Coordinator and collaborators.
TIMELINE: Ongoing.
RESOURCES REQUIRED: Personnel and funding.

COLLABORATORS:

- Government.
- Consultants.
- Other NGO's.
- Tourism industry.

MEASURABLE OUTCOMES:

- Improved awareness of crane conservation.
- Increased monitoring of cranes.
- Reduced threats to cranes.
- Harnessing the economic value of Blue Cranes to conserve them.
- Increased opportunities for birders to view and appreciate the Blue Crane.

IMPACT:

- Better understanding of the value (moral/ethical, economic and ecological) of Blue Cranes.
- Providing people with the knowledge and means to contribute to Blue Crane conservation.
- Reduced threats to Blue Cranes.

OBSTACLES: World economics.

Covered by the Education and Awareness group.

- Ensure that Information and Awareness programme is launched (E & A Group). It should be a Government approach and a public approach.

Education and Awareness

Participants: David Gaynor, Samson Phikathi, Nadia Kraucamp, Sindi Zwane and Jana Richards

WORKING GROUP TASK ONE: ISSUE DEVELOPMENT

Issues were brainstormed with the following results:

- Community attitude ("community" was defined as local residents, industry etc.) and divided into:
  - Rural: (Farming and schools)
  - Urban (Schools, industrial and suburban)
  - Institutions (Farmers' associations, SANCO, Chambers of Commerce, NGOs)
- Community awareness
- Ignorance
- Apathy
- Tourism
- Communication (Language)
- National pride / Asset
- Human responsibility
- Community involvement
- Industry green attitude
- Human socio-economic attitudes (Conservation is a luxury, in some areas it is low priority – e.g. deprived communities)
- Economic values (Conservation relies on funding from industry / business)
- Marketing
- Research and monitoring

GROUPING OF ISSUES:

GROUP 1: Community Issues
Issues prioritised as follows :
1. Awareness
   Ignorance
2. Attitude
3. Involvement
   Apathy

GROUP 2: Economic Factors
Issues prioritised as follows :
1. Human socio-economic
2. Industry green attitude
3. Economic values (of the BC)
4. Tourism

GROUP 3: Other Issues
Issues prioritised as follows :
1. National pride / asset
2. Language of communication
3. Marketing
4. Human responsibility

Research & Monitoring - overarching process

Research & Monitoring:
Research & monitoring has not been dealt with as a separate issue because it is seen as an overarching process which could be relevant to any or all the issues.

<u>WORKING GROUP TASK TWO: PROBLEM STATEMENTS</u>

<u>GROUP 1:</u> COMMUNITY ISSUES

ISSUE 1:
IGNORANCE / AWARENESS
We are dealing with different communities that have no understanding for or awareness of the BC and consequently do not understand the importance and value of the bird and its conservation status.

ISSUE 2:
ATTITUDE
Each community has a different attitude towards the BC. There is hostility to the BC, for example, by farmers who suffer crop damage. Without a positive attitude there will be no effort to conserve BCs. Also, people are not aware of the economic value of BCs on their land which, for example often feed on locust eggs.

ISSUE 3:
INVOLVEMENT / APATHY
The BC relies on human intervention for its survival. Without active involvement, the BC population will continue to decline. The same applies for those community members that are apathetic and disinterested in the plight of the BC. Lack of interest on their part will continue the demise of the species.

Although there are three issues under the heading of **COMMUNITY ISSUES**, the group decided that the solutions developed are common to all three, and consequently combined these three under a single heading.

SOLUTION 1: Identify the different and various communities with whom one wishes to interact, and the key role players within each community.

SOLUTION 2: Develop and implement educational programmes, relevant to the various communities, and train educational personnel for implementation.

SOLUTION 3: Prepare promotional material such as pamphlets, posters and information sheets; conduct workshops, arrange farmers days and other community activities to promote awareness; make use of media as and when opportunity arises.

SOLUTION 4: Establish links with other conservation groups, including official bodies, to promote BC conservation.

GROUP 2: ECONOMIC FACTORS

ISSUE 4:
HUMAN SOCIO-ECONOMIC FACTORS
We are dealing with a number of communities that are forced to put their personal / primary / basic survival needs first. Consequently, they are not interested in conservation. This issue is not confined solely to this group, but also extends to people / communities that depend on the income generated from their crops which they perceive to be threatened by the presence of the BCs.

SOLUTION 1: Poverty alleviation and related matters were seen to be beyond the competencies of SACWG and consequently ignored. A solution for the second target group was established.

SOLUTION 2: Develop a close working relationship with those farmers whose crops may be affected by BC activities and provide them with information and advice.

ISSUE 5:
INDUSTRY GREEN
Industries exist because of profit motives. Some industries ignore the requirements of the environment – they do not have an environmental policy and they tend to harbour contempt for legal requirements. In addition, law enforcement is inadequate. In light of these factors, the BC will be last on their list of priorities.

SOLUTION 1: Identify industries that are potentially threatening to the environment and in particular, those in BC range areas.

SOLUTION 2: Establish a "watch dog" organisation to ensure compliance by industry with the various environmental acts and regulations.

SOLUTION 3: Identify persons within industry that can positively influence that industry's attitudes to the BC; also identify those industries with a strong conservation ethic, and use to influence other organisations.

ISSUE 6:
ECONOMIC VALUE OF THE BLUE CRANE

Already threatened BC populations are being further jeopardised by an increase in the trade of the species, especially illegal, as well as an increase in the muthi trade. People do not understand how their activities affect the BC population.

SOLUTION 1: Develop an education/ awareness programme directed specifically at exploiters of BC commercially.

SOLUTION 2: Determine the cultural uses of crane parts, the cultural differences that may exist, and hence the substitution of BC parts by alternative products.

ISSUE 7:
TOURISM

Uncontrolled tourism results in disturbance in the form of breeding failure. This also alienates property owners – changing their positive attitude towards BCs into negative attitudes. Lack of the kind of right awareness could lead to illegal trade – with disastrous consequences. Environmental degradation also becomes a problem with uncontrolled tourist numbers.

SOLUTION 1: Develop tourist packages that can be used by travel agents, tourism groups and that advocate sound eco-ethical practices; develop controlled BC crane routes; publicise these packages with bird clubs to promote eco-tourism.

GROUP 3: OTHER ISSUES

ISSUE 8:
NATIONAL PRIDE / ASSET

Not many people know or support the fact that the BC is our national bird. This lack of support could, in part, be due to South Africa's political past. This could be translated into a general lack of pride. For instance, SA's new coat of arms does not feature a BC, it features a Secretary bird. People do not attach a value to the BC – be that moral & ethical, economic and ecological.

<u>SOLUTION:</u> The group concluded that this issue would be covered by solutions contained in the previous two groupings of problems.

ISSUE 9:
LANGUAGE OF COMMUNICATION
Language barriers make if difficult to disseminate information.

<u>SOLUTION:</u> The group concluded that this issue would be covered by solutions contained in the previous two groupings of problems.

ISSUE 10:
MARKETING
There has been ineffective promotion and marketing of the plight of the BC.

<u>SOLUTION:</u> The group concluded that this issue would be covered by solutions contained in the previous two groupings of problems.

ISSUE 11:
HUMAN RESPONSIBILITY
Ultimately, human beings are the biggest threat to the BC. There is a lack of understanding of who is responsible for BC conservation. The onus lies on all of us and not just conservation groups or officials.

<u>SOLUTION:</u> The group concluded that this issue would be covered by solutions contained in the previous two groupings of problems.

WORKING GROUP TASK THREE: PRIORITISING SOLUTIONS

The group then combined all the solutions into one list and ranked them in order of priority by means of paired ranking, with the following results:

SOLUTIONS IN ORDER OF PRIORITY:

1. Identify the different and various communities with whom one wishes to interact, and the key role players within each community.

2. Develop and implement educational programmes, relevant to the various communities, and train educational personnel for implementation.

3. Develop a close working relationship with those farmers whose crops may be affected by BC activities and provide them with information and advice.

4. Identify those industries with a strong conservation ethic, and use to influence other organisations. Also identify persons within industry that can positively influence that industry's attitudes to the BC.

5. Identify industries that are potentially threatening to the environment and in particular, those in BC range areas.

6. Develop an education/ awareness programme directed specifically at exploiters of BC commercially.

7. Establish a "watch dog" organisation to ensure compliance by industry with the various environmental acts and regulations.

8. Establish links with other conservation groups, including official bodies, to promote BC conservation.

9. Prepare promotional material such as pamphlets, posters and information sheets; conduct workshops, arrange farmers days and other community activities to promote awareness; make use of media as and when opportunity arises.

10. Develop tourist packages that can be used by travel agents, tourism groups and that advocate sound eco-ethical practices; develop controlled BC crane routes; publicise these packages with bird clubs to promote eco-tourism.

11. Determine the cultural uses of crane parts, the cultural differences that may exist, and hence the substitution of BC parts by alternative products.

WORKING GROUP TASK FOUR: ACTION STEP DEVELOPMENT

Action steps were worked out for the solutions in order of priority as follows:

1. Identify the different and various communities with whom one wishes to interact, and the key role players within each community.

ACTION	RESP.	TIME	RESOURCES	OTHER (Outcomes / Impact / Obstacles)
Appoint a national co-ordinator	SACWG	1 month	From existing	None identified
Set up a working group within each BC region, each with a co-ordinator	Regional Field Worker	6 months	Access to communication; transport; venue to meet	None identified
List relevant communities and	Members	12 – 18	Access to	Collaborators

identify key role players; Physically make initial contact with key players; Follow up initial contact or contact individual to whom you have been referred.	of relevant working groups	months	communication; transport; venue to meet	: SACWG; Conservation Services Impact / obstacles not identified

2. **Develop and implement educational programmes, relevant to the various communities, and train educational personnel for implementation.**

ACTION	RESP.	TIME	RESOURCES	OTHER (Outcomes / Impact / Obstacles)
Appoint a national co-ordinator	SACWG	1 month	1 person day per week @ R 1000 / month	None identified
Identify potential BC educators in communities	Regional field worker	6 months	Access to communication; transport; venue to meet	None identified
Set basic course guidelines that can be adapted to different target groups; Train educators through workshops (it was agreed that these steps could be run concurrently)	National co-ordinator; Educators	9 months	Access to communication; transport; venue to meet; workshop; printing; budget of R 10 000 to host workshops and document course guidelines	Collaborate with : Share-Net; Institutional Management & Policy Group Impact / obstacles not identified

3. **Develop a close working relationship with those farmers whose crops may be affected by BC activities and provide them with information and advice.**

ACTION	RESP.	TIME	RESOURCES	OTHER (Outcomes / Impact / Obstacles)

Visit the farming community to assess which farms are affected by BCs	Regional field worker	3 months	Field worker; vehicle; information packages; project funding (will vary from one region to another)	Collaborate with : Dept of Agriculture; Poison experts; Farmers' associations. Impact / obstacles not identified.
Visit affected farmers, exchange information and provide them with basic Crane data	Regional field worker	Within 2 months	Field worker; vehicle; information packages; project funding (will vary from one region to another)	
Repeat visits to specific farming communities to maintain and develop relationships	Regional field worker	Every 2 months	Field worker; vehicle; information packages; project funding (will vary from one region to another)	
Respond to farmers' call outs promptly	Regional field worker	Within 24 hours	Field worker; vehicle; information packages; project funding (will vary from one region to another)	

4. **Identify persons within industry that can positively influence that industry's attitudes to the BC; also identify those industries with a strong conservation ethic, and use to influence other organisations.**

ACTION	RESP.	TIME	RESOURCES	OTHER (Outcomes / Impact / Obstacles)
Appoint a national co-ordinator	SACWG	1 month	From existing	Collaborate with other associations such as : Wildlife Society; Birdlife
Identify those corporate entities that appear to have a conservation ethic and the appropriate individual within each organisation	National co-ordinator	3 months	From existing	

Establish and maintain ongoing sound relationships with corporates and relevant individuals within each	National co-ordinator	Ongoing		Impact / obstacles not identified.
Involve corporates in all Crane related promotional activities – both on a national and regional level	National co-ordinator	Ongoing (as and when activities are held)		
NOTE : These action steps are not designed as a fund raising exercise. They will be implemented primarily for awareness.				

5. **Identify industries that are potentially threatening to the environment and in particular, those in BC range areas.**

ACTION	RESP.	TIME	RESOURCES	OTHER (Outcomes / Impact / Obstacles)
Appoint a national co-ordinator	SACWG	1 month	From existing	Collaborate with : Environmental organisations; Law enforcers All collaboration undertaken in strictest confidence.
Brief field workers about the project and about sources of information (e.g. Provincial Gazettes)	National co-ordinator	1 month	From existing	
Set up confidential reporting system between field workers and national co-ordinator	National co-ordinator	1 week	From existing	
Develop information packages and distribute to these industries	National field workers together with field workers	1 month	From existing	
NOTE : This is a potentially sensitive exercise hence the reason for the confidential reporting system. It is essential not to accuse any organisation. In this instance, it is hoped that field workers will uncover information and feed this back to the national co-ordinator. 'Guilty' companies will not be implicated, but rather receive information as part of an environmental education and awareness programme.				

6. **Develop an education/ awareness programme directed specifically at exploiters of BC commercially.**

NOTE : It was agreed that this point correlated to Solution 2 above – as 'exploiters of the BC commercially' are in fact a target community. For this reason, it was agreed that action steps for Solution 2 and Solution 6 would be identical. As a result, no separate Action Steps were drawn up for Solution 6.

7. **Establish a "watch dog" organisation to ensure compliance by industry with the various environmental acts and regulations.**

ACTION	RESP.	TIME	RESOURCES	OTHER (Outcomes / Impact / Obstacles)
Report any contraventions or possible contraventions to the national co-ordinator, the local conservation authority or the police.	Regional field worker	Ongoing	From existing	
Recommendation : This group felt that although this point was important, it was not the role of SACWG and that it should be allocated to another group. Recommendations to be made to WESSA and regional NGOs.				

8. **Establish links with other conservation groups, including official bodies, to promote BC conservation.**

ACTION	RESP.	TIME	RESOURCES	OTHER (Outcomes / Impact / Obstacles)
Appoint a national co-ordinator	SACWG	1 month	From existing	None identified
Research existing conservation groups and links with SACWG and establish whether these are satisfactory	National co-ordinator	1 month	From existing	
If links not satisfactory, establish links and set up a means of regular contact	National co-ordinator	6 months Regular meetings on an ongoing basis	From existing	

9. **Prepare promotional material such as pamphlets, posters and information sheets; conduct workshops, arrange farmers days and other community activities to promote awareness; make use of media as and when opportunity arises.**

ACTION	RESP.	TIME	RESOURCES	OTHER (Outcomes / Impact / Obstacles)
Appoint a national co-ordinator	SACWG	1 month	From existing	None identified
Assess existing promotional materials and activities planned	National co-	1 month And	From existing	None identified

and identify gaps, deficiencies and opportunities	ordinator; Regional field workers	then ongoing		
Update, renew or develop new promotional materials and plan additional activities in collaboration with various community activities	National co-ordinator; Regional field workers	2 months And then ongoing	Existing staff; Funding (project dependent);	None identified
Establish and maintain relationships with local and national media and involve them in all activities planned	National co-ordinator; Regional field workers	Ongoing	From existing	Collaborate with : Media (local and national); Share-Net
Implement planned activities and obtain required promotional materials	Regional field workers	Ongoing	Existing staff; New resources (eg leaflets, posters etc)	None identified

10. **Develop tourist packages that can be used by travel agents, tourism groups and that advocate sound eco-ethical practices; develop controlled BC crane routes; publicise these packages with bird clubs to promote eco-tourism.**

ACTION	RESP.	TIME	RESOURCES	OTHER (Outcomes / Impact / Obstacles)
Identify tourist organisations in BC areas, advise them of BC issues / SACWG's existence and provide with BC info on request	SACWG central; Field officers	Ongoing	Minimum requirement	None identified
NOTE : This issue was not taken any further as the group felt that it was not within its core area of capabilities / expertise (i.e. do not fall under the Education & Awareness umbrella).				

11. **Determine the cultural uses of crane parts, the cultural differences that may exist, and hence the substitution of BC parts by alternative products.**

ACTION	RESP.	TIME	RESOURCES	OTHER (Outcomes / Impact / Obstacles)

NOTE : Research into this area is being This falls within the Captivity & Trade group as part of their research activities. Only after the results of this are to hand can substitutes for crane parts and related education and awareness be addressed.

GENERAL COMMENTS

Measurable Outcomes

In all the above steps the measurable outcome would be the achievement of the object outlined in the action statement.

Impact

The whole education and awareness programmes is aimed at increasing the knowledge and awareness of the BC in the target audience and hence creating a positive attitude towards the animal. Thus the long term survival potential of the BC would be improved.

Obstacles

Change of attitude is influenced by an inherent reluctance to change for a variety of reasons and is perceived as a major obstacle. Lack of funding and lack of suitable personnel will also inhibit progress.

Complementary Action Steps

The ‘Causes of Mortality’ workgroup recognised the need to react with the farming community and change attitudes. This work is complementary to those actions defined by the ‘Education and Awareness’ group and it would be incumbent on the national coordinator to ensure that duplication of work or resources does not take place.

Trade and Captive Breeding

Participants: Claire Patterson, Lara Thick, Ronel Steenkamp, John Spence and Shaun Wilkinson

<u>ISSUES:</u>

The group brainstormed some of the issues facing trade and captive breeding of Blue Cranes and using the table below, prioritised them using a scoring system.

Prioritisation: 1 – Very Important; 10 – Not important

General issues	Specific issues	Details		Rank
Trade	Illegal	Poaching	• Eggs • Chicks • Adults	10
		Chicks – removal from the wild		5
		Aviculture		4
		Traditional Use	• Feathers • Muti	10
		Meat		10
		General Law Enforcement		3
		Economic Value		3
	Legal	Aviculture (permits)		8
		General Law Enforcement		6
		Traditional Use	• Feathers • Muti	10
		Permits for removal of eggs/chicks from the wild		10
		Hunting (legal)		???
		Sustainable Utilisation		9
		Economic Value		10
Law Enforcement	General Law Enforcement	Prioritisation of Law Enforcement Efforts		2
		Poor Funding & Capacity		2
	Inadequate Law Enforcement (Policy)			2
	Co-operation			1
	Poisoning	Direct		To Mortality WG
		Indirect		To Mortality WG

	Prioritisation of law enforcement efforts			See General Law Enforcement
	Public Awareness of Legal Requirements			1
	Deterrents of Illegal Trade			2
Husbandry	Inbreeding			8
	Reintroduction			1
	General Husbandry			7
	Economic Value			See Trade
	Sustainable Utilisation			See Trade Legal
	Studbook			1

PROBLEM STATEMENTS AND SOLUTIONS:

ISSUE 1

1.1. ILLEGAL TRADE

Poaching is a problem in the East Cape and Natal, where BC chicks are killed for food, BCs are used for traditional and medicinal purposes and are colleted from the wild for the aviculture industry. It is not known how many are taken and what effect it has on the population. The economic value of the BC also creates demand for birds as a status symbol and as a money-making tool. More information is required in this area.

Note: Local communities are defined here as schools, landowners, local villages etc.

SOLUTION 1: Conduct research or gather information on the numbers of Blue Cranes (BC) being poached throughout the country, so that a baseline of data can be formed. This includes determining the DNA signature of the BC, number of BCs taken, by whom and why i.e. culture and food.

SOLUTION 2:

Create an awareness of the legal requirements of South African law and cultural taboo's, amongst law enforcement officers, the local community, NGOs, bird clubs and aviculturists relating to Blue Cranes.

SOLUTION 3:

Increase the supply of captive birds to flood the market to prevent people from buying young birds from the roadside, or capturing them from the wild. This would require making permits more accessible.

SOLUTION 4:

Stricter enforcement and penalties for people dealing in/keeping Blue Cranes illegally

SOLUTION 5:

Improved permit administration and accessibility

SOLUTION 6:

Adequate registration systems through studbooks, DNA testing, chipping and closed ringing.

SOLUTION 7:

Strategic media drives targeted at the general public regarding law, conservation, compliance

<u>SOLUTION 8</u>:

Organise training workshops for law enforcement staff (ID skills) and aviculturists (trade issues).

<u>SOLUTION 9</u>:

'Lobbying' for increased budgets for law enforcement activities.

<u>SOLUTION 10</u>:

Increase/improve prioritisation of Blue Crane in law enforcement activities

1.2. LEGAL TRADE

Aviculture can increase the demand for BCs, exacerbated by limitations within legal permitting frameworks, i.e. lack of expiry dates on permits leading to illegal stock replacement. This is accentuated by limited requirements for registration of individual birds (i.e. no requirement for DNA testing, microchipping or close-ringing). There is not enough information on wild or captive populations to determine what sustainable utilisation would be.

<u>SOLUTION 1</u>:

Increase the supply of captive birds to flood the market to prevent people from buying young birds from the road side, or capturing them from the wild. This would require making permits more accessible.

<u>SOLUTION 2</u>:

Adequate registration systems through studbooks, DNA testing, chipping and closed ringing.

<u>SOLUTION 3</u>:

Improved permit administration and accessibility

<u>SOLUTION 4</u>:

Made available from the moulted feathers of captive population in organisations such as zoos, bird gardens and private collections.

<u>SOLUTION 5</u>:

Increased permit accessibility for traditional feather demand

<u>SOLUTION 6</u>:

Improved permit administration and accessibility

<u>SOLUTION 7</u>:

Strategic media drives targeted at the general public regarding law, conservation, compliance

<u>SOLUTION 8</u>:

Organise training workshops for law enforcement staff (ID skills) and aviculturists (trade issues).

<u>SOLUTION 9</u>:

'Lobbying' for increased budgets for law enforcement activities.

<u>SOLUTION 10</u>:

Increase/improve prioritisation of Blue Cranes in law enforcement activities

<u>SOLUTION 11</u>:

Research into what is 'sustainable utilisation' and whether it can exist.

<u>SOLUTION 12</u>:

Research into the forms sustainable utilisation can take in wild or captive populations.

ISSUE 2
LAW ENFORCEMENT
Changes in general law enforcement structures resulting in reduced budgets, staff changes and lack of training, as well as political apathy and low prioritisation of cranes compared to other species has resulted in ineffective law enforcement. A breakdown in co-operation and communication between aviculturalists, NGO's and nature conservation officials has furthermore lead to an antagonistic working relationship. There is also public ignorance regarding the legal requirements/permits required for keeping captive Blue Cranes and courts do not afford cases involving BC with sufficient importance to be a deterrent of the Illegal trade, nor is the fine structure of adequate severity.

SOLUTION 1:
Strategic media drives targeted at the general public regarding law, conservation, compliance
SOLUTION 2:
Organise training workshops for law enforcement staff (ID skills) and aviculturists (trade issues).
SOLUTION 3:
'Lobbying' for increased budgets for law enforcement activities.
SOLUTION 4:
Increase/improve prioritisation of Blue Crane in law enforcement activities
SOLUTION 5:
Raise awareness of Blue Crane and their problems among politicians
SOLUTION 6:
Improved business administration skills among clerical/administration staff
SOLUTION 7:
Organise Day Workshops covering anything new which effects the blue crane e.g. changes in CITIES legislation
SOLUTION 8:
Ensure regular feedback/contact sessions occur between the three groups
SOLUTION 9:
The three groups to respond to requests for information and co-operation between each other
SOLUTION 10:
Strategic media drives targeted at the general public regarding law, conservation, compliance
SOLUTION 11:
Organise training workshops for law enforcement staff (ID skills) and aviculturists (trade issues).
SOLUTION 12:
'Lobbying' for increased budgets for law enforcement activities.
SOLUTION 13:
Increase/improve prioritisation of Blue Crane in law enforcement activities
SOLUTION 14:
Create an awareness and co-operation of blues cranes and legal requirements of S. African law and cultural taboo's, amongst law enforcement officers, the local community, NGOs, bird clubs and aviculturists.
SOLUTION 15:
Stricter enforcement's and penalties for people dealing in /keeping illegal blue cranes

ISSUE 3
HUSBANDRY
There is a threat of inbreeding as captive populations are too small with insufficient exchange of bloodlines. The release of birds is not always carried out to IUCN protocol because it is not practically possible or because they are not released as part of a particular programme. These releases could lead to a possible spread of disease and possible genetic contamination thus these topics need more research. Imprinted birds that are released may seek human habitation and be killed in the process. Many aviculturalists are not aware of BC studbook which is thus not being used to its full advantage. Manipulation of parentage (due to lack of DNA testing, microchips and close-ring) and incorrect information (claiming chicks not bred in captivity) can occur.

SOLUTION 1:
Research to determine whether there are differences in DNA between the three main groups of BCs within the South African population
SOLUTION 2:
Increased use of the Blue Crane studbook to incorporate all captive Blue Crane populations/individuals
SOLUTION 3:
Increase captive population for breeding to prevent a genetic bottleneck
SOLUTION 4:
Increase maximum number of pairs that can be kept legally per facility
SOLUTION 5:
Improve communication between captive facilities and the studbook keeper to facilitate proper genetic representation
SOLUTION 6:
Research into natural diseases and contracted diseases in captive and wild stocks
SOLUTION 7:
IUCN Protocol needs to be adapted so as to be locally (nationally) practical
SOLUTION 8:
Research into haematology (and disease resistance) with regards to disease contamination
SOLUTION 9:
Research into feedlots modifications e.g. putting a lid on top of a feedlot may prevent cranes feeding as they do not like to put their heads under things.
SOLUTION 10:
Research into spread of diseases at feedlots
SOLUTION 11:
Increase awareness of appropriate diets for captivity/suggest guidelines for Blue Cranes
SOLUTION 12:
Incorporate into permit issuance procedure
SOLUTION 13:
Increase awareness of the studbook to law enforcers, aviculturist or any interested party
SOLUTION 14:
Specify adequate registration systems on the studbook e.g. microchips, DNA, close-rings (identifiable)
SOLUTION 15:
Revised information submitted to studbook i.e. space on form for microchip and permit number
SOLUTION 16:
Development of a BC studbook keeper into close-ring master

ISSUE 4
RESEARCH
Not enough information is known on the numbers of individuals of chicks and eggs taken from the wild and the effects on the population, the traditional uses of blue crane and the effects on the population, what defines a sustainable utilisation of Blue Cranes (chicks and feathers), on the DNA signature of the species to prove origin, parentage and avoid possible re-introduction problems or the potential infectious diseases that could be spread from accidental or conservation related re-introduction.

SOLUTIONS:

All the solutions were then grouped and listed separately. Duplicate solutions were combined or deleted. The group then voted on which were the most important issues. The ten issues voted as being of major importance to Blue Crane conservation were selected for the Paired Ranking process.

The resultant list of solutions was then as follows:

PAIRED RANKING OF ALL SOLUTIONS

	Solution	Score	Rank
1	Establish baseline data on the extent of removal of Blue Cranes from the wild (poaching/aviculture/traditional use)	37	1
9	Research into natural diseases, contracted diseases and feedlot diseases	30	2
7	Gain better understanding of DNA and haematology	25	3
3	Adequate registration systems (for studbook and permits through DNA, microchips and close-rings)	24	4
5	Organised training courses for law enforcement (ID Skills) and aviculturalists (trade issues)	23	5
2	Create awareness and co-operation amongst I&Aps re SA legislation and cultural taboos	22	6
6	Day workshops to improve co-operation; provide regular feedback/contact sessions; respond to requests for information and co-operation	20	7
10	Research into feedlot modifications	18	8
4	Strategic media drives re law, conservation, compliance (public)	16	9
8	Improve communication between captive facilities and the studbook keeper to facilitate proper genetic representation	16	9

ACTION STEPS FOR SOLUTIONS IN ORDER OF IMPORTANCE

ISSUE 1.2:
ILLEGAL TRADE

SOLUTION 1: CONDUCT RESEARCH / GATHER INFORMATION ON THE NUMBERS OF BLUE CRANES BEING POACHED THROUGHOUT THE COUNTRY. THIS INCLUDES DETERMINING THE DNA STRICTURE OF THE BLUE CRANE, NUMBER OF BC'S TAKEN, BY WHOM AND WHY I.E. CULTURE OR FOOD.

ACTION STEP 1:
Define what research is needed. Develop project proposals for the necessary research to develop baseline data taking into account the specific requirements and limitations of each area. This should cover the number of birds being removed from the wild, their source and origin, the purpose for them being taken (e.g. culture / meat), DNA information relating to parentage and origin of chicks and the meaning or importance of cranes within African cultures

RESPONSIBILITY: SACWG
TIMELINE: 3 months
RESOURCES REQUIRED: Anecdotal information should be taken into account
COLLABORATORS: Community leaders, environmental educators, farmers, farm workers, law enforcers
MEASURABLE OUTCOMES: Research is defined
IMPACT: Clear guidelines for direction research is to take
OBSTACLES: Other time and work commitments of SACWG

ACTION STEP 2:
Seek funding to carry out the necessary research and develop funding proposals and submit them to funders.

RESPONSIBILITY: SACWG
TIMELINE: 9 months
RESOURCES REQUIRED: Personnel time
COLLABORATORS: EWT
MEASURABLE OUTCOMES: Funding obtained
IMPACT: Allows projects to go ahead
OBSTACLES: Funding not found

ACTION STEP 3:
Identify individuals to carry out the research (students, fieldworkers, NGOs) appropriate to collect baseline data

RESPONSIBILITY: SACWG to co-ordinate research
TIMELINE: 3 months
RESOURCES REQUIRED: Funding, researchers, transport, computer
COLLABORATORS: University, NGOs, ESPU
MEASURABLE OUTCOMES: Researchers identified and put into place

IMPACT: N/A
OBSTACLES: Suitable researchers not identified

ACTION STEP 4:
Commence collecting baseline data by collecting fieldwork data and capturing and submitting the results to a central point

RESPONSIBILITY: Researchers
TIMELINE: Ongoing
RESOURCES REQUIRED: Transport, computer
COLLABORATORS: Farmers, farm workers, local communities
MEASURABLE OUTCOMES: Collection of data and submission of regular reports
IMPACT: N/A
OBSTACLES: Insufficient information gathered, making contact with appropriate people; people may be unwilling or reluctant to give up their data and information

ACTION STEP 5:
Capture Data at a central point to build a national database of information dealing with BC chicks being removed from the wild

RESPONSIBILITY: SACWG
TIMELINE: Ongoing
RESOURCES REQUIRED: Computer and personnel
COLLABORATORS: TRAFFIC ?
MEASURABLE OUTCOMES: Database is initiated
IMPACT: SACWG put into a position to analyse what is happening on the ground
OBSTACLES: Reports not submitted, data not captured, computer problems

ACTION STEP 6:
Compile a draft report detailing the results of research, specifically numbers taken from wild, why, cultural uses etc.

RESPONSIBILITY: SACWG
TIMELINE: Ongoing – first report to be produced within 9 months, thereafter updated every 6 months
RESOURCES REQUIRED: Computer and baseline data
COLLABORATORS: Stakeholders
MEASURABLE OUTCOMES: Report produced and distributed regularly
IMPACT: Wider knowledge and understanding of threats facing cranes
OBSTACLES: Report not produced, report not distributed and running out of funds over a long period

ISSUE 3:
GENERAL HUSBANDRY AND INBREEDING

<u>SOLUTIONS 2 & 3:</u> PERFORM RESEARCH INTO NATURAL AND CONTRACTED DISEASES IN CAPTIVE AND WILD BLUE CRANES TO GAIN A BETTER IDEA OF DNA AND HAEMATOLOGY

ACTION STEP 1:
Define what research is needed and draw up project proposals for research projects which will identify the disease risks facing BCs and provide baseline data for registration and law enforcement purposes

RESPONSIBILITY: SACWG
TIMELINE: 3 months
RESOURCES REQUIRED: Time and personnel
COLLABORATORS: wBRC, Onderstepoort, Ken Jones (Uni. Chacago), International Crane Foundation, Eric Harley (Uni. Cape Town), Terry Robinson (Uni. Stellenbosch), Paulette Bloomer (Uni. Pretoria)
MEASURABLE OUTCOMES: Research needs defined and project proposals written up
IMPACT: Enables fundraising to commence and suitable researcher to be found
OBSTACLES: Time and personnel not available to write up proposals

ACTION STEP 2:
Seek necessary funding

RESPONSIBILITY: SACWG
TIMELINE: 9 months
RESOURCES REQUIRED: Suitable funders
COLLABORATORS: EWT
MEASURABLE OUTCOMES: Funding obtained
IMPACT: Allows research to continue
OBSTACLES: Funding source not identified; funding not obtained

ACTION STEP 3:
Identify a suitable candidate to carry out the research into DNA signatures, haematology and diseases (e.g. PhD student). Different students may be needed for the different research foci.

RESPONSIBILITY: SACWG
TIMELINE: 3 months
RESOURCES REQUIRED: Field collection facilities/equipment, laboratory facilities
COLLABORATORS: University, WBRC, Irene ??
MEASURABLE OUTCOMES: Researcher identified and able to commence research
IMPACT: With identification of suitable candidate, research can go ahead
OBSTACLES: Funding not available, researcher not identified

ACTION STEP 4:
Conduct fieldwork to collect material, analyse this material

RESPONSIBILITY: Researcher
TIMELINE: 3 years
RESOURCES REQUIRED: Field collection facilities/equipment, laboratory facilities
COLLABORATORS: Farmers, SACWG fieldworkers, universities
MEASURABLE OUTCOMES: DNA signature mapped, disease information obtained and haematology understood
IMPACT: Better understanding of these issues as they relate to management
OBSTACLES: Funding not available

ACTION STEP 5:
Publish findings in scientific papers, theses and general papers
RESPONSIBILITY: Researcher & SACWG
TIMELINE: Ongoing
RESOURCES REQUIRED: Results of researcher, computer
COLLABORATORS: SACWG, university
MEASURABLE OUTCOMES: Findings published in a variety of formats
IMPACT: Improved knowledge of DNA, haematology and diseases
OBSTACLES: Researcher doesn't complete research; insufficient funding

ISSUE 1.1, 1.2. AND 3:
LEGAL AND ILLEGAL TRADE AND HUSBANDRY

<u>SOLUTION 4:</u> ADEQUATE REGISTRATION SYSTEMS SUCH AS THE STUDBOOK AND PERMITS THROUGH DNA, MICROCHIPS AND CLOSE-RINGS

ACTION STEP 1:
Increase awareness of studbook's existence and requirements as well as permitting requirements, accessibility and procedures and encourage people who are not participants of the studbook to join.

RESPONSIBILITY: Law enforcement, PAAZAB, SACWG, zoos and bird facilities, NGOs
TIMELINE: 1 year commencing immediately
RESOURCES REQUIRED: Personnel
COLLABORATORS: Media sources, reporters, owners of unregistered birds
MEASURABLE OUTCOMES: Articles are published and the information is made available via other forms of media; increased participants to the studbook
IMPACT: Increased awareness among owners of illegal (and legal) birds; more birds registered on the studbook
OBSTACLES: Articles are not published and information is not disseminated

ACTION STEP 2:
Encourage Studbook Keeper to collect additional information such as adding permit number and DNA information to the studbook to bring it in line with proposed legislation amendments.

RESPONSIBILITY: SACWG; Studbook Keeper (Shaun Wilkinson)
TIMELINE: Immediate

RESOURCES REQUIRED: Possible changes to the studbook database
COLLABORATORS: Law enforcement; Dr Ferdie Schoeman
MEASURABLE OUTCOMES: Studbook Keeper requests additional information from owners of BCs and information is provided
IMPACT: Improved capacity for law enforcement and control of captive BC trade
OBSTACLES: Studbook Keeper not co-operative, owners do not provide information, processes such as DNA mapping are not accessible

Recommendation: Permits to keep BCs are not renewed unless the birds are registered with the studbook and new permits are not issued unless a compulsory system of registering birds unregistered with the studbook in the studbook is put in place. This can be cross-checked by nature conservation permit departments submitting copies of all permits to the Studbook Keeper.

Recommendation: A system should be put into place which will allow a person in illegal possession of BCs to apply for the necessary permits without fear of the birds being confiscated or physically removed from the property. The system must include a registration and marking system for the birds i.e. microchipped and rings.

Recommendation: These above points should be included in the proposed development for national policy as outlined by the Institutional Management and Policy Working Group.

ISSUE 1.1, 1.2 AND 2
LEGAL AND ILLEGAL TRADE AND LAW ENFORCEMENT

SOLUTION 5 & 7: ORGANISE TRAINING COURSES FOR LAW ENFORCEMENT (ID SKILLS) AND AVICULTURALISTS (TRADE ISSUES) AS WELL AS DAY WORKSHOPS TO IMPROVE COOPERATION, TO PROVIDE REGULAR FEEDBACK AND CONTACT SESSIONS AND TO RESPOND TO REQUESTS FOR INFORMATION AND COOPERATION.

ACTION STEP 1:
Identify and initiate appropriate contact between people from law enforcement, NGOs and the formal avicultural sector to participate in informal contact sessions which should be facilitated at the local level and initially just be offers of help and collaboration and introductions

RESPONSIBILITY: SACWG
TIMELINE: Ongoing
RESOURCES REQUIRED: N/A
COLLABORATORS: Aviculturalists, law enforcers, NGOs
MEASURABLE OUTCOMES: Better working relationships developed between the three sectors
IMPACT: Better relations and better trade control; better knowledge of number of birds held in captivity
OBSTACLES: attitude; lack of willingness to comply
ACTION STEP 2:
Organise workshops for law enforcement officers to specifically cover ID skills, problems faced by the formal avicultural industry and husbandry techniques

RESPONSIBILITY: SACWG
TIMELINE: Hold within 6 months
RESOURCES REQUIRED: Venue, funding
COLLABORATORS: TRAFFIC
MEASURABLE OUTCOMES:
IMPACT: Increased identification skills and awareness among law enforcement officers; building of partnerships and bridges of trust; better enforcement of illegal trade
OBSTACLES: Distrust; funding; motivation; lack of attendance

ACTION STEP 3:
Organise workshops for formal aviculturalists to specifically cover legislation, husbandry techniques and the problems faced by the law enforcement officers

RESPONSIBILITY: SACWG
TIMELINE: Hold in 6 month's time
RESOURCES REQUIRED: Venue, funding
COLLABORATORS: TRAFFIC
MEASURABLE OUTCOMES: Increased knowledge of legislation among the formal avicultural industry; building of partnerships and bridges of trust
IMPACT: Increased awareness of legislation and problems facing law enforcement officers; better compliance with the legislation
OBSTACLES: Distrust; funding; motivation; lack of attendance

Recommendation: A system should be put into place which will allow a person in illegal possession of BCs to apply for the necessary permits without fear of the birds being confiscated or physically removed from the property. The system must include a registration and marking system for the birds i.e. microchipped and rings.

Note: The Institutional Management and Policy group has developed actions steps relating to the creation of awareness of applicable legislation to the general public (including aviculturalists) for the Blue Crane.

ISSUE 1.1. AND 3
ILLEGAL TRADE AND LAW ENFORCEMENT

<u>SOLUTION 6:</u> CREATE AWARENESS AND COOPERATION AMONGST STAKEHOLDERS WITH REGARD TO SA LEGISLATION AND CULTURAL TABOOS

ACTION STEP 1:
Develop a factsheet on importance of cranes in African cultures and cultural beliefs to highlight the importance of cultural beliefs which can be used to limit the illegal and unregulated taking of birds from the wild; factsheet should also let people know where they can obtain feathers legally.

RESPONSIBILITY: SACWG
TIMELINE: 1 year
RESOURCES REQUIRED: Information gathered through collection of baseline data relating to removal of birds from the wild

COLLABORATORS: Local communities, researchers; zoos and bird facilities that can supply feathers, law enforcement officers
MEASURABLE OUTCOMES: Factsheet is produced and distributed
IMPACT: Less illegal and unregulated removal of birds from the wild
OBSTACLES: Data not available; manpower not available; language barrier

ACTION STEP 2:
Translation of factsheet into appropriate languages and/or use of pictures made

RESPONSIBILITY: SACWG
TIMELINE: 3 months
RESOURCES REQUIRED: Translators
COLLABORATORS: University language schools
MEASURABLE OUTCOMES: Factsheet translated into appropriate languages or suitable pictures
IMPACT: N/A
OBSTACLES: Translators not available; funding

ACTION STEP 3:
Facilitating distribution of information/factsheet to members of the farming community through farmers' day and other forms of contact.

RESPONSIBILITY: SACWG field workers; law enforcement officers
TIMELINE: Distributed to the majority of the members of farming communities within 18 months; thereafter ongoing
RESOURCES REQUIRED: Translated factsheets; interpreters
COLLABORATORS: Environmental education officers
MEASURABLE OUTCOMES: Factsheet information made available to members of the farming community
IMPACT: Increased awareness of cultural limitation on the taking of birds from the wild
OBSTACLES: Interpreters not available;

Note: The Institutional Management and Policy group has developed actions steps relating to the creation of awareness of applicable legislation to the general public (including aviculturalists) for the Blue Crane.
Note: Feed into information packs developed by Education and Awareness Working Group which will be distributed to various identified stakeholders.

ISSUE 3:
GENERAL HUSBANDRY

<u>SOLUTION 8:</u> **RESEARCH ITO FEEDLOT MODIFICATIONS**

ACTION STEP:
The Mortality Working Group is conducting research into this issue and can ensure that the effects of feedlot diets on chicks which lead to disease are corrected or limited.

ISSUE 3:
GENERAL HUSBANDRY

SOLUTION 9a: IMPROVE COMMUNICATION BETWEEN CAPTIVE FACILITIES AND THE STUDBOOK KEEPER TO FACILITATE PROPER GENETIC REPRESENTATION

ACTION STEP 1:
Establish means of correspondence to facilitate management of the studbook, buy-in to the process and collection of information to ensure that participants feed in to the studbook

RESPONSIBILITY: Studbook Keeper (Shaun Wilkinson)
TIMELINE: As soon as studbook handed over
RESOURCES REQUIRED: Various forms of communication facilities e.g. computers and fax machines
COLLABORATORS: Owners of captive Blue Cranes
MEASURABLE OUTCOMES: Effective methods of communication are established
IMPACT: Feeding information into the studbook becomes easier
OBSTACLES: Forms of communication not available and/or not effectively used

ACTION STEP 2:
Act as advisory service to owners of captive BCs to give advice on pairing and exchange of captive breeding birds to ensure that minimal inbreeding takes place

RESPONSIBILITY: Studbook Keeper (Shaun Wilkinson)
TIMELINE: Ongoing
RESOURCES REQUIRED: Information from participants as to parentage and DNA of individuals
COLLABORATORS: Owners of captive BCs
MEASURABLE OUTCOMES: advise is given as to pairing which minimises in-breeding
IMPACT: Minimisation of in-breeding
OBSTACLES: Owners do not provide necessary information

ISSUE 1.2. AND 3
LEGAL TRADE AND LAW ENFORCEMENT

SOLUTION 9b: STRATEGIC MEDIA DRIVES WITH REGARD TO LEGISLATION, CONSERVATION AND COMPLIANCE – SPECIFICALLY WITH REGARD TO THE GENERAL PUBLIC

ACTION STEP:
The Institutional Management and Policy group has developed actions steps relating to the creation of awareness of applicable legislation to the general public (including aviculturalists) for the Blue Crane.

Habitat and Land Use

PARTICIPANTS: Wicus Leeuwner, Kerryn Morrison, Glen Ramke, Kevin Shaw, Donella Young, Brian Colahan, Ann Scott and Poena Basson.

ISSUES:

After brainstorming, the following issues were identified by the group:

- Lack of knowledge of the biological requirements of Blue Crane
- Lack of information on the interactions of Blue Cranes within ecosystems
- Low level environmental awareness among local communities
- Effect of climate change on habitat and landuse
- Effect of change in land use
- Farming practices
- Habitat modification
- Agricultural manipulation e.g. seasonal rotation of crops
- Supplementary feeding of agricultural stock
- Growth hormones in the supplementary feed of stock and the affect thereof on cranes
- Need to quantify crop damage by cranes
- Afforestation
- Poisoning (direct and indirect) referred to mortality group
- Blue Crane habitat loss/degradation
- Declining food availability for Blue Cranes
- Inadequate knowledge on habitat requirements for breeding and feeding e.g. in terms of crane age and seasonal changes
- Blue Cranes reaching carrying capacity and the resulting competition for space
- Current foraging requirements in terms of diet and feeding habitat
- Historical factors responsible for declining Blue Crane grassland population
- Lack of protection of key Blue Crane areas
- Research and monitoring of habitat and land use and the effect thereof on Blue Cranes
- Information about and protection of roost sites
- Threats of human development and settlement to the Blue Crane
- Movement of cranes between habitats and areas

PROBLEM STATEMENTS:

These issues were grouped and expanded into the following six problem statements:

1. Lack of information on crane habitat requirements and preferences
2. Human influence on crane habitat
3. Historical factors involved in population trends
4. Lack of protection for key crane areas
5. Natural environmental factors

SOLUTIONS:

The following solutions were suggested for each problem statement:

1. Lack of information on crane habitat requirements and preferences

   - minimum would be to conduct a literature search on crane habitat requirements and preferences
   - synthesize and collate available data, including all unpublished data on crane habitat requirements and preferences
   - maximum would be to conduct research on crane habitat requirements and preferences
   - obtain accurate data on ideal habitats in three core areas
   - disseminate available information on crane habitat requirements and preferences
   - comparative studies of diet in three core areas
   - surveys among farmers and their personnel to determine crane habitat requirements and preferences

2. Human influence on crane habitat

   - bill of crane rights
   - ideally all land should be managed in a manner beneficial to cranes
   - investigate mitigation measures to reduce impacts
   - monitor trends in land use and their effects on Blue Crane populations
   - determine the effects that various land uses and farming practices have on Blue Cranes
   - increase awareness of human impacts on Blue Crane habitats

3. Historical factors involved in population trends

   - attempt to identify the historical factors involved in population changes in the 3 core areas

4. Lack of knowledge regarding the interaction between cranes and their environment

   - minimum obtain information on other bird species sharing the same environment
   - maximum research interactions with the whole environment
   - to identify and quantify crop depredation by Blue Cranes and other species

5. Lack of protection for key crane areas

   - identify and determine the best conservation options to protect key crane areas
   - identify key crane areas
   - encourage land managers to adopt an appropriate conservation option

6. Natural environmental factors

   - monitor to determine effects of natural environmental factors on crane populations

Prioritisation of solutions:

The group combined “monitor trends in land use and their effects on Blue Crane populations” with “Determine the effects that various land uses and farming practices have on Blue Cranes” to read: “ Determine and monitor the effects of various land use and farming practices on Blue Cranes”.

The group then used paired ranking to prioritise solutions. Results of the groups’ paired ranking exercise is presented in the tale below.

Group members

Solution *								
	1	2	3	4	5	6	7	Total
1	19	18	8	16	21	18	16	116
2	17	20	15	18	16	13	8	107
3	21	7	14	11	14	12	19	98
4	18	16	3	13	14	18	11	93
5	2	14	13	20	9	19	10	87
6	8	8	7	16	18	9	16	82
7	16	7	20	3	4	14	12	76
8	14	15	8	6	14	10	7	74
9	12	6	22	12	9	10	2	73
10	15	17	5	3	15	7	11	73
11	2	19	7	13	13	3	16	73
12	6	10	12	5	2	15	20	70
13	10	9	4	13	14	10	9	69
14	2	7	7	10	8	15	17	66
15	2	12	6	12	11	4	11	58
16	12	10	17	6	2	5	5	57
17	11	6	16	4	3	6	8	54
18	5	3	5	9	7	14	7	50
19	7	5	13	11	4	2	1	43
20	5	0	1	9	8	6	3	32
21	6	1	7	0	4	0	1	19
Total	210	210	210	210	210	210	210	1470

* the numbers in this column correspond to the numbers of the solutions below.

The solutions according to priority are as follows:

1 Determine and monitor effects of various land uses and farming practices on Blue Cranes.
2 Identify and quantify crop damage stock feed loss by Blue Cranes and associated species.
3 Obtain accurate data on habitat requirements (e.g. for feeding, breeding, etc) and preferences of Blue Cranes in the three core areas.
4 Encourage land managers to adopt an appropriate conservation option.
5. Attempt to identify the historical factors involved in population changes in the 3 core areas.
6. Synthesize and collate available data, including all unpublished data

7. Increase awareness of human impacts on Blue Crane habitats.
8. Surveys among farmers and their personnel to determine crane habitat and preferences.
9. Investigate mitigation measures to reduce impacts.
10. Identify key crane areas.
11. To conduct research into crane habitat requirements and preferences.
12. Comparative studies of diet in three core areas.
13. Ideally all land should be managed in a manner beneficial to cranes.
14. Identify and determine the best conservation options to protect key crane areas.
15. Disseminate available information on crane habitat requirements and preferences.
16. To conduct a literature survey on crane habitat requirements and preferences.
17. Conduct research on crane interactions with the whole environment.
18. Obtain information on the interactions of other bird species with the cranes and the crane's environment.
19. Monitor to determine effects of natural environmental factors on crane populations.
20. Bill of crane rights.

- The **top six** solutions were worked and given action steps, timelines and responsible people.

- The **first five** prioritised solutions were accepted by all the participants in the plenary session to be included in the complete group list of solution priorities.

ISSUE 1:

LACK OF INFORMATION ON CRANE HABITAT AND PREFERENCES

The lack of information on crane habitat requirements and preferences prevents various land managers managing their land in a manner which would be beneficial to cranes. This lack of information relates to information on:

- diet
- feeding habitat
- breeding habitat
- roosting
- adaptability
- movement between habitats
- home range and territory size (competition for space)

SOLUTION 1: OBTAIN ACCURATE DATA ON HABITAT REQUIREMENTS (FEEDING, BREEDING, ETC.) AND PREFERENCES OF BLUE CRANE IN 3 CORE AREAS

ACTION STEP:
Approach academic institutions to conduct a research project to determine habitat requirements and preferences of Blue Cranes in 3 core areas.

RESPONSIBLE:
South African Crane Working Group (SACWG).
TIMELINE:

- Six months to approach institutions
- Three years to complete once project has started.

RESOURCES REQUIRED: Personal time, funding, Co-ordinated Avifaunal Roadcounts (CAR Counts), Karoo Large Terrestrial Bird Survey.
COLLABORATORS: Relevant SACWG participants, land managers and Avian Demography Unit.
MEASURABLE OUTCOMES: Research document
IMPACT: There will be information to supply land managers and conservationists. The project will increase awareness of both the species and SACWG among land managers and affected parties.
OBSTACLES: Finding a suitable student and funding.

SOLUTION 2: SYNTHESISE AND COLLATE AVAILABLE DATA INCLUDING UNPUBLISHED DATA ON CRANE HABITAT REQUIREMENTS AND PREFERENCES.

ACTION STEP:
Seek out suitable candidate to carry out this task.

RESPONSIBLE: SACWG
TIMELINE: 1 Year
RESOURCES REQUIRED: Personnel time, funding.
COLLABORATORS: Anyone with info.
MEASURABLE OUTCOMES:

Document that will provide information for project on habitat requirements and preferences of Blue Cranes in the 3 core areas.
IMPACT: Greater understanding. Access to unpublished data.
OBSTACLES: Unwillingness to part with unpublished data.

<u>RECOMMENDATIONS</u>
Urgency to complete this action step to provide information for the research project on habitat requirements and preferences.

Other solutions which were considered for this issue but which were not worked include:

- minimum would be to conduct a literature search on crane habitat requirements and preferences
- maximum would be to conduct research on crane habitat requirements and preferences
- disseminate available information on crane habitat requirements and preferences
- comparative studies of diet in three core areas
- surveys among farmers and their personnel to determine crane habitat requirements and preferences

ISSUE 2:
HUMAN INFLUENCE ON CRANE HABITAT
Humans have the potential to make far-reaching impacts on crane habitat and therefore on crane populations. These impacts may be both positive (such as creating favourable habitat resulting in an increase in crane numbers) or negative (such as loss of habitat and/or disturbance).

- food shortages
- loss of suitable habitat
- basic environmental education
- change in land use
- farming practices
- habitat modification
- agricultural manipulation
- supplementary feed
- growth hormones
- human development - settlements

<u>SOLUTION:</u> DETERMINE AND MONITOR THE EFFECTS OF VARIOUS LAND USES AND FARMING PRACTICES ON BLUE CRANES

ACTION STEP 1:
Approach academic institutions to conduct a research project to determine the effects of various land uses and farming practices on Blue Cranes.

RESPONSIBLE: South African Crane Working Group (SACWG).
TIMELINE: Six months to approach institutions – three years to complete once project has started.

RESOURCES REQUIRED: Personal time, funding.
COLLABORATORS: Relevant SACWG participants and land managers.
MEASURABLE OUTCOMES: Research project.
IMPACT: There will be information to supply land managers. Possible to predict population changes of Blue Cranes to changing land uses and farming practices. The project will increase awareness of both the species and SACWG among land managers and affected parties.
OBSTACLES: Finding a suitable student and funding.

ACTION STEP 2:
Monitoring the effects of various land uses and farming practices on Blue Cranes.

RESPONSIBLE: SACWG and Avian Demography Unit (information from the Co-ordinated Avifaunal Roadcount).
TIMELINE: To a degree it has already started and it is ongoing
RESOURCES REQUIRED: Funding, field officers
COLLABORATORS: Land managers
MEASURABLE OUTCOMES: Information on the trends in land use and farming practices and their effects on Blue Crane populations.
IMPACT: The project will increase awareness of both the species and SACWG among land managers and affected parties. Information gathered can serve as an early warning to changes in Blue Crane numbers due to change in land use.
OBSTACLES: Lack of personnel and funding

Other solutions which were considered for this issue but which were not worked include:

- bill of crane rights
- ideally all land should be managed in a manner beneficial to cranes
- investigate mitigation measures to reduce impacts
- increase awareness of human impacts on Blue Crane habitats

ISSUE 3:
HISTORICAL FACTORS INVOLVED IN POPULATION TRENDS
The lack of information on the historical factors influencing crane population trends, particularly declines, prevents the introduction of mitigation measures, where appropriate.

- decline (grassland & Karoo)
- increase

<u>SOLUTION:</u> ATTEMPT TO IDENTIFY THE HISTORICAL FACTORS INVOLVED IN POPULATION CHANGES IN THREE CORE AREAS.

ACTION STEP:
Approach academic institutions to identify the historical factors involved in population changes in three core areas.

RESPONSIBLE: South African Crane Working Group (SACWG).
TIMELINE: Six months to approach institutions – three years to complete once project has started.
RESOURCES REQUIRED: Personal time, funding.
COLLABORATORS: Relevant ACWG participants, land managers, Department of Agriculture, conservation agencies and academic institutions.
MEASURABLE OUTCOMES: Research document. With this information it may be possible to mitigate current factors that contributed to historical declines.
IMPACT: There will be information to supply land managers and conservationists. The project will increase awareness of both the species and SACWG among the community and land managers.
OBSTACLES: Information unobtainable. Finding a suitable student and funding.

ISSUE 4:
LACK OF KNOWLEDGE REGARDING THE INTERACTION BETWEEN CRANES AND THEIR ENVIRONMENT

An inadequate understanding of the interactions and inter- relatedness between cranes and other components of their environment prevent us from approaching crane conservation in a holistic manner

<u>SOLUTION:</u> IDENTIFY AND QUANTIFY CROP DAMAGE AND STOCKFEED LOSS BY BLUE CRANES AND ASSOCIATED SPECIES.

ACTION STEP:
Approach academic institutions to carry out an accurate assessments of the losses suffered by farmers due to Blue Cranes and a comparison of these with associated species

RESPONSIBLE: SACWG
TIMELINE: Six months to approach institutions – three years to complete once project has started.
RESOURCES REQUIRED: Personal time, funding
COLLABORATORS: Relevant SACWG participants and land managers.
MEASURABLE OUTCOMES: Research document.
IMPACT: There will be information to supply land managers. The project will increase awareness of both the species and SACWG among land managers and affected parties.
OBSTACLES: Finding a suitable student and funding.

Other solutions which were considered for this issue but which were not worked include:

- minimum obtain information on other bird species sharing the same environment
- maximum research interactions with the whole environment

ISSUE 5:
LACK OF PROTECTION FOR KEY CRANE AREAS

Key crane areas are inadequately protected by one of the suite of conservation options; the potential loss of these areas could severely impact on crane populations.

- roost sites

<u>SOLUTION:</u> ENCOURAGE LAND MANAGERS TO ADOPT AN APPROPRIATE CONSERVATION OPTION

ACTION STEP 1:
Identify and determine the best conservation options (e.g. accreditation system, Natural Heritage Sites, Private Nature Reserves, etc.) for crane areas

RESPONSIBLE: To be co-ordinated by a SACWG member, which will be determined by SACWG committee. Regional individual to be identified by groups in various regions.
TIMELINE: December 2002
RESOURCES REQUIRED: Personnel time
COLLABORATORS: Various conservation agencies, BirdLife South Africa, crane field officers, crane groups, farmers, Botanical Society, Department of Agriculture and Good Agricultural Practices.
MEASURABLE OUTCOMES: A document setting out the best options for each area.
IMPACT: Awareness
OBSTACLES: Time, lack of co-operation

ACTION STEP 2:
Encourage land managers to adopt appropriate conservation options.

RESPONSIBLE: SACWG participants
TIMELINE: From December 2002 and ongoing
RESOURCES REQUIRED: Personnel, funding
COLLABORATORS: Provincial and national conservation agencies, BirdLife South Africa, Avian Demography Unit, sponsors and land owners.
MEASURABLE OUTCOMES: Increase in the number of conserved areas, awareness
IMPACT: Awareness
OBSTACLES: Lack of support by land managers and/or conservation agencies and potential collaborators.

Other solutions which were considered for this issue but which were not worked include:

- identify and determine the best conservation options to protect key crane areas
- identify key crane areas

ISSUE 6:

NATURAL ENVIRONMENTAL FACTORS:

Natural environmental factors (e.g. Climatic factors or changes in food availability) may have major on crane populations

- climate change
- food shortages/availability
- loss of suitable habitat

<u>SOLUTION:</u>

MONITORING TO DETERMINE THE EFFECTS OF NATURAL ENVIRONMENTAL FACTORS ON BLUE CRANE POPULATIONS

The group did not work this solution it was not felt to be a priority.

Population Dynamics and Modelling

MODELLING OF THE WILD SOUTH AFRICAN BLUE CRANE POPULATION

INTRODUCTION

Species : *Anthropoides paradisea*

Study population location : Entire range in the Republic of South Africa, focusing on the three core populations shown in Figure 1.

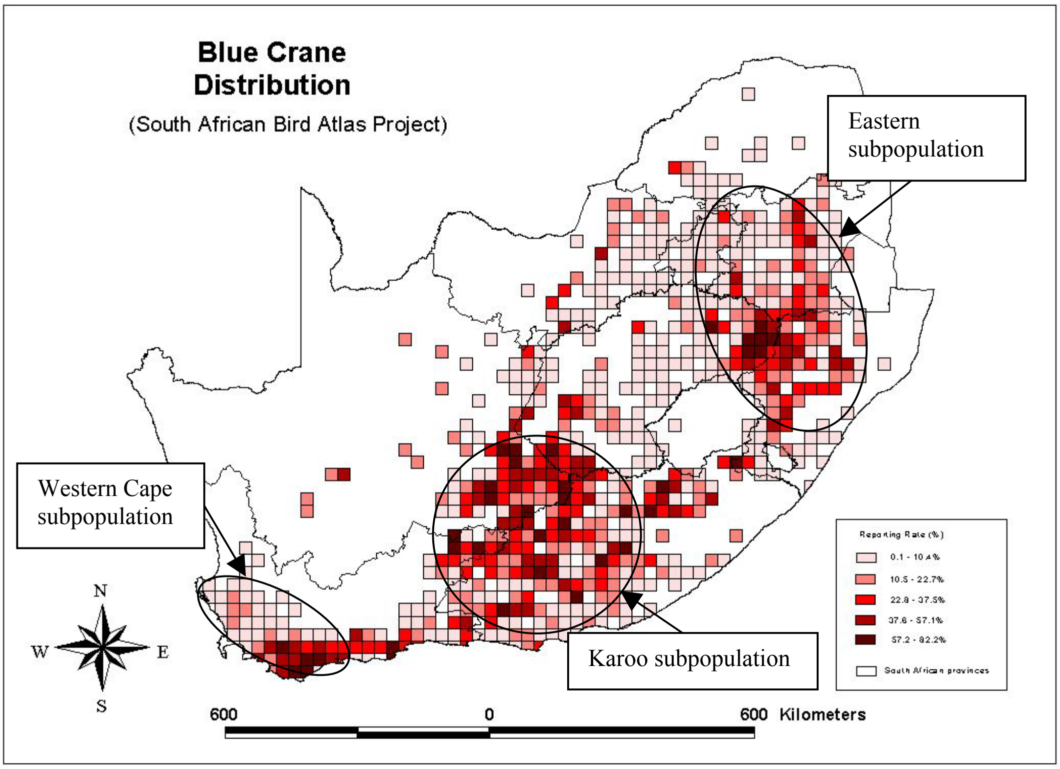


Fig. 1 : The distribution of the Blue Crane in South Africa according to the South African Bird Atlas Project, showing the location of the three core populations.

Working Group Task:

The Modelling Working Group was tasked with developing a baseline model which best approximates the current population dynamics of the three Blue Crane subpopulation in South Africa (namely the Eastern, Karoo and Western Cape subpopulations), taking into account knowledge of the current population parameters, genetic structure and carrying capacity. The model was then used to predict the outcome of different scenarios on the population so as to improve decision-making in respect of management / objectives needed to maintain a viable Blue Crane population.

The main questions which were asked were the following

- What effect do basic population parameters (such as age of first breeding and age of breeding senescence) have on the population outcome ?
- What level of juvenile, subadult and adult mortality rates allows for a positive growth rate in the Eastern and Karoo subpopulations ?
- What level of juvenile, subadult and adult mortality rates causes a negative growth rate in the Western Cape subpopulation ?
- How does a potentially inaccurate initial population size of the Karoo subpopulation affect the populations' long-term viability ?
- How does the potential habitat loss / change affect the Eastern and Western Cape subpopulations, shown as a change in carrying capacity ?

Baseline Model:

Input parameters for baseline model were as follows -

- **Definition of Extinction :**
  Extinction was defined as the complete absence of one or the other sex.

- **Number of Populations :**

The overall South African Blue Crane population was split into three subpopulations, which were each classed separate populations with no intermixing (determined through colour ringing and satellite telemetry).

- **Inbreeding Depression :**
  No inbreeding depression was assumed (depressed survival due to mating between close relatives).

- **EV (reproduction) to be concordant with EV (survival) :**
  In the absence of data to the contrary, it was assumed that environmental variation (EV) would affect reproduction and survival equally. See default values that were used in each of the subpopulation models at the end of this chapter.

- **Types of Catastrophes :**
  Of the three subpopulations, a single catastrophe was only modelled in the Karoo subpopulation. This population endures fairly regular drought conditions, which severely affect the Blue Crane during the breeding summer months. The catastrophe modelled the negative affect on breeding during these dry periods. This was modelled as depressing reproduction by 67% and survival by 10%, with a 20% probability of the event occurring each year.

- **Monogamous, Polygynous or Hermaphroditic population :**
  Blue Cranes are assumed to mate for life and are therefore classed as long-term monogamous breeders.

- **Age at First Reproduction (males and females) :**
  Due to the lack of field data and the resultant group consensus, males and females were assumed to breed at age 4.

- **Maximum Breeding Age :**

  The maximum breeding age was assumed to be 25 years of age. Discussion was held in plenary on the maximum breeding age, with opinions ranging from 20 years to 30 years. Consensus was reach by the group to use 25 years as the best estimate of maximum breeding age.

- **Sex Ratio :**

  Found to be 1 : 1 (n = 38), from an internal examination of 38 Blue Crane carcasses which were poisoned in the Western Cape in 1991 (Allan & Ryan 1996). Therefore, an even sex ratio was chosen, 50 : 50 sex ratio.

- **Maximum Litter Size :**

  All literature of clutch size indicates 2 eggs are laid and hatched. A litter size of 2 was used.

Comments box :

It is important how you specifically defined "reproduction". In birds, it is fairly common to define reproduction as the production of fledglings, as these are the data most easily obtained in the field. In this case, the % adult females that "breed" was defined as as the % that fledge 1-2 chicks - and not the % that merely lay eggs. Furthermore, the "litter size" distribution must then be the distribution of fledglings that are produced per female, not the number of eggs laid. Finally, since the day that a chick is fledged is defined as day 0, mortality of "juveniles" (age class 0-1) is then the mortality from the day they're fledged until their first birthday. Irrespective of how it was performed - the laying of eggs or the fledging of chicks - you have to make sure that you have consistent definitions of reproduction. It would appear in these models that the fledging definition is used in the "litter size" distribution, but eggs as the definition for 0-1 mortality.

PLEASE NOTE THESE COMMENTS WHEN INTERPRETING THE RESULTS

- **Density Dependent Breeding :**

  No data exists to disprove the use of density dependence.

Comments box :

If you are going to use density dependence in breeding, you should provide some justification for its parameterization. For example, the way in which it was used in WCAPE.OUT model indicates that there is no decrease in breeding at high densities, and an Allee effect that reduces the % females breeding by 50% at low population densities (i.e., N/K <0.10). Is this what really happens in Blue Crane populations? If, as you say, there are no data to disprove density dependence, you should really justify its inclusion.

PLEASE NOTE THESE COMMENTS WHEN INTERPRETING THE RESULTS

- **Percentage of Adult Females Breeding :**

Eastern subpopulation –
Best guess estimate of breeding – 60% found in Mpumalanga (one region of the eastern subpopulation), while it was felt to be far lower in the other regions of this subpopulation = therefore took 50%

Karoo subpopulation –
Literature – states 47% of adult population breeds each year

Western Cape subpopulation –
One paper states proportion of pairs (outside of flocks) during breeding season with young = 60.1%, while a second states that 28% of adult birds occur in pairs during the summer months
Consensus from the group feels that 28% was the best figure to use, therefore this is the minimum value to be used

- **Breeding – percentage of pairs with litter size of 1 at fledging**

  Eastern subpopulation – Calculated from colour ringing data, where 20 out of 23 breeding pairs had only 1 chick just prior to fledging = 87%

  Karoo subpopulation – Calculated from colour ringing data, where 78 out of 105 breeding pairs had only 1 chick just prior to fledging = 74%

  Western Cape subpopulation – Calculated from colour ringing data, where 34 out of 104 breeding pairs had only 1 chick just prior to fledging = 33%

- **Mortality Rates :**

  Eastern subpopulation –

  Juvenile = 70% (Literature – mortality rate up until fledging was found to be 52%, with an additional 18% added for further powerline / poisoning mortalitites over the next 6 months of their lives)
  Subadult = 10%
  Adult = 5%

  Karoo subpopulation –

  Juvenile = 60% (Best estimate from staff of Northern Cape Nature Conservation Services)
  Subadult = 9% (Based on Karoo (Northern Cape) powerline project (1998 – 2001), where Blue Crane mortalities from powerline collisions were determined)
  Adult = 7% (Based on Karoo (Northern Cape) powerline project (1998 – 2001), where Blue Crane mortalities from powerline collisions were determined)

  Western Cape subpopulation –
  Juvenile = 50% (Best estimate from members of the Overberg Crane Group)
  Subadult and adult = 5% (Consensus reached by members of the Overberg Crane Group – best guess)

- **Population Age Distribution :**
  The population is assumed to have a stable age distribution.

- **Initial Population Size :**

  The initial population size of each subpopulation was set as follows (according to the National Crane Census):

  Eastern subpopulation – 2 000 individuals

  Karoo subpopulation – 6 000 individuals

  Western Cape subpopulation – 12 000 individuals

- **Carrying Capacity :**

  The carrying capacity was set as follows :
  Eastern subpopulation – 10 000 individuals

  Karoo subpopulation – 12 000 individuals

  Western Cape subpopulation – 15 000 individuals

- **Trend in Carrying Capacity :**

  Eastern subpopulation – Due to loss of grassland through afforestation and ploughing for agriculture, if was felt that a negative trend of 2.5% in the carrying capacity over the next 5 years was appropriate

  Karoo subpopulation – No trend was set for the carrying capacity

  Western Cape subpopulation – No trend was set for the carrying capacity

- **Harvest / Supplementation :**
  None

Output Data:

The model was run producing the following population response :

Table 1 : *VORTEX* output data from the baseline model of the three Blue Crane subpopulations.

Deterministic Growth rate R	Stochastic Growth rate R	Standard Deviation	Probability of Extinction (%)	Population Size (N)	Standard Deviation	Time to Extinction (years)	Observed Heterozygocity (%)
Eastern subpopulation							
-0.014	-0.0084	0.0868	0.000	1121.14	802.53	0	0.9956
Karoo subpopulation							
-0.031	-0.028	0.110	0.000	621.65	705.49	0	0.9944
Western Cape subpopulation							
0.025	0.0365	0.0923	0.000	16925.41	1655.41	0	0.9996

Eastern subpopulation –

Year 0 in Figure 2 represents the year 2001, which then models the population with a starting size of 2000 individuals over the following 100 years. This population has a negative growth rate (Table 1 – r = -0.014), indicating that the population is in deterministic decline (the numbers of deaths outpace the numbers of births), and will become extinct even in the absence of any stochastic fluctuations. Following the model simulation, the stochastic growth rate becomes less negative (-0.0084) indicating that stochastic fluctuations have little or no effect on the population. No simulations went extinct over 100 years, although the population dropped by 44% over this period to a final size of only 1121 individuals. In summary, this baseline model indicates that the Eastern Blue Crane population (without any management intervention) has a low chance of extinction over the next 100 years, although will maintain a negative growth rate (Figure 2).

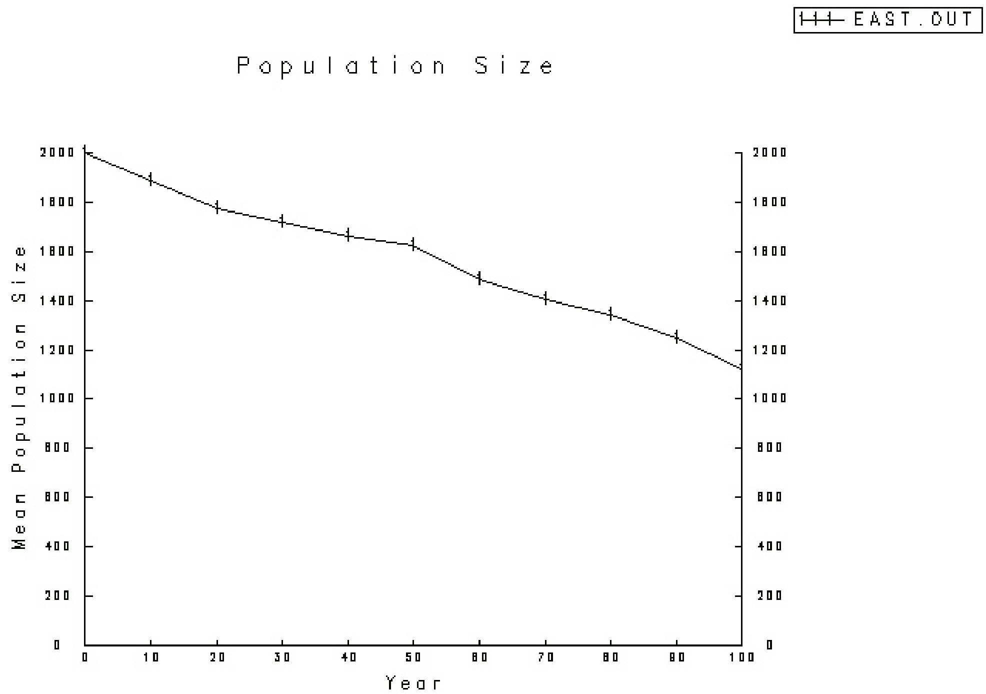


Fig 2 : The overall mean Blue Crane population size for the Eastern population over the next 100 years.

Karoo subpopulation –

Year 0 in Figure 3 represents the year 2001, which then models the population with a starting size of 6000 individuals over the following 100 years. This population has a negative growth rate (Table 1 – r = -0.031), indicating that the population is in deterministic decline (the numbers of deaths outpace the numbers of births), and will become extinct even in the absence of any stochastic fluctuations. Following the model simulation, the stochastic growth rate is very similar to the deterministic rate (-0.028) indicating that stochastic fluctuations have little or no effect on the population. No simulations went extinct over 100 years, although the population dropped by 89% over this period to a final size of only 621 individuals. In summary, this baseline model indicates that the Karoo Blue Crane population (without any management intervention) has a low chance of extinction over the next 100 years, although will maintain a negative growth rate (Figure 3).

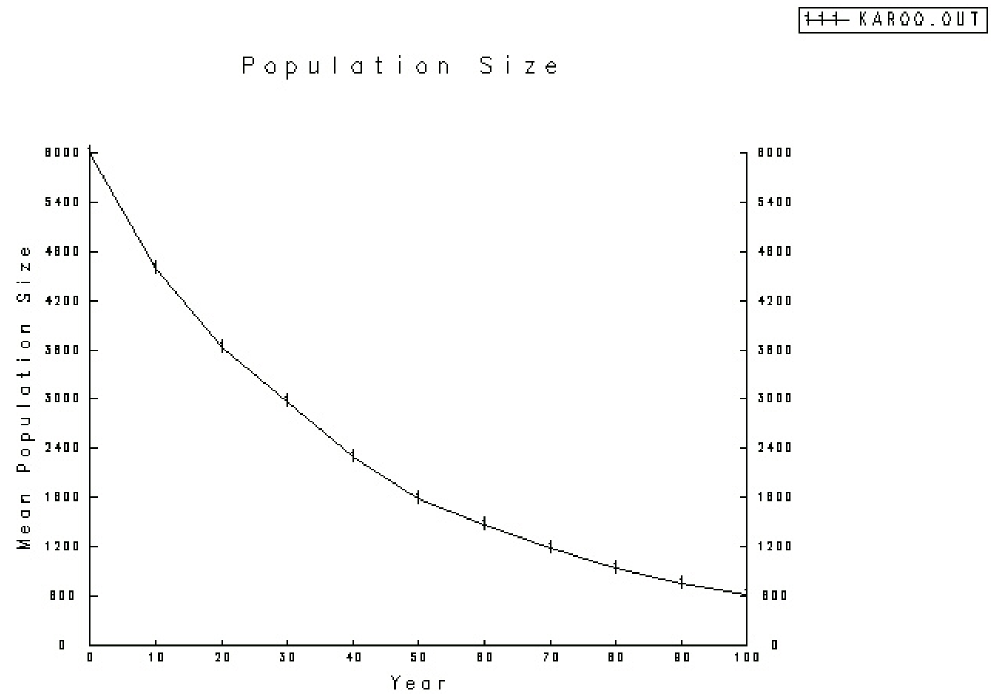


Fig 3 : The overall mean Blue Crane population size for the Karoo population over the next 100 years.

Western Cape subpopulation –

Year 0 in Figure 4 represents the year 2001, which then models the population with a starting size of 12 000 individuals over the following 100 years. This population has a positive growth rate (Table 1 – r = 0.025), indicating that the population is increasing (the numbers of births outpace the numbers of deaths). Following the model simulation, the stochastic growth rate becomes more positive (0.0365) indicating that stochastic fluctuations with this large initial population size have little or no effect on the population. The population increases to just below the carrying capacity, which was set at 18 000 individuals, in only 10 years. No simulations went extinct over 100 years, with the population increasing to a final size fluctuating around 16 925 individuals. In summary, this baseline model indicates that conditions are highly favourable for the Western Cape Blue Crane population to increase dramatically over a short period of time (without any management intervention) to carrying capacity (Figure 4).

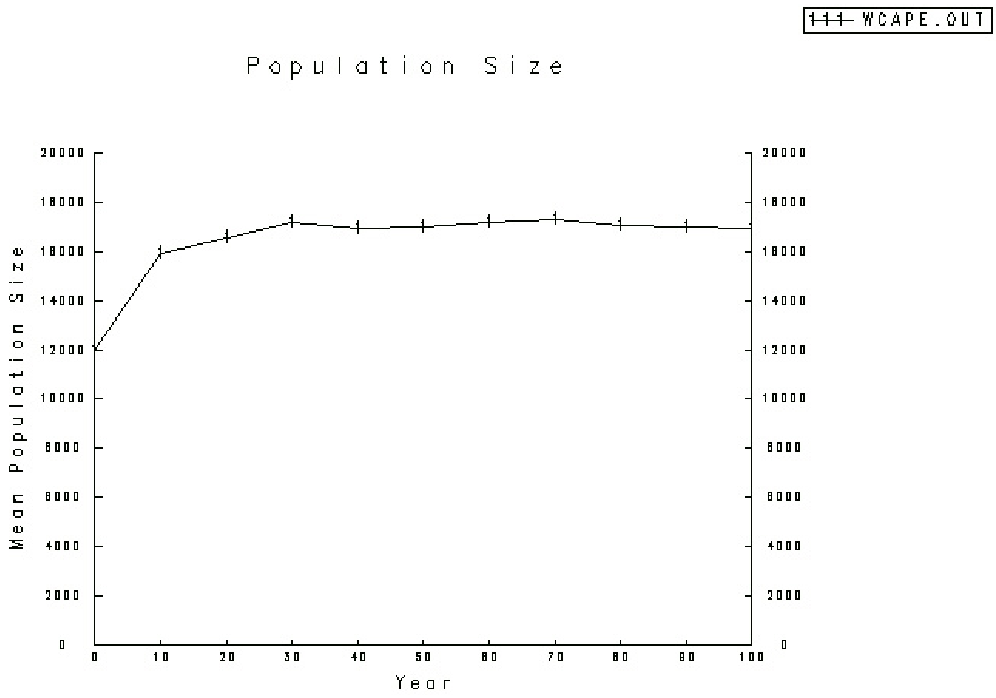


Fig 4 : The overall mean Blue Crane population size for the Western Cape population over the next 100 years.

SCENARIO MODELLING

These baseline models were then used to model the following scenarios, testing the sensitivities of the following factors :

Eastern subpopulation –

The following parameters and scenarios were modelled :

> Age of first Breeding
Factors : 3 years of age – file : eastba3
4 years of age – file : east
5 years of age – file : eastba5

> Max breeding age (breeding scenesence)
Factors : 20 years of age – file : eastsc20
25 years of age – file : east
30 years of age – file : eastsc30

> Juvenile mortality
Factors : 60% - file : eastmj60
65% - file : eastmj65
70% - file : east

> Subadult mortality
Factors : 5% – file : eastms5
10% – file : east
15% - file : eastms15

> Adult mortality
Factors : 5% – file : east
7.5% – file : eastma75
10% – file : eastma10

> Trend in carrying capacity
Factors : -2.5% over first 5 years – file : east
-5% over first 5 years – file : eastkt5
-7.5% over first 5 years – file : eastkt75

Age of first breeding

- Age of first breeding has not been determined and remains unclear for Blue Cranes.

Model : The age of first breeding was varied between 3, 4 and 5 years of age, maintaining all other baseline demographic parameters, and modelled over 100 years.

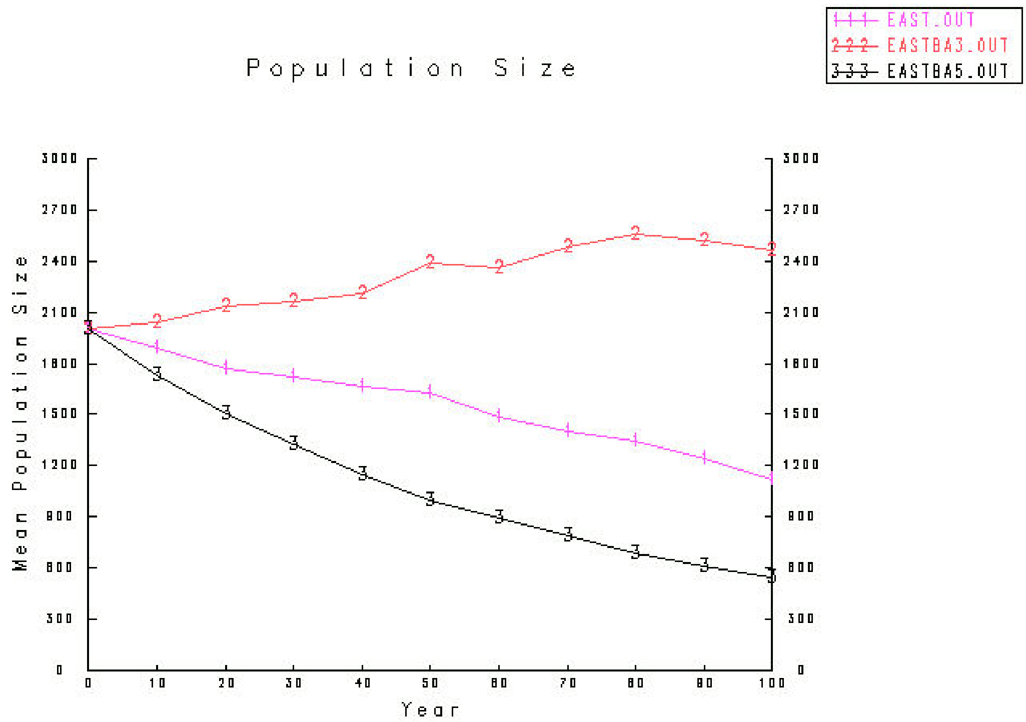


Figure 5 : The change in the mean Eastern Blue Crane population size over 100 years at different ages of first breeding (**Eastba3** = 3 years of age**, East** = 4 years of age, **Eastba5** = 5 years of age).

Result : The final population showed significant differences between the different variables of age of first breeding.

Interpretation : *VORTEX* modelling has demonstrated that the age of first breeding has a significant influence on the overall population outcome. A decrease in age of first breeding from 4 years of age to 3 years results in a change in the population growth rate from a negative to a positive rate, maintaining all other population parameters constant. Therefore, it is important to determine the age of first breeding accurately as this will have a significant impact on any interpretation of the success of any management applications to the population.

Maximum Breeding Age (reproductive senescence)

- The maximum breeding age is not known for Blue Cranes.

Model : The maximum breeding age was varied between 20, 25 and 30 years of age, maintaining all other baseline demographic parameters, and modelled over 100 years.

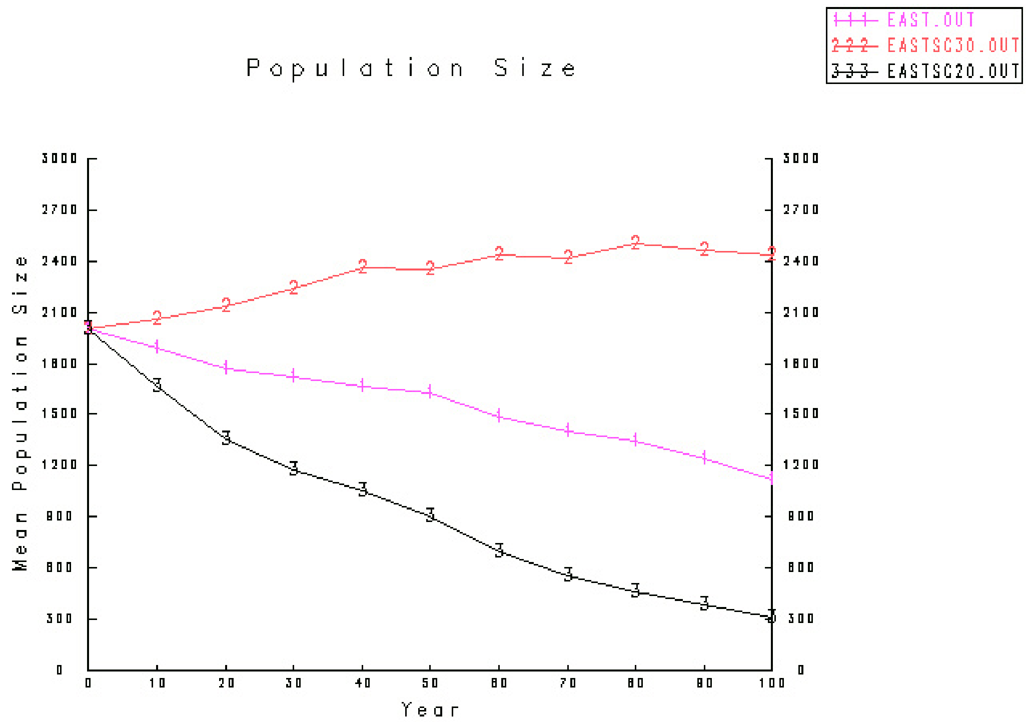


Figure 6 : The change in the mean Eastern Blue Crane population size over 100 years at different ages of breeding senescence (**Eastsc20** = 20 years of age, **East** = 25 years of age, **Eastsc30** = 30 years of age).

Result : The final population showed significant differences between the different variables of the maximum age of breeding (reproductive senescence).

Interpretation : *VORTEX* modelling has demonstrated that the maximum age of breeding has a significant influence on the overall population outcome. Both 20 and 25 years of age result in negative growth rates, with a maximum breeding age of 20 years resulting in a population nearing extinction. An increase in the maximum breeding age to 30 years results in an overall increase in the population. Therefore, it is important to determine the maximum age of breeding (reproductive senescence) accurately as this will have a significant impact on any interpretation of the success of any management applications to the population, as this parameter may cause the population change rather than the manipulation of management options.

Juvenile Mortality Rates

- Mortality rates of the juvenile age class (hatching to 1 year of age) are an important parameter in a species population biology, this factor being unclear for Blue Cranes.

Model : The juvenile mortality rate was varied between 60%, 65% and 70%, maintaining all other baseline demographic parameters, and modelled over 100 years.

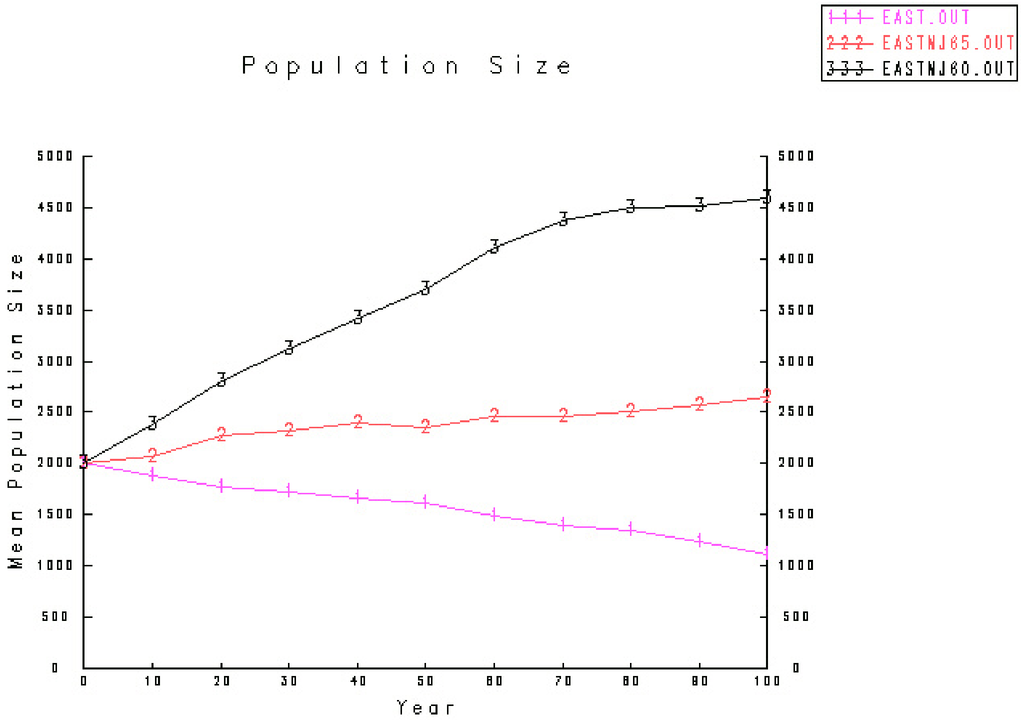


Figure 7 : The change in the mean Eastern Blue Crane population size over 100 years at different juvenile mortality rates (**Eastmj60** = 60%, **Eastmj65** = 65%, **East** = 70%).

Result : The final population showed significant differences between the different variables of juvenile mortality rates.

Interpretation : *VORTEX* modelling has demonstrated that at the estimated juvenile mortality rate used in the baseline model (70%) the population maintains a negative growth rate over 100 years. With a change (decrease) in the juvenile mortality rate to 60% or even 65%, then the population maintains a positive growth rate over the next 100 years. Therefore, <u>any management manipulation of the eastern population to reduce the juvenile mortality rate to 60% will have a large positive influence on this population.</u>

Subadult Mortality Rates

- Mortality rates of the subadult age class (1 year to 4 years of age) are an important parameter in a species population biology, this factor being unclear for Blue Cranes.

Model : The subadult mortality rate was varied between 5%, 10% and 15%, maintaining all other baseline demographic parameters, and modelled over 100 years.

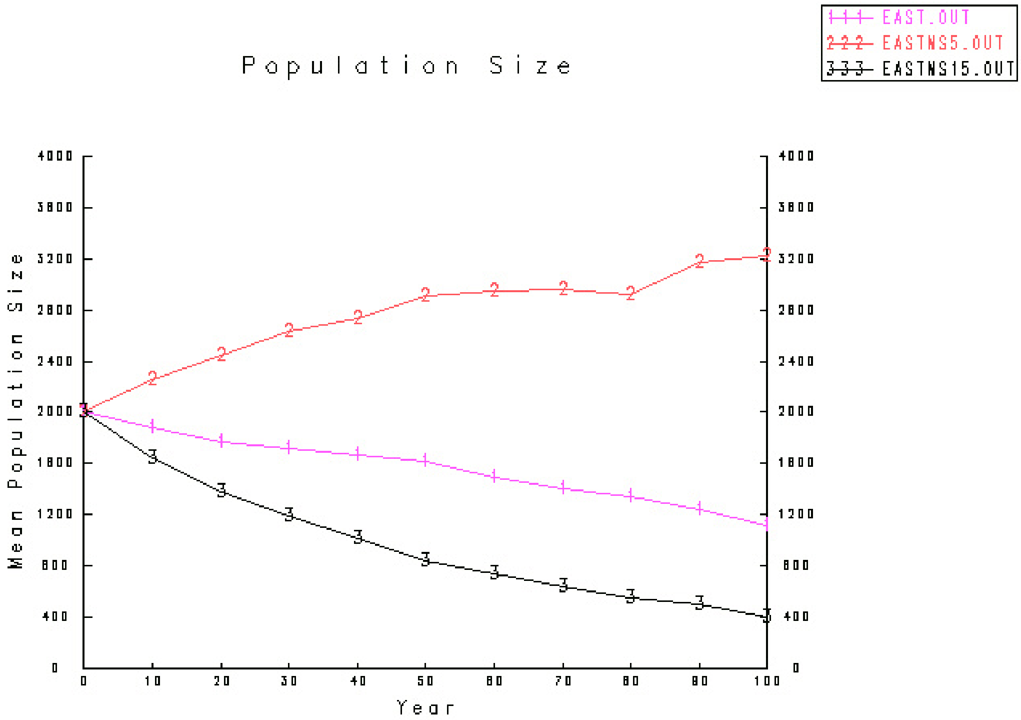


Figure 8 : The change in the mean Eastern Blue Crane population size over 100 years at different subadult mortality rates (**Eastms5** = 5%, **East** = 10%, **Eastms15** = 15%).

Result : The final population showed significant differences between the different variables of subadult mortality rates.

Interpretation : *VORTEX* modelling has demonstrated that varying the subadult mortality rate has less of an influence than varying juvenile mortality rates. Maintaining both a 10% or 15 % mortality rate results in an overall negative growth rate, while decreasing the mortality rate to 5% results in a significant positive growth rate. Therefore, <u>any management manipulation of the eastern population to reduce the subadult mortality rate to 5% will have a large positive influence on this population.</u>

Adult Mortality Rates

- Mortality rates of the adult age class (older than 4 years of age) are an important parameter in a species population biology, this factor being unclear for Blue Cranes.

Model : The adult mortality rate was varied between 5%, 7.5% and 10%, maintaining all other baseline demographic parameters, and modelled over 100 years.

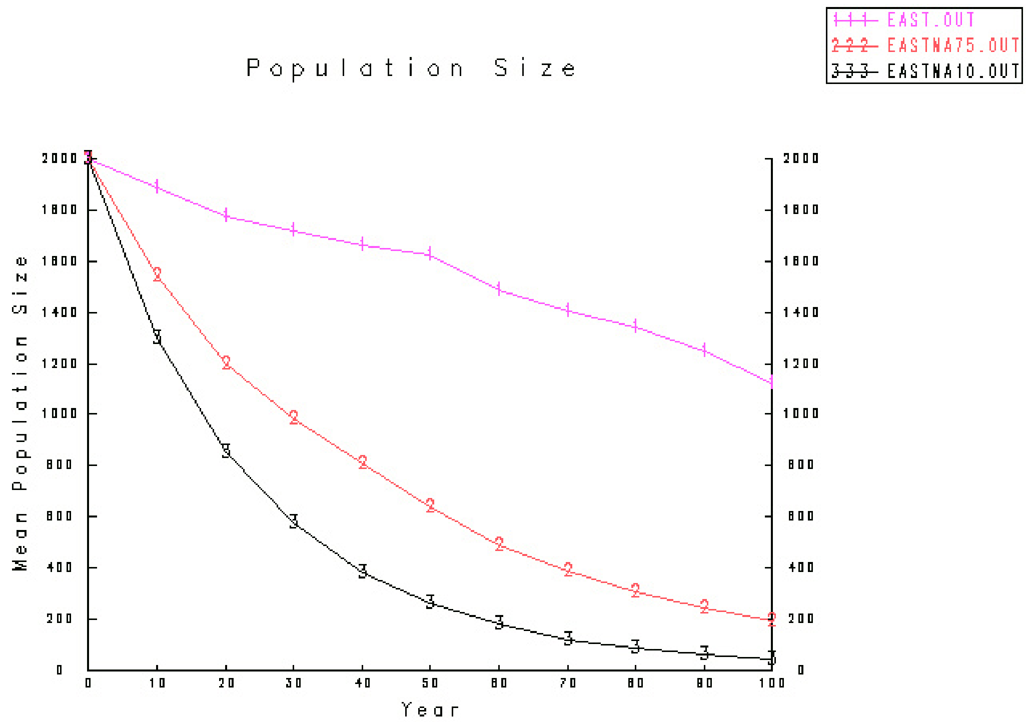


Figure 9 : The change in the Eastern Blue Crane population size over 100 years at different adult mortality rates (**East** = 5%, **Eastma75** = 7.5%, **Eastma10** = 10%).

Result : The final population showed significant differences between the different variables of adult mortality rates.

Interpretation : *VORTEX* modelling has demonstrated that adult mortality rates have the largest influence on the population, obviously due to its impact on the breeding portion of the population. Using the current population parameters, including a low adult mortality rate of 5% results in a negative growth rate of the population over 100 years. Therefore, most effort needs to go into reducing the adult mortality rate of the eastern Blue Crane population, probably in conjunction with reducing juvenile and subadult mortality rates in order to maintain a positive growth rate in the population.

Trends in Carrying Capacity

- Changes in the grassland carrying capacity due to landuse changes are thought to have played a significant role in the decline in the Eastern Blue Crane population size.

Model : The grassland carrying capacity trend was varied between -2.5%, -5% and -7.5%, maintaining all other baseline demographic parameters, and modelled over 100 years.

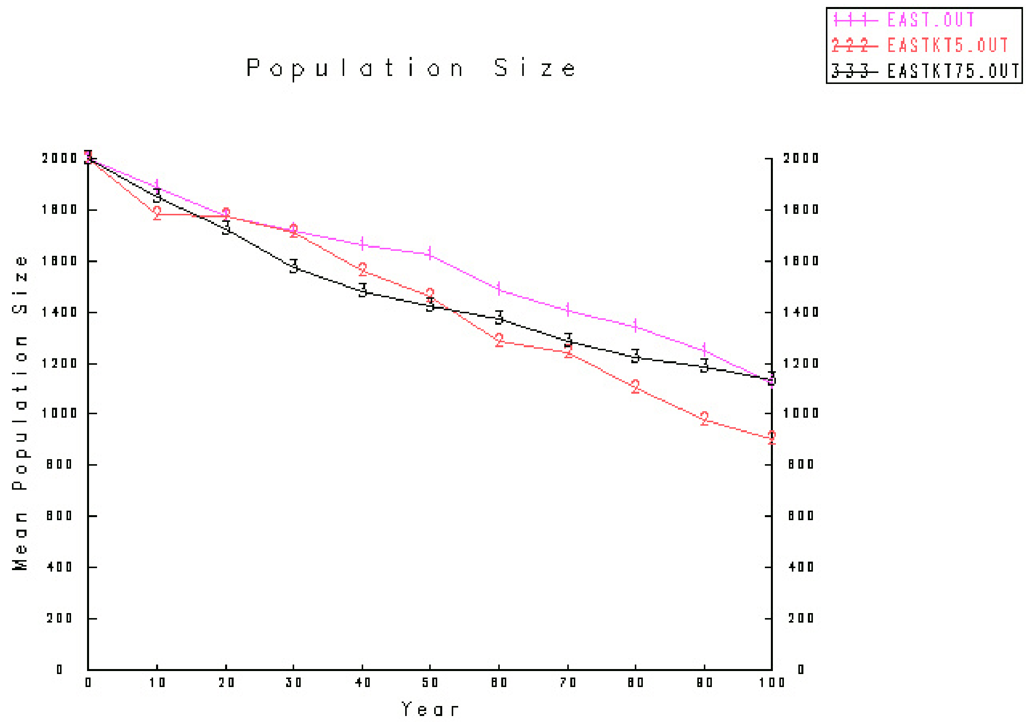


Figure 10 : The change in the mean Eastern Blue Crane population size over 100 years at different carrying capacity trends (**East** = -2.5%, **Eastkt5** = -5%, **Eastkt75** = -7.5%).

Result : The final population showed insignificant differences between the different carrying capacity trends.

Interpretation : *VORTEX* modelling has demonstrated that using the current population parameters, it is unlikely that any changes in the grassland carrying capacity have influenced the population to any large degree, although the carrying capacity was only affecting the population over the first 5 years. Changes in carrying capacity between –2.5% and –7.5% result in very similar population outcomes, although all resulting in a negative growth rate. Therefore,

Karoo subpopulation -

The following population parameters and scenarios were modelled :

> Initial Population size
> Factors : 6000 initial population size – file : karoo
> 8000 initial population size – file : karps8
> 10000 initial population size – file : karps10

> Mortality Scenarios
> Factors : Juv mort. = 60%, sudabdult = 9%, Adult = 7% – file : karoo
> Juv mort. = 60%, sudabdult = 9%, Adult = 5% – file : karms1
> Juv mort. = 60%, sudabdult = 7%, Adult = 5% – file : karms2
> Juv mort. = 60%, sudabdult = 7%, Adult = 3% – file : karms3
> Juv mort. = 50%, sudabdult = 5%, Adult = 5% – file : karms4

Initial Population Size

- Changes in the initial population size is an important population parameter affecting the overall outcome of the population, with varying population sizes being used in this analysis.

Model : The initial population size of the Karoo population was varied between 6 000, 8 000 and 10 000 individuals, maintaining all other baseline demographic parameters, and modelled over 100 years.

Result : The final population showed insignificant differences in the population outcomes having had different initial population sizes .

Interpretation : *VORTEX* modelling has demonstrated that factors other than the initial population size is dominating the population outcome. It appears as if the mortality rates for this population, especially the subadult and adult rates, influence the population in a negative manner in spite of an increased initial population size. Therefore, <u>any increase in the population size, through captive breeding and release, or translocation, will have very little influence on the population, as the overall mortality rates (particularly through powerline collisions in this population) dominate the population outcome</u>.

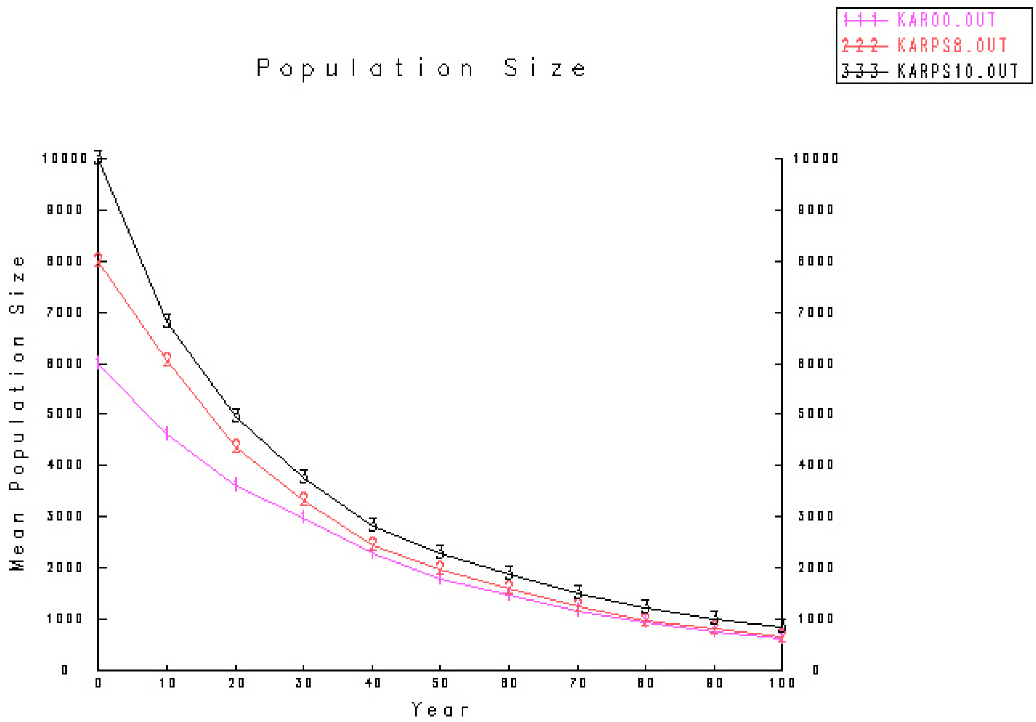


Figure 11 : The change in the mean Karoo Blue Crane population size over 100 years at different initial population sizes (**karoo** = 6 000 individuals, **karps8** = 8000 individuals, **karps10** = 10 000 individuals).

Mortality Rate scenarios

- Mortality rates in the Karoo population appear to play the most significant role in the population outcome, with varying scenarios being used in this analysis.

Model : The mortality rates of juveniles, subadults and adults were varied for the Karoo population (see Figure 12 for explanations of the scenarios), maintaining all other baseline demographic parameters, and modelled over 100 years.

Result : The final population showed varying differences in the population outcomes with the different mortality rate scenarios.

Interpretation : *VORTEX* modelling has demonstrated that manipulating the subadult and adult mortality rates results in the most significant population outcome changes. By reducing the subadult rate to 7% and the adult rate to 5% reduces but still maintains a highly negative growth rate. Even reducing the adult mortality rate to only 3% improves the population outcome dramatically, although still shows a slight negative growth rate. The combination of reducing the subadult and adult mortality rates to 5% each, as well as reducing the juvenile rate has the largest impact on the population, the only scenario showing a positive growth rate. Therefore, in order to achieve any significant conservation result in the Karoo population, significant effort must be placed in reducing the subadult and adult mortality rates.

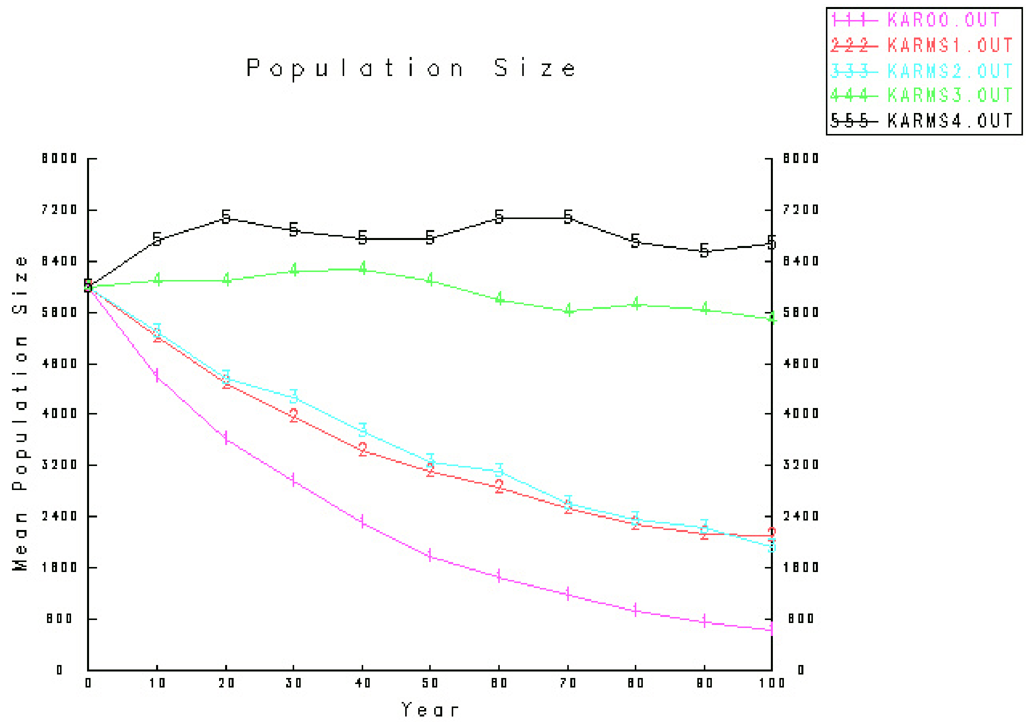


Figure 12 : The change in the mean Karoo Blue Crane population size over 100 years at different mortality rate scenarios (karoo = juvenile mort. = 60%, sudabdult = 9%, Adult = 7%, karms1 = juvenile mort. = 60%, sudabdult = 9%, Adult = 5%, karms2 = juvenile mort. = 60%, sudabdult = 7%, Adult = 5%, karms3 = juvenile mort. = 60%, sudabdult = 7%, Adult = 3%, karms4 = juvenile mort. = 50%, sudabdult = 5%, Adult = 5%).

Western Cape subpopulation –

The following population parameters and scenarios were modelled :

> Different subadult / adult mortality combinations
Factors : Subadult 5% / adult 5 % - file : wcape
Subadult 7.5% / adult 7.5% – file : wcapes1
Subadult 10% / adult 7.5% – file : wcapes2
Subadult 15% / adult 7.5% – file : wcapes3
Subadult 7.5% / adult 10% – file : wcapes4
Subadult 10% / adult 10% – file : wcapes5
Subadult 15% / adult 10% – file : wcapes6

> Trend in carrying capacity
Factors : No trend – file : wcape
-2% over first 10 years – file : wcapkt2
-5% over first 10 years – file : wcapkt5
-10% over first 10 years – file : wcapkt10

Subadult / Adult Mortality Rate scenarios

- The Western Cape population is currently showing a positive growth rate, allowing an analysis of the factors that could possible cause the population to decline.

Model : The subadult and adult mortality rates were varied for the Western Cape population (see Figure 13 for explanations of the scenarios), maintaining all other baseline demographic parameters, and modelled over 100 years.

Result : The final population showed varying differences in the population outcomes with the different mortality rate scenarios.

Interpretation : *VORTEX* modelling has demonstrated that manipulating the subadult and adult mortality rates results in the most significant population outcome changes. The Western Cape population will begin declining with an adult mortality rate of 7.5% combined with a subadult rate of 15%, or with an adult mortality rate of 10% combined with a subadult rate of 7.5% or higher. By further increasing the mortality rates (of both subadults and adults) causes the population to decline more dramatically. Therefore, in order for the Western Cape Blue Crane population to survive into the long-term, subadult mortality rates must be kept below 10%, combined with an adult mortality rate of below 7.5%.

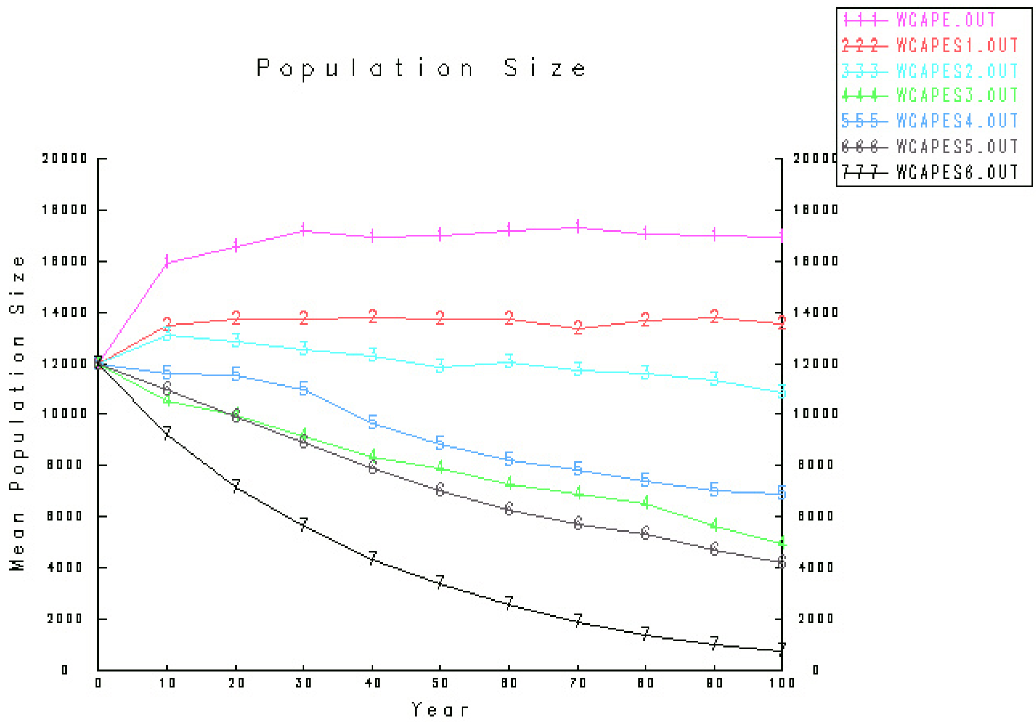


Figure 13 : The change in the mean Western Cape Blue Crane population size over 100 years at different mortality rate scenarios (wcape - sudabdult = 5%, Adult = 5%, wcapes1 - sudabdult = 7.5%, Adult = 7.5%, wcapes2 - sudabdult = 10%, Adult = 7.5%, wcapes3 - sudabdult = 15%, Adult = 7.5%, wcapes4 - sudabdult = 7.5%, Adult = 10%, wcapes5 – subadult = 10%, adult = 10%, wcapes6 – subadult = 15%, adult = 10%).

Trends in Carrying Capacity

- Due to the potential for the habitat suitability to change in the Western Cape due to a potential landuse change, the impact of the trend in carrying capacity in this population was tested.

Model : The habitat carrying capacity trend was varied between no trend, -2%, -5% and -10% over the first 10 years, maintaining all other baseline demographic parameters, and modelled over 100 years.

Result : The final population showed highly significant differences between the different carrying capacity trends.

Interpretation : *VORTEX* modelling has demonstrated that using the current population parameters (with no carrying capacity trend), the population maintains a highly positive growth rate and reaches carrying capacity within approximately 30 years. By imposing a –2% trend over the first 10 years results in a much reduced overall carrying capacity, with the population reaching this reduced carrying capacity of approximately 13 000 individuals within the first 10 years. By reducing it further to –5% the carrying capacity of 8 500 is reached after 20 years, with a negative growth rate. If the carrying capacity trend is reduced to –10% over the next 10 years, then the population has a 100% chance of extinction within 11 years from now. Therefore, in order to maintain the Western Cape population with a positive growth rate, we must ensure that the carrying capacity of the area is not reduced by more than 2% each year for the following 10 years.

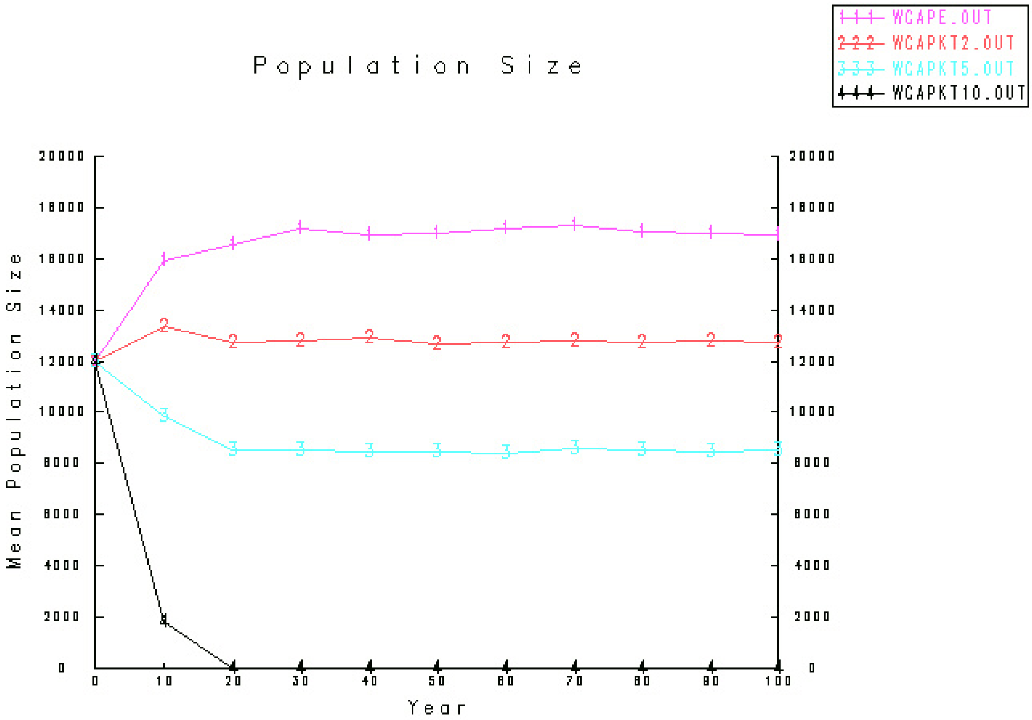


Figure 14 : The change in the mean Western Cape Blue Crane population size over 100 years at different carrying capacity trends (**wcape** = no trend, **wcapkt2** = -2%, **wcapkt5** = -5%, **wcapkt10** = -10%).

Table 2 : The output table of the Eastern population of varying scenarios of age of first breeding, breeding senescence, juvenile, subadult and adult mortality rates and carrying capacity.

INPUT VALUES							OUTPUT VALUES FOR 100 ITERATIONS OVER 100 YEARS							
File	Breeding age	Breeding scenesence	% Juvenile Mortality	% Subadult mortality	% Adult mortality	Carrying capacity trend	Deterministic.r	Stochastic.r	Standard Deviation (r)	Probability of Extinction	Total population (N)	Standard Deviation (N)	Observed Heterozygosity	Mean Time to Extinction
EAST – base model	4	25	70%	10%	5%	-2.5%	-0.014	-0.008	0.087	0.000	1121.14	802.53	0.9933	0
EASTBA3	3	25	70%	10%	5%	-2.5%	-0.004	-0.001	0.089	0.000	2467.29	1749.76	0.9949	0
EASTBA5	5	25	70%	10%	5%	-2.5%	-0.023	-0.016	0.086	0.000	542.98	444.44	0.9891	0
EASTSC30	4	30	70%	10%	5%	-2.5%	-0.005	0.000	0.086	0.000	2437.69	1509.09	0.9962	0
EASTSC20	4	20	70%	10%	5%	-2.5%	-0.030	-0.022	0.092	0.000	315.56	279.21	0.9802	0
EASTMJ65	4	25	65%	10%	5%	-2.5%	-0.002	0.001	0.084	0.000	2654.13	1441.72	0.9961	0
EASTMJ60	4	25	60%	10%	5%	-2.5%	0.009	0.008	0.082	0.000	4585.90	1691.10	0.9975	0
EASTMS5	4	25	70%	5%	5%	-2.5%	-0.001	0.003	0.084	0.000	3217.25	1765.68	0.9966	0
EASTMS15	4	25	70%	15%	5%	-2.5%	-0.027	-0.020	0.092	0.010	398.38	457.92	0.9862	0
EASTMA75	4	25	70%	10%	7.5%	-2.5%	-0.032	-0.028	0.080	0.010	195.43	240.75	0.9712	0

EASTMA10	4	25	70%	10%	10%	-2.5%	-0.051	-0.045	0.093	0.060	45.07	75.97	0.8968	0
EASTKT5	4	25	70%	10%	5%	-5%	-0.014	-0.011	0.087	0.000	901.23	646.74	0.9922	0
EASTKT75	4	25	70%	10%	5%	-7.5%	-0.014	-0.008	0.088	0.000	1132.69	789.16	0.9931	0

Table 3 : The output table of the Karoo and Western Cape populations of varying scenarios of initial population size, juvenile, subadult and adult mortality rates and carrying capacity.

INPUT VALUES							OUTPUT VALUES FOR 100 ITERATIONS OVER 100 YEARS							
File	Breeding age	Breeding scenesence	% Juvenile Mortality	% Subadult mortality	% Adult mortality	Initial population size	Deterministic.r	Stochastic.r	Standard Deviation (r)	Probability of Extinction	Total population (N)	Standard Deviation (N)	Observed Heterozygosity	Mean Time to Extinction
KAROO – base model	4	25	60%	9%	7%	6 000	-0.031	-0.028	0.110	0.000	621.65	705.49	0.9863	0
KARPS8	4	25	60%	9%	7%	8 000	-0.031	-0.030	0.110	0.000	664.02	711.01	0.9887	0
KARPS10	4	25	60%	9%	7%	10 000	-0.031	-0.030	0.109	0.000	834.91	1066.30	0.9922	0
KARMS1	4	25	60%	9%	5%	6 000	-0.017	-0.014	0.108	0.000	2118.81	1764.97	0.9947	0
KARMS2	4	25	60%	7%	5%	6 000	-0.015	-0.015	0.106	0.000	1940.30	1712.36	0.9958	0
KARMS3	4	25	60%	7%	3%	6 000	0.003	-0.002	0.102	0.000	5486.63	2591.86	0.998	0

													4	
KARMS4	4	25	50%	5%	5%	6 000	0.013	0.001	0.106	0.000	6666.06	2397.62	0.998 6	0
WCAPE – base model	28%	25	50%	5%	5%	N/A	0.025	0.036	0.092	0.000	16925.4 1	1655.41	0.999 5	0
WCAPES1	28%	25	50%	7.5%	7.5%	N/A	0.001	0.011	0.095	0.000	13552.6 5	3907.46	0.999 3	0.0
WCAPES2	28%	25	50%	10%	7.5%	N/A	- 0.006	0.003	0.096	0.000	10870.2 0	4623.52	0.999 1	0.0
WCAPES3	28%	25	50%	15%	7.5%	N/A	- 0.020	-0.011	0.098	0.000	4965.54	3134.86	0.998 4	0.0
WCAPES4	28%	25	50%	7.5%	10%	N/A	- 0.017	-0.007	0.095	0.000	6911.94	4265.65	0.998 6	0.0
WCAPES5	28%	25	50%	10%	10%	N/A	- 0.024	-0.014	0.097	0.000	4175.03	3556.39	0.997 7	0.0
WCAPES6	28%	25	50%	15%	10%	N/A	- 0.039	-0.032	0.101	0.000	761.45	694.64	0.992 3	0.0
WCAPKT2	28%	25	50%	5%	5%	-2.5%	0.025	0.036	0.091	0.000	12731.1 9	949.70	0.999 3	0
WCAPKT5	28%	25	50%	5%	5%	-5%	0.025	0.037	0.094	0.000	8545.66	674.37	0.999 0	0
WCAPKT10	28%	25	50%	5%	5%	-10%	0.025	0.034	0.089	1.000	0.00	0.00	0.000 0	11

Conclusions

The use of *VORTEX* to model the Blue Crane population allows for the interpretation of the effects of different ranges of factors and different management actions on the population. This allows for the setting of conservation management goals, which are more likely to reverse any population declines.

The baseline models show the current trend of the wild Blue Crane subpopulations in South Africa, using the most current information on population demographic parameters. These models show that the Eastern subpopulation is in moderate decline, the Karoo subpopulation is in severe decline while the Western Cape subpopulation maintains a highly positive growth rate, reaching carrying capacity within 10 years.

Therefore, the modelling scenarios show the overall result of several questions posed at the beginning of this chapter, as well as several hypothetical management actions. The resulting outcomes and interpretations are as follows :

- What effect do basic population parameters (such as age of first breeding and age of breeding senescence) have on the population outcome ?

Age of first breeding and age of reproductive senescence both have a significant influence on the outcome of a population. Group discussions have shown that this information is not yet accurately known. Therefore, it is recommended that a comprehensive colour-ringing programme is maintained so as to ascertain these important population parameters more accurately.

- What level of juvenile, subadult and adult mortality rates allows for a positive growth rate in the Eastern and Karoo subpopulations ?

The sensitivity analysis of the age-specific mortality rates has shown that varying the mortality rates for each of the age classes individually for the Eastern subpopulation results in severely different population outcomes. In the Karoo subpopulation, different combinations were analysed, with the combination of reducing the subadult and adult mortality rates to 5% each, as well as reducing the juvenile rate to only 50% had the largest impact on the population, the only scenario showing a positive growth rate.

- What level of subadult and adult mortality rates causes a negative growth rate in the Western Cape subpopulation ?

The sensitivity analysis showed that in order for the Western Cape Blue Crane population to survive into the long-term, subadult mortality rates must be kept below 10%, combined with an adult mortality rate of below 7.5%. Any age-specific mortality rates greater that these shown above will cause the population to decline.

- How does a potentially inaccurate initial population size of the Karoo subpopulation affect the populations' long-term viability ?

Much emphasis in the past has been placed on accurately determining the populations sizes of crane species. The analysis of vastly different initial population sizes for the Karoo subpopulation showed negligible differences in the final population outcomes. The most significant influence on the population, irrespective of the initial population size was the mortality rates of the different age classes. This is where emphasis must be placed for the Karoo subpopulation.

- How does the potential habitat loss / change affect the Eastern and Western Cape subpopulations, shown as a change in carrying capacity ?

Any changes or losses of habitats in the Eastern subpopulation appear to have very little influence on the population. In spite of even a 7.5% decline in habitat carrying capacity over a five year period had a very similar population outcome to that with only a 2.5% carrying capacity decline. The emphasis for this subpopulation again appears to be on the age-specific mortality rates.

Changes in the Western Cape subpopulation’s carrying capacity had a significant influence on the population. In order to maintain the subpopulation with a positive growth rate, no more than 2% of the currently available habitat can be lost each year over the next 10 years. Any more loss than this could have catastrophic consequences for the population.

Concluding Remarks

The long-term survival of the wild population of Blue Cranes in South Africa relies on the implementation of several research projects, assessment programmes as well as management actions, as indicated by the Vortex modelling. Future emphasis must be placed on gaining more accurate age-specific mortality data, determining age of first reproduction and breeding lifespan, as well as addressing the potential habitat change / loss in the Western Cape subpopulation.

Wild Blue Crane Population *VORTEX* output data:

VORTEX 8.21 -- simulation of genetic and demographic stochasticity

EAST.OUT
Tue Feb 5 08:41:47 2002

1 population(s) simulated for 100 years, 100 iterations
Extinction is defined as no animals of one or both sexes.
No inbreeding depression
First age of reproduction for females: 4   for males: 4
Maximum breeding age (senescence): 25
Sex ratio at birth (percent males): 50.000000

Population: Pop1
Monogamous mating; all adult males in the breeding pool.

Reproduction is assumed to be density dependent, according to:
% breeding = ((50.00*[1-((N/K)^2.00)])+(25.00*[(N/K)^2.00]))*(N/(1.00+N))
EV in % adult females breeding = 12.50 SD

Of those females producing litters, ...
87.00 percent of females produce litters of size 1
13.00 percent of females produce litters of size 2

70.00 percent mortality of females between ages 0 and 1
EV in % mortality = 20.000000 SD
10.00 percent mortality of females between ages 1 and 2
EV in % mortality = 3.000000 SD
10.00 percent mortality of females between ages 2 and 3
EV in % mortality = 3.000000 SD
10.00 percent mortality of females between ages 3 and 4
EV in % mortality = 3.000000 SD
5.00 percent mortality of adult females (4<=age<=25)
EV in % mortality = 3.000000 SD
70.00 percent mortality of males between ages 0 and 1
EV in % mortality = 20.000000 SD
10.00 percent mortality of males between ages 1 and 2
EV in % mortality = 3.000000 SD
10.00 percent mortality of males between ages 2 and 3
EV in % mortality = 3.000000 SD
10.00 percent mortality of males between ages 3 and 4
EV in % mortality = 3.000000 SD
5.00 percent mortality of adult males (4<=age<=25)
EV in % mortality = 3.000000 SD

EVs may be adjusted to closest values possible for binomial distribution.
EV in reproduction and mortality will be concordant.

Initial size of Pop1:   2000
(set to reflect stable age distribution)

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total	
	70	63	58	53	51	49	47	46	44	42	41	39	38	36	35	34	33	31	30	29	29	27	26	25	24	1000	Males
	70	63	58	53	51	49	47	46	44	42	41	39	38	36	35	34	33	31	30	29	29	27	26	25	24	1000	Females

Carrying capacity = 10000

with a 2.500 percent decrease for 5 years.
EV in Carrying capacity = 0.00 SD

Deterministic population growth rate (based on females, with assumptions of no limitation of mates, no density dependence, and no inbreeding depression):

r = -0.014 lambda = 0.986 R0 = 0.836
Generation time for: females = 12.75 males = 12.75

Stable age distribution:

Age class	females	males
0	0.093	0.093
1	0.028	0.028
2	0.026	0.026
3	0.024	0.024
4	0.022	0.022
5	0.021	0.021
6	0.020	0.020
7	0.019	0.019
8	0.019	0.019
9	0.018	0.018
10	0.017	0.017
11	0.017	0.017
12	0.016	0.016
13	0.015	0.015
14	0.015	0.015
15	0.014	0.014
16	0.014	0.014
17	0.013	0.013
18	0.013	0.013
19	0.012	0.012
20	0.012	0.012
21	0.011	0.011
22	0.011	0.011
23	0.011	0.011
24	0.010	0.010
25	0.010	0.010

Ratio of adult (>= 4) males to adult (>= 4) females: 1.000

Population 1: Pop1

Year 10
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1885.03 (54.00 SE, 539.96 SD)
Means across extant populations only:
Population size = 1885.03 (54.00 SE, 539.96 SD)
Expected heterozygosity = 0.999 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 2202.04 (31.21 SE, 312.08 SD)

Year 20
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1772.09 (68.50 SE, 684.99 SD)
Means across extant populations only:
Population size = 1772.09 (68.50 SE, 684.99 SD)
Expected heterozygosity = 0.999 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 1478.38 (34.42 SE, 344.22 SD)

Year 30
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1716.63 (93.35 SE, 933.51 SD)
Means across extant populations only:
Population size = 1716.63 (93.35 SE, 933.51 SD)
Expected heterozygosity = 0.998 (0.000 SE, 0.001 SD)
Observed heterozygosity = 0.999 (0.000 SE, 0.001 SD)
Number of extant alleles = 1080.63 (32.50 SE, 324.95 SD)

Year 40
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1661.47 (91.46 SE, 914.60 SD)
Means across extant populations only:
Population size = 1661.47 (91.46 SE, 914.60 SD)
Expected heterozygosity = 0.998 (0.000 SE, 0.001 SD)
Observed heterozygosity = 0.999 (0.000 SE, 0.001 SD)
Number of extant alleles = 857.72 (29.73 SE, 297.29 SD)

Year 50
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1622.39 (96.01 SE, 960.10 SD)
Means across extant populations only:
Population size = 1622.39 (96.01 SE, 960.10 SD)
Expected heterozygosity = 0.997 (0.000 SE, 0.001 SD)
Observed heterozygosity = 0.998 (0.000 SE, 0.001 SD)
Number of extant alleles = 708.76 (26.60 SE, 266.00 SD)

Year 60
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1487.54 (93.09 SE, 930.90 SD)
Means across extant populations only:
Population size = 1487.54 (93.09 SE, 930.90 SD)
Expected heterozygosity = 0.997 (0.000 SE, 0.002 SD)
Observed heterozygosity = 0.998 (0.000 SE, 0.001 SD)
Number of extant alleles = 592.70 (23.69 SE, 236.90 SD)

Year 70
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1402.00 (89.35 SE, 893.50 SD)
Means across extant populations only:
Population size = 1402.00 (89.35 SE, 893.50 SD)
Expected heterozygosity = 0.996 (0.000 SE, 0.002 SD)
Observed heterozygosity = 0.998 (0.000 SE, 0.002 SD)
Number of extant alleles = 505.16 (21.52 SE, 215.23 SD)

Year 80
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1343.50 (90.82 SE, 908.17 SD)
Means across extant populations only:
Population size = 1343.50 (90.82 SE, 908.17 SD)
Expected heterozygosity = 0.995 (0.000 SE, 0.003 SD)
Observed heterozygosity = 0.997 (0.000 SE, 0.002 SD)
Number of extant alleles = 438.47 (19.90 SE, 199.02 SD)

Year 90
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1244.50 (85.93 SE, 859.30 SD)
Means across extant populations only:
Population size = 1244.50 (85.93 SE, 859.30 SD)
Expected heterozygosity = 0.994 (0.000 SE, 0.003 SD)
Observed heterozygosity = 0.997 (0.000 SE, 0.002 SD)
Number of extant alleles = 382.17 (18.18 SE, 181.78 SD)

Year 100
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1121.14 (80.25 SE, 802.53 SD)
Means across extant populations only:
Population size = 1121.14 (80.25 SE, 802.53 SD)
Expected heterozygosity = 0.993 (0.000 SE, 0.004 SD)
Observed heterozygosity = 0.996 (0.000 SE, 0.003 SD)
Number of extant alleles = 332.18 (16.50 SE, 165.03 SD)

In 100 simulations of Pop1 for 100 years:
0 went extinct and 100 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Means across all populations (extant and extinct) ...
Mean final population was 1121.14 (80.25 SE, 802.53 SD)

Age 1	2	3	Adults	Total	
39.64	35.99	28.06	455.56	559.25	Males
39.46	35.41	28.30	458.72	561.89	Females

Across all years, prior to carrying capacity truncation,
mean growth rate (r) was -0.0084 (0.0009 SE, 0.0868 SD)

Final expected heterozygosity was 0.9933 (0.0004 SE, 0.0042 SD)
Final observed heterozygosity was 0.9956 (0.0003 SE, 0.0031 SD)
Final number of alleles was 332.18 (16.50 SE, 165.03 SD)
****

VORTEX 8.21 -- simulation of genetic and demographic stochasticity

KAROO.OUT
Tue Feb 5 08:33:34 2002

1 population(s) simulated for 100 years, 100 iterations
Extinction is defined as no animals of one or both sexes.
No inbreeding depression
First age of reproduction for females: 4 for males: 4
Maximum breeding age (senescence): 25
Sex ratio at birth (percent males): 50.000000

Population: Pop1
Monogamous mating; all adult males in the breeding pool.

Reproduction is assumed to be density dependent, according to:
% breeding = ((47.00*[1-((N/K)^2.00)])+(25.00*[(N/K)^2.00]))*(N/(1.00+N))
EV in % adult females breeding = 12.50 SD

Of those females producing litters, ...
74.00 percent of females produce litters of size 1
26.00 percent of females produce litters of size 2

60.00 percent mortality of females between ages 0 and 1
EV in % mortality = 20.000000 SD
9.00 percent mortality of females between ages 1 and 2
EV in % mortality = 3.000000 SD
9.00 percent mortality of females between ages 2 and 3
EV in % mortality = 3.000000 SD
9.00 percent mortality of females between ages 3 and 4
EV in % mortality = 3.000000 SD
7.00 percent mortality of adult females (4<=age<=25)
EV in % mortality = 3.000000 SD
60.00 percent mortality of males between ages 0 and 1
EV in % mortality = 20.000000 SD
9.00 percent mortality of males between ages 1 and 2
EV in % mortality = 3.000000 SD
9.00 percent mortality of males between ages 2 and 3
EV in % mortality = 3.000000 SD
9.00 percent mortality of males between ages 3 and 4
EV in % mortality = 3.000000 SD
7.00 percent mortality of adult males (4<=age<=25)
EV in % mortality = 3.000000 SD

EVs may be adjusted to closest values possible for binomial distribution.
EV in reproduction and mortality will be concordant.

Frequency of type 1 catastrophes: 20.000 percent
with 0.330 multiplicative effect on reproduction
and 0.900 multiplicative effect on survival

Initial size of Pop1: 6000
(set to reflect stable age distribution)

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total	
	242	222	205	188	176	167	156	147	138	130	122	114	108	101	96	89	84	79	75	70	65	62	58	55	51	3000	Males
	242	222	205	188	176	167	156	147	138	130	122	114	108	101	96	89	84	79	75	70	65	62	58	55	51	3000	Females

Carrying capacity = 12000
EV in Carrying capacity = 0.00 SD

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = -0.031 lambda = 0.970 R0 = 0.700
Generation time for: females = 11.53 males = 11.53

Stable age distribution:

Age class	females	males
0	0.083	0.083
1	0.034	0.034
2	0.031	0.031
3	0.028	0.028
4	0.026	0.026

5	0.025	0.025
6	0.023	0.023
7	0.022	0.022
8	0.020	0.020
9	0.019	0.019
10	0.018	0.018
11	0.017	0.017
12	0.016	0.016
13	0.015	0.015
14	0.014	0.014
15	0.013	0.013
16	0.012	0.012
17	0.012	0.012
18	0.011	0.011
19	0.010	0.010
20	0.010	0.010
21	0.009	0.009
22	0.009	0.009
23	0.008	0.008
24	0.008	0.008
25	0.007	0.007

Ratio of adult (>= 4) males to adult (>= 4) females: 1.000

Population 1: Pop1

Year 10
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 4595.51 (123.55 SE, 1235.48 SD)
Means across extant populations only:
Population size = 4595.51 (123.55 SE, 1235.48 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 5358.62 (92.54 SE, 925.41 SD)

Year 20
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 3619.66 (129.70 SE, 1296.95 SD)
Means across extant populations only:
Population size = 3619.66 (129.70 SE, 1296.95 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 3169.78 (75.74 SE, 757.45 SD)

Year 30
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 2971.81 (149.22 SE, 1492.19 SD)
Means across extant populations only:
Population size = 2971.81 (149.22 SE, 1492.19 SD)
Expected heterozygosity = 0.999 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.001 SD)
Number of extant alleles = 2075.75 (64.47 SE, 644.67 SD)

Year 40
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 2297.27 (152.86 SE, 1528.58 SD)

Means across extant populations only:
Population size = 2297.27 (152.86 SE, 1528.58 SD)
Expected heterozygosity = 0.999 (0.000 SE, 0.001 SD)
Observed heterozygosity = 0.999 (0.000 SE, 0.001 SD)
Number of extant alleles = 1418.19 (55.01 SE, 550.14 SD)

Year 50
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1780.93 (125.00 SE, 1249.96 SD)
Means across extant populations only:
Population size = 1780.93 (125.00 SE, 1249.96 SD)
Expected heterozygosity = 0.998 (0.000 SE, 0.001 SD)
Observed heterozygosity = 0.999 (0.000 SE, 0.001 SD)
Number of extant alleles = 1015.67 (48.46 SE, 484.59 SD)

Year 60
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1461.30 (115.56 SE, 1155.56 SD)
Means across extant populations only:
Population size = 1461.30 (115.56 SE, 1155.56 SD)
Expected heterozygosity = 0.997 (0.000 SE, 0.002 SD)
Observed heterozygosity = 0.999 (0.000 SE, 0.002 SD)
Number of extant alleles = 750.47 (41.50 SE, 414.98 SD)

Year 70
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 1176.91 (102.39 SE, 1023.94 SD)
Means across extant populations only:
Population size = 1176.91 (102.39 SE, 1023.94 SD)
Expected heterozygosity = 0.996 (0.000 SE, 0.005 SD)
Observed heterozygosity = 0.998 (0.000 SE, 0.003 SD)
Number of extant alleles = 563.13 (34.85 SE, 348.54 SD)

Year 80
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 937.06 (88.18 SE, 881.76 SD)
Means across extant populations only:
Population size = 937.06 (88.18 SE, 881.76 SD)
Expected heterozygosity = 0.994 (0.001 SE, 0.007 SD)
Observed heterozygosity = 0.997 (0.000 SE, 0.004 SD)
Number of extant alleles = 429.99 (28.66 SE, 286.57 SD)

Year 90
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 752.75 (73.98 SE, 739.83 SD)
Means across extant populations only:
Population size = 752.75 (73.98 SE, 739.83 SD)
Expected heterozygosity = 0.990 (0.001 SE, 0.014 SD)
Observed heterozygosity = 0.995 (0.001 SE, 0.008 SD)
Number of extant alleles = 329.90 (23.99 SE, 239.95 SD)

Year 100
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 621.65 (70.55 SE, 705.49 SD)

Means across extant populations only:
Population size = 621.65 (70.55 SE, 705.49 SD)
Expected heterozygosity = 0.986 (0.002 SE, 0.023 SD)
Observed heterozygosity = 0.994 (0.001 SE, 0.007 SD)
Number of extant alleles = 255.96 (19.70 SE, 196.96 SD)

In 100 simulations of Pop1 for 100 years:
0 went extinct and 100 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Means across all populations (extant and extinct) ...
Mean final population was 621.65 (70.55 SE, 705.49 SD)

Age 1	2	3	Adults	Total	
23.96	25.63	22.86	236.46	308.91	Males
24.77	25.88	23.38	238.71	312.74	Females

Across all years, prior to carrying capacity truncation,
mean growth rate (r) was -0.0280 (0.0011 SE, 0.1100 SD)

Final expected heterozygosity was 0.9863 (0.0023 SE, 0.0233 SD)
Final observed heterozygosity was 0.9944 (0.0007 SE, 0.0067 SD)
Final number of alleles was 255.96 (19.70 SE, 196.96 SD)
****

VORTEX 8.21 -- simulation of genetic and demographic stochasticity

WCAPE.OUT
Tue Feb 5 08:12:06 2002

1 population(s) simulated for 100 years, 100 iterations
Extinction is defined as no animals of one or both sexes.
No inbreeding depression
First age of reproduction for females: 4 for males: 4
Maximum breeding age (senescence): 25
Sex ratio at birth (percent males): 50.000000

Population: Pop1
Monogamous mating; all adult males in the breeding pool.

Reproduction is assumed to be density dependent, according to:
% breeding = ((28.00*[1-((N/K)^2.00)])+(28.00*[(N/K)^2.00]))*(N/(1.00+N))
EV in % adult females breeding = 12.50 SD

Of those females producing litters, ...
33.00 percent of females produce litters of size 1
67.00 percent of females produce litters of size 2

50.00 percent mortality of females between ages 0 and 1
EV in % mortality = 20.000000 SD
5.00 percent mortality of females between ages 1 and 2
EV in % mortality = 3.000000 SD
5.00 percent mortality of females between ages 2 and 3
EV in % mortality = 3.000000 SD
5.00 percent mortality of females between ages 3 and 4
EV in % mortality = 3.000000 SD
5.00 percent mortality of adult females (4<=age<=25)

EV in % mortality = 3.000000 SD
50.00 percent mortality of males between ages 0 and 1
EV in % mortality = 20.000000 SD
5.00 percent mortality of males between ages 1 and 2
EV in % mortality = 3.000000 SD
5.00 percent mortality of males between ages 2 and 3
EV in % mortality = 3.000000 SD
5.00 percent mortality of males between ages 3 and 4
EV in % mortality = 3.000000 SD
5.00 percent mortality of adult males (4<=age<=25)
EV in % mortality = 3.000000 SD

EVs may be adjusted to closest values possible for binomial distribution.
EV in reproduction and mortality will be concordant.

Initial size of Pop1: 12000
(set to reflect stable age distribution)

Age 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
22 23 24 25 Total
519 481 445 413 382 354 327 304 281 260 242 223 207 192 177 165 152 141
130 121 113 103 96 90 82 6000 Males
519 481 445 413 382 354 327 304 281 260 242 223 207 192 177 165 152 141
130 121 113 103 96 90 82 6000 Females

Carrying capacity = 18000
EV in Carrying capacity = 0.00 SD

Deterministic population growth rate (based on females, with assumptions of
no limitation of mates, no density dependence, and no inbreeding depression):

r = 0.025 lambda = 1.026 R0 = 1.356
Generation time for: females = 12.01 males = 12.01

Stable age distribution:

Age class	females	males
0	0.075	0.075
1	0.037	0.037
2	0.034	0.034
3	0.032	0.032
4	0.029	0.029
5	0.027	0.027
6	0.025	0.025
7	0.023	0.023
8	0.021	0.021
9	0.020	0.020
10	0.018	0.018
11	0.017	0.017
12	0.016	0.016
13	0.015	0.015
14	0.014	0.014
15	0.013	0.013
16	0.012	0.012
17	0.011	0.011
18	0.010	0.010
19	0.009	0.009
20	0.009	0.009
21	0.008	0.008
22	0.007	0.007
23	0.007	0.007
24	0.006	0.006
25	0.006	0.006

Ratio of adult (>= 4) males to adult (>= 4) females: 1.000

Population 1: Pop1

Year 10
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 15885.57 (241.27 SE, 2412.69 SD)
Means across extant populations only:
Population size = 15885.57 (241.27 SE, 2412.69 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 15141.67 (100.42 SE, 1004.22 SD)

Year 20
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 16569.29 (172.07 SE, 1720.71 SD)
Means across extant populations only:
Population size = 16569.29 (172.07 SE, 1720.71 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 10870.82 (70.03 SE, 700.26 SD)

Year 30
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 17200.28 (104.59 SE, 1045.87 SD)
Means across extant populations only:
Population size = 17200.28 (104.59 SE, 1045.87 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 8491.68 (44.73 SE, 447.35 SD)

Year 40
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 16948.78 (130.21 SE, 1302.06 SD)
Means across extant populations only:
Population size = 16948.78 (130.21 SE, 1302.06 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 6973.70 (29.85 SE, 298.54 SD)

Year 50
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 16951.95 (135.47 SE, 1354.66 SD)
Means across extant populations only:
Population size = 16951.95 (135.47 SE, 1354.66 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 5913.81 (21.92 SE, 219.20 SD)

Year 60
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 17193.23 (116.59 SE, 1165.89 SD)
Means across extant populations only:

Population size = 17193.23 (116.59 SE, 1165.89 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 5148.02 (18.56 SE, 185.64 SD)

Year 70
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 17270.17 (114.55 SE, 1145.54 SD)
Means across extant populations only:
Population size = 17270.17 (114.55 SE, 1145.54 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 4553.84 (15.05 SE, 150.53 SD)

Year 80
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 17036.67 (118.27 SE, 1182.73 SD)
Means across extant populations only:
Population size = 17036.67 (118.27 SE, 1182.73 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 4080.70 (12.65 SE, 126.55 SD)

Year 90
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 17000.94 (139.57 SE, 1395.70 SD)
Means across extant populations only:
Population size = 17000.94 (139.57 SE, 1395.70 SD)
Expected heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 3701.45 (10.95 SE, 109.48 SD)

Year 100
N[Extinct] = 0, P[E] = 0.000
N[Surviving] = 100, P[S] = 1.000
Mean size (all populations) = 16925.41 (165.54 SE, 1655.41 SD)
Means across extant populations only:
Population size = 16925.41 (165.54 SE, 1655.41 SD)
Expected heterozygosity = 0.999 (0.000 SE, 0.000 SD)
Observed heterozygosity = 1.000 (0.000 SE, 0.000 SD)
Number of extant alleles = 3379.37 (10.98 SE, 109.76 SD)

In 100 simulations of Pop1 for 100 years:
0 went extinct and 100 survived.

This gives a probability of extinction of 0.0000 (0.0000 SE),
or a probability of success of 1.0000 (0.0000 SE).

Means across all populations (extant and extinct) ...
Mean final population was 16925.41 (165.54 SE, 1655.41 SD)

Age 1	2	3	Adults	Total	
770.15	707.44	661.03	6328.70	8467.32	Males
773.87	710.16	666.49	6307.57	8458.09	Females

Across all years, prior to carrying capacity truncation, mean growth rate (r) was 0.0365 (0.0009 SE, 0.0923 SD)

Final expected heterozygosity was 0.9995 (0.0000 SE, 0.0000 SD)
Final observed heterozygosity was 0.9996 (0.0000 SE, 0.0000 SD)
Final number of alleles was 3379.37 (10.98 SE, 109.76 SD)
****

Group Prioritisation of Solutions and Recommendations

Each working group brought their top four or five solutions, chosen by means of paired ranking their group's total list of solutions, to a plenary session where they were combined into a list of twenty (20) solutions for the whole group. Each person then went back and pair-ranked this list of twenty solutions in order to arrive at a prioritised list of solutions for effective Blue Crane conservation which the whole group had contributed towards and agreed upon. The results were as follows:

	Solution	Rank	Score
A.	Establish baseline data on the removal of birds form the wild – for any reasons	16	169
B.	Adequate registration systems – DNA, microchips, close-ring, studbook	18	144
C.	Gain a better understanding of DNA and haematology	19	104
D.	Research into natural and contracted diseases	17	136
E.	Make problem powerlines visible using an effective marking device	9	304
F.	Route new powerlines away from Blue Crane hotspots	14	225
G.	Promote an awareness amongst farmers and farm labourers of the negative impacts and effects of poisons on non-target animals	11	285
H.	Encourage farmers to tolerate Blue Cranes	13	251
I.	Investigate and determine the relative impact of the different natural and unnatural causes of mortality of Blue Crane populations, including age-specific data	8	309
J.	Lobby for adoption of appropriate legislation and policy, and for implementation of policies through the supply of adequate resources	10	291
K.	Establish a national committee with provincial presentation from all interested and affected parties	15	218
L.	Promote general awareness of Blue Crane conservation policies to the public	12	266
M.	Identify the various different communities with whom one wishes to interact and the key role players within each community and within industry who can positively influence that community or industry's attitude to Blue Crane conservation	9	304
N.	Develop and implement educational programmes relevant to the various communities and train educational personnel for implementation	6	337
O.	Develop a close working relationship with those farmers whose crops may be effected by Blue Crane activities and provide them with information and advice	4	**366**
P.	Determine and monitor the effects of various land uses and farming practices on cranes	2	**416**
Q.	Identify and quantify crop and feedlot depredation by cranes and associated species	7	312
R.	Obtain accurate data on habitat requirements and preferences of Blue Cranes in the three core areas.	1	**426**
S.	Encourage land managers to adopt an appropriate conservation plan	5	363
T.	Attempt to identify the historical factors involved in population changes in the three core areas	3	**369**

Order of priority:

R: Obtain accurate data on habitat requirements and preferences of Blue Cranes in the three core areas.

P: Determine and monitor the effects of various land uses and farming practices on cranes

T: Attempt to identify the historical factors involved in population changes in the three core areas

O: Develop a close working relationship with those farmers whose crops may be effected by Blue Crane activities and provide them with information and advice

BLUE CRANE

(Anthropoides Paradiseus)

Population and Habitat Viability Assessment Workshop

1 – 4 October 2001

Villiersdorp, South Africa

FINAL REPORT

SECTION 4

BIBLIOGRAPHY

References

Allan, D.G. 1985. Southern African cranes in captivity. *Bokmakierie* 37: 81-83.

Allan, D.G. 1993. Aspects of the biology and conservation of the Blue Crane *Anthropoides paradiseus*, and the Ludwig's *Neotis ludwigii* and Stanley's *N. denhami stanleyi* Bustards in southern Africa. MSc thesis, University of Cape Town.

Allan, D.G. 1994a. Cranes and Farmers. Endangered Wildlife Trust, Johannesburg, South Africa.

Allan, D.G. 1994b. *Cranes and Farmers*. Johannesburg: Endangered Wildlife Trust.

Allan, D.G. 1995a. Habitat selection by blue cranes in the Western Cape Province and the Karoo. South African Journal of Wildlife Research. 25: 90-97.

Allan, D.G. 1995b. Observations on roosting Blue Cranes. Ostrich 66: 148 – 150

Allan, D.G. 1996. A review of the biology and conservation status of cranes. In: *Proceedings 1993 African Crane and Wetland Training Workshop* (Ed. R.D. Beilfuss, W.R. Tarboton & N.N. Gichuki), Baraboo : International Crane Foundation.

Allan, D.G. 1997. Movements of the Blue Crane Anthropoides paradisea (Aves : Gruidae) in South Africa as assessed by bird-atlas data and road counts. *Durban Museum Novitates* 22 : 43 – 52.

Allan, D.G. and Ryan, P.G. 1996. Morphometrics, sex ratio, molt, and stomach contents of Blue Cranes in the western Cape Province, South Africa. Pages 377-388 in R.D. Beilfuss, W.R. Tarboton, N.N. Gichuki (eds) Proceedings of the African Crane and Wetland Training Workshop 1993. International Crane Foundation. Baraboo, Wisconsin. USA.

Archibald, G.W. 1976. Crane taxonomy as revealed by the unison call. *In : Crane Research Around the World 1980 Proceedings of the International Crane Symposium* (Ed. J.C. Lewis & H. Masatomi) Baraboo: International Crane Foundation.

Archibald, G.W. & Meine, C.D. 1996. Family Gruidae (cranes). In : *Handbook of the birds of the world Volume 3*. (eds) J. Hoyo, A. Elliot & J. Saratal. Barcelona, Lynx Edicion.

Archibald, G.W., Shigeta, Y., Matsumoto, K. and Momose, K. 1981. Endangered Cranes. Pages 1-12 in J.C. Lewis and H. Masatomi, eds. Crane research around the world: Proceedings of the International Crane Symposium at Sapporo, Japan in 1980 and papers from the World Working Group on Cranes, International Council for Bird Preservation. International Crane Foundation. Wisconsin. USA.

Aucamp, E. 1996. Breeding biology of the Blue Crane in the Overberg, S Cape, South Africa in R.D. Beilfuss, W.R. Tarboton, N.N. Gichuki (eds) Proceedings of the African Crane and Wetland Training Workshop 1993. International Crane Foundation. Baraboo, Wisconsin. USA.

Barnes, K.N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Birdlife South Africa, Johannesburg.

Bibby, C.J., Burgess, N.D. & Hill, D.A. 1992. Bird Census Techniques. Academic Press Limited, Cambridge.

Brooke, R.K. 1984. *South African Red Data Book – Birds*. South African National Science Programme, Report 97. Pretoria: Foundation for Research Development, Council for Scientific and Industrial Research.

Brown, C.J. 1992. The status of cranes in Namibia. In : Porter, D.J., Craven, H.S., Johnson, D.N. & Porter, M.J. (eds.) Proceedings of the First South African Crane Conference, Natal: Southern African Crane Foundation, pp 73 – 75.

Collar, N.J. & Stuart, S.N. 1985. Threatened birds of Africa and related islands. In: *The ICBP/IUCN Red Data Book, Part 1* Cambridge: ICBP/IUCN.

Dean, W.R.J. 1971. Breeding data for the birds of Natal and Zululand. Durban Museum Novitates vol IX, part 6.

Ellis, D.H., Gee, G.F., & Mirande, C.M. (Eds). 1996. *Cranes : Their biology, husbandry and conservation*, Washington, D.C., and Baraboo : National Biological Service, International Crane Foundation.

Filmer, R.J. &. Holtshausen, G.R. 1992. The southern African crane census, 1985/1986. In : Porter, D.J., Craven, H.S., Johnson, D.N. & Porter, M.J. (eds.) Proceedings of the First South African Crane Conference, Natal: Southern African Crane Foundation, pp 132 – 153.

Geldenhuys, J.N. 1984. The status of cranes (Aves: Gruidae) in the Orange Free State. South African Journal of Wildlife Research 14: 15-18.

Ginn, P.J., McIlleron, W.G. and Millstein. P. le S. 1991. *The Complete Book of Southern African Birds.* Unifoto (Pty) Ltd, Capetown. 760 pp.

Harrision, J.A., Allan, D.G., & Martinez, P. 1992. The distribution and relative abundance of cranes in South Africa as assessed by bird atlas data. In : *Proceedings of the First South African Crane Conference* (Ed. D.J. Porter, H.S. Craven, D.N. Johnson & M.J. Porter), Natal : Southern African Crane Foundation.

Harrision, J.A., Allan, D.G., Underhill, L.G., Herremans, M, Tree, A.J., Parker, V. & Brown, C.J. (eds). 1997. The Atlas of southern Africam Birds. Vol. 1 : Non-passerines. Birdlife South Africa, Johannesburg.

Holtshausen, G. & Ledger, J. 1985. Southern African Crane Census 1985/86. *African Wildlife* 39: 196-199.

Holtshausen, G. & Ledger, J. 1985. Southern African Crane Census 1985 / 86. *Bokmakierie* 37 (3), 79 – 80.

Ingold, J.L., Sheldon, S.I., & Osborne, D.R. 1987. Biochemical systematics and evolution of cranes (Aves Gruidae). In : *Proceedings of the 1983 International Crane Workshop (*Ed. G.W. Archibald & R.F. Pasquier), Baraboo: International Crane Foundation.

Ingold, J.L., Vaughn, J.C., Sheldon, S.I. & Maxson, L.R. 1989. Phylogeny of the cranes (Aves : Gruidae) as deduced from DNA-DNA hydridization and albumin micro-complement fixation analyses. *Auk* 106 : 595 – 602.

Johnsgard, P.A. 1983. *Cranes of the World*. Bloomington: Indiana University Press.

Johnson, D.N. 1985. Hybridization between wattled and blue cranes. *Bokmakierie* 37 : 126.

Johnson, D.N. 1992. The status of cranes in Natal in 1989. In : Porter, D.J., Craven, H.S., Johnson, D.N. & Porter, M.J. (eds.) Proceedings of the First South African Crane Conference, Natal: Southern African Crane Foundation, pp 20 –28.

Johnson, D.N., & Barnes, P.R. 1986. The Natal crane census. Lammergeyer 37 : 40 – 49.

Krajewski, C. 1989. Phylogentic relationships among cranes (Gruiformes ; Gruidae) based on DNA hybridization. *Auk* 106 : 603 – 618.

Krajewski, C., & Fetzner, J.W. 1994. Phylogeny of cranes (Gruiformes:Gruidae) based on cytochrome-b DNA sequences. *Auk* 111: 351 – 356.

Krajewski, C., and Archibald, G.W. 1995. The evolution of cranes. Unpublished Report.

Kuchler, C & Good, J. 1990. *Artificial Incubation of bird eggs at the Zoological Society of San Diego.* International Zoo Year Book, Volume 29, p131

Low, A.B. and Rebelo, A.G. (eds) 1996. Vegetation of South Africa, Lesotho and Swaziland. Dept of Environment Affairs and Tourism, Pretoria.

MacDonald, I.A.W. 1989. Man's role in changing the face of southern Africa. In : *Biotic diversity in southern Africa*. Oxford: Oxford University Press.

Maclean, G.L. 1985. Roberts Birds of southern Africa. John Voelcker Bird Book Fund. Cape Town. South Africa.

Maclean, G.L. 1993. Roberts Birds of southern Africa. John Voelcker Bird Book Fund. Cape Town. South Africa.

McCann, K.I. 1999. National crane census results. Cr*ane Link-biannual newsletter of the South African Crane Working Group* December 6: 2-3.

McCann, K.I. 2001. The population status of South Africa's three crane species as of the end of 1999 : based on a national crane census and regional aerial surveys. *Ostrich Supplement* (Proceedings of the 10th Pan African Ornithological Congress, Kampala, Uganda) No. 15 : 126 – 129.

McCann, K., Burke, A., Rodwell, L., Steinacker, M., & Seal, U.S. (Eds). 2000. Population and Habitat Viability Assessment for the wattled crane (*Bugeranus carunculatus*) in South Africa. Final Workshop Report. IUCN / SSC Conservation Breeding Specialist Group.

McCann, K.I., Shaw, K., Anderson, M.D. & Morrison, K. 2001. Techniques for determining movement patterns of Blue and Wattled Cranes in South Africa – colour ringing versus satellite telemetry. **Ostrich Supplement** (Proceedings of the 10th Pan African Ornithological Congress, Kampala, Uganda) No. 15 : 104 – 108.

McCann, K.I., & Wilkins, H. 1995. A study of the annual biology and movement patterns of the three crane species in the KwaZulu-Natal Midlands. *Eskom and Endangered Wildlife Trust Environmental Impact Assessment*.

Meine, C.D. & Archibald, G.W. (eds) 1996. The Cranes : Status survey and conservation action plan. IUCN, Gland, Switzerland, and Cambridge, U.K.

Morrison, K.L. 1998. Habitat utilization and the population ecology of cranes in the Dullstroom area of the Mpumalanga province. MSc thesis, University of Pretoria.

Morrison, K.L. & Bothma, J. 1998. Wetland nesting sites of wattled and grey crowned cranes on the Steenkampsberg Plateau, South Africa. *South African Journal of Wildlife Research* 28: 110-120.

Nesbitt, S.A. 1988. Nesting, renesting and manipulative nesting of Florida sandhill cranes. *Journal of Wildlife Management* 52 : 758-763.

Nesbitt, S.A. 1992. First reproductive success and individual productivity in sandhill cranes. *Journal of Wildlife Management* 56 : 573-577.

Newton, I. 1998. Population limitation in birds. Academic Press, London.

Parker, V. 1994. *Swaziland Bird Atlas 1985 – 1991*. Mbabane : Websters.

Quickelberg, C.D. 1989. *Birds of the Transkei*. Durban Natural History Museum, Durban.

Sauey, Ronald T. & Brown, B. 1980. *The captive management of cranes.* International Zoo Year Book, Volume 19, p89

Schoeman, F.R. 2000. 1998 African Regional Studbook for the Blue / Stanley Crane (*Anthropoides paradiseus*). Pan African Association of Zoological Gardens, Aquaria and Botanical Gardens, Pretoria.

Scott, A. and Scott, R.M. 1996. A conservation programme for the Blue Crane *Anthropoides paradiseus* in the Overberg, Southern Cape, South Africa. *Proceedings of the 1993 Arican. Crane and Wetland Training Workshop*, Maun, Botswana.

Siegfried, W.R. 1985. Relative abundance of cranes (Gruidae) in the Cape Province. Ostrich 56 : 101-103.

Siegfried, W.R. 1992. Conservation Status of the South African endemic avifauna. South African Journal of Wildlife Research 22 : 61 – 64.

Tarboton, W. 1976. Growth and fledging period of Blue Crane chicks. *Wits Bird Club Newsheet* 93 : 14-15.

Tarboton, W.R., Kemp, M.I. & Kemp, A.C. 1987. Birds of the Transvaal. Pretoria, Transvaal Museum.

Tyson, N. 29 Blue Cranes poisoned in the Cape. *African Wildlife* vol 41, no. 5, 266.

Urban, E.K. 1987. The cranes of Africa – An overview. In : *Proceedings of the 1983 International Crane Workshop* (Ed. Archibald, G.W. & R.F. Pasquier), Baraboo : International Crane Foundation.

Urban, E.K., Fry, C.H. and Keith, S. 1986. The birds of Africa – Volume 2. Academic Press, London. 552 pp.

Urban, E.K. 1988. Status of cranes in Africa. In : *Proceedings of the 6th Pan African Ornithological Congress*.

Urban, E.K. 1996. Status of cranes in Africa, 1994. In : Beilfuss, R.D., Tarboton, W.R. & Gichuki, N.N. (eds) Proceedings of the 1993 African Crane and Wetland Training Workshop, Maun, Botswana, pp 53 - 59.

Van Ee, C.A. 1981. Status of the Blue Crane in South and Southwest Africa. Proceedings of the International Crane Symposium at Sapporo, Japan in 1980 and papers from the World Working Group on Cranes, International Council for Bird Preservation, J.C.

Lewis & H. Masutomi (eds). Baraboo, Wisconsin, International Crane Foundation, pp. 125.

Van Ee, C.A. 1966. Notes on the breeding behaviour of the Blue Crane *Tetrapteryx paradisea*. The Ostrich 37 : 23 - 29

Vernon, C.J., Boshoff, A.F. & Stretton, W.S. 1992. The status and conservation of cranes in the Eastern Cape province. In : Porter, D.J., Craven, H.S., Johnson, D.N. & Porter, M.J. (eds.) Proceedings of the First South African Crane Conference, Natal: Southern African Crane Foundation, pp 47 - 72.

Walkinshaw, L.H. 1963. Some life history studies of the Stanley Crane. Proceedings of the Thirteenth International Ornithological Congress 13: 344-353

Walkinshaw, L.H. 1973. Cranes of the world. Winchester Press. New York. USA.

Wood, D.S. 1979. Phenetic relationships within the family Gruidae. *Wilson Bulletin* 91: 384-399.

BLUE CRANE

(Anthropoides Paradiseus)

Population and Habitat Viability Assessment Workshop

1 – 4 October 2001

Villiersdorp, South Africa

FINAL REPORT

SECTION 5

BLUE CRANE PHVA PARTICIPANTS

Blue Crane PHVA Participants

Mr Mark Anderson Northern Cape Nature Conservation Services Private Bag X6102 Kimberley, 8300	Tel : (053) 832 2143 Fax : (053) 831 3530 Cell : 082 788 0961 e-mail : m.anderson@grand.ncape.gov.za
Mr Poena Basson Farmer – North West Province P O Box 827 Delareyville, 2770	Tel : (053) 948 1607 Fax : (053) 948 1607 Cell : 082 575 4213 e-mail : barbersp@lantic.net
Mr Brian D. Colahan Free State Environmental Affairs P O Box 264 Bloemfontein, 9300	Tel : (051) 403 3770 Fax : (051) 403 3024 / 1 e-mail : bdcolahan@xsinet.co.za
Mr Brent Coverdale KZN Crane Foundation P O Box 115 Mooi River, 3300	Tel : (033) 263 6268 Fax : (033) 263 2737 Cell : 082 376 9464 e-mail : crane@futurenet.co.za
Mr Mick D'Alton Farmer Kosieskraal Box 400 Bredasdorp, 7280	Tel : (028) 424 2142 Fax : (028) 424 2142 e-mail : mandjdalton@mail.com
Mr Vlooi Du Toit Farmer Die Kop Wydgelegen, 7282	Tel : (028) 542 1037 Fax : (028) 542 1037
Mr Gustav Engelbrecht Agriculture, Conservation, Environment : NW P O Box 5396 Kochspark, 2523	Tel : (018) 299 6645 Fax : (018) 294 6008 Cell : 082 813 6954 e-mail : gustav@agric.nw.za
Mr Steven W Evans Bird Life South Africa / EWT BSWG P O Box 515 Randburg, 2125	Tel : (011) 789 1122 Fax : (011) 789 5188 Cell : 082 850 6480 e-mail : iba@birdlife.org.za
Ms Yolan Friedmann CBSG South Africa P O Box 582 Pretoria, 0001	Tel : (011) 701 3811 Fax : (011) 701 3811 Cell : 082 990 3534 e-mail : cbsgsa@wol.co.za
Mr David Gaynor Highlands Crane Group P O Box 23 Dullstroom, 1110	Tel ; (013) 254 0051 Fax : (013) 254 0051 Cell : 083 691 9335 e-mail : gaynor@dullstroom.net
Mrs Helen Gaynor Highlands Crane Group P O Box 23 Dullstroom, 1110	Tel ; (013) 254 0051 Fax : (013) 254 0051 Cell : 083 691 9335 e-mail : gaynor@dullstroom.net
Ms Vicki Hudson Overberg Crane Group P O Box 846 Caledon, 7230	Tel : (028) 212 2933 Cell : 082 676 1734 e-mail : vickih@global.co.za
Nadia Kraucamp Rand Water / SACWG Project	Tel : (058) 924 0543 Fax : (058) 924 0159

P O Box 240 Memel, 2970	Cell : 082 330 0476 e-mail : nadian@yebo.co.za
Mr Wicus Leeuwner Overberg Crane Group P O Box 541 Caledon, 7230	Tel : (028) 214 8916 Fax : (028) 214 8916 Cell : 082 371 3617 e-mail : wicus@intekom.co.za
Mr Hennie Lotter Farmer Klipfontein Bus 82 Caledon, 7230	Tel : (028) 284 9855 Cell : 082 556 5397 e-mail : alotter@telkomsa.net
Mr Kevin McCann SACWG P O Box 1047 Mooi River, 3300	Tel : (033) 263 2750 Fax : (033) 263 2750 Cell : 083 447 0657 e-mail : mccrane@iafrica.com
Ms Kerryn Morrison SACWG Private Bag X11 Parkview, 2122	Tel : (011) 486 1102 Fax : (011) 486 1506 Cell : 082 877 5126 e-mail : kerryn@ewt.org.za
Mr Shaun Page WCNCB Private Bag X13 Hermanus, 7200	Tel : (028) 314 0062 Fax : (028) 314 1814 Cell : 082 443 3326 e-mail : cncwbay@mweb.co.za
Ms Claire Patterson EWT – Traffic Private Bag X11 Parkview, 2122	Tel : (011) 486 1102 Fax : (011) 486 1506 Cell : 083 235 2553 e-mail : trafficza@uskonet.com
Mr Samson Phakathi Wakkerstroom Crane Working Group P O Box 54 Wakkerstroom, 2480	Cell : 082 708 0268
Mr Kobus Pienaar Northern Province Environmental Affairs P O Box 3567 Potgietersrus	Tel : (015) 491 8010/1/5 Fax : (015) 491 8140 Cell : 082 771 8068 e-mail : k.pienaar@freemail.absa.co.za
Ms Glenn Ramke Wakkerstroom Crane Monitoring P O Box 289 Wakkerstroom, 2480	Tel : (017) 730 0001 Fax : (017) 730 0674 Cell : 082 759 2529 e-mail : cranenut@vlr.dorea.co.za
Ms Jana Richards SACWG Private Bag X11 Parkview, 2122	Tel : (011) 486 1102 Fax : (011) 486 1506 Cell : 083 604 0439 e-mail : crane@ewt.org.za
Mr Mike Scott Overberg Crane Group P O Box 439 Gansbaai, 7220	Tel : (028) 384 1241 Fax : (028) 384 1241 Cell : 082 950 8135 e-mail : ecoserve@telkomsa.net
Mrs Ann Scott Overberg Crane Group P O Box 439 Gansbaai, 7220	Tel : (028) 384 1241 Fax : (028) 384 1241 Cell : 082 950 8135 e-mail : ecoserve@telkomsa.net
Mr Kevin Shaw Western Cape Nature Conservation Board Private Bag X5014 Stellenbosch,	Tel : (021) 889 1560 Fax : (021) 889 1523 Cell : 083 309 3845 e-mail : shawka@cncjnk.wcape.gov.za

Mr Jon Smallie SACWG Eastern Cape P O Box 441 Ugie, 5470	Tel : (045) 933 1991 Cell : 082 444 8919 e-mail : jon.s@xsinet.co.za
Mr John M Spence Tygerbeg Zoo Park P O Box 524 Kraaifontein	Tel : (021) 884 4494 Fax : (021) 884 4238 Cell : 083 630 1718 e-mail : tzp@kingsley.co.za
Ms Ronel Steenkamp Highlands Crane Group P O Box 172 Dullstroom, 1110	Tel : (013) 254 0191 Fax : (013) 254 0191 Cell : 082 351 7072 e-mail : hcg@mweb.co.za
Ms Lara Thick Chester Zoo Northern Zoological Society - Chester Zoo Caugall Rd Chester, ENGLAND	Tel : (0944) 1244 3802 e-mail : l.thick@chesterzoo.co.uk
Mr FJ Uys Farmer Patryskraal Bredasdorp, 7280	Fax : (028) 424 2152 Cell : 082 872 4916 e-mail : face@dorea.co.za
Mr Sampie van der Merwe North West Parks & Tourism Board P O Box 743 Delareyville, 2770	Tel : (053) 948 1854 Fax : (053) 648 0101 Cell : 082 443 9777 e-mail : barbersp@lantic.net
Mr Chris van Rooyen EWT Private Bag X11 Parkview, 2122	Tel : (011) 486 1102 Fax : (011) 486 1506 Cell : 082 454 9570 e-mail : chrisv@ewt.org.za
Mr Shawn Wilkinson Montecasino Bird Gardens Cnr Montecasino Blvd & William Nicol Drive Fourways	Tel : (011) 511 0474 Cell : 082 344 5330 e-mail : lorie@icon.co.za
Mrs Donella Young ADU UCT Avian Demography Unit University of Cape Town Rondebosch	Tel : (021) 650 4239 Fax : (021) 650 3434 e-mail donella@maths.uct.ac.za
Ms Sindi Zwane North West Dept of Agriculture, Conservation & Environment Private Bag 118 Mmabatho, 2735	Tel : (018) 381 0220/4 Fax : (018) 381 0220/4 Cell : 082 662 7787

BLUE CRANE

(Anthropoides Paradiseus)

Population and Habitat Viability Assessment Workshop

1 – 4 October 2001

Villiersdorp, South Africa

FINAL REPORT

SECTION 6

BLUE CRANE PHVA PARTICIPANTS GOALS AND HOPES

Participant Goals and Hopes

Workshop participants were asked to write down the answers to the following two questions:

1. What do you want to accomplish at this workshop?
2. What do you think you can contribute to this workshop?

The answers are as follows:

ACCOMPLISHED	CONTRIBUTE
I hope a thorough and thoughtful assessment of the status and trends in the Crane population will be established. Also would like to workshop the important factors on which to focus for the conservation and management of this species.	I would like to contribute the results from the CAR and KLTBS project which monitors Cranes (counts done by labourers, birdclub members, other interested people). These include information on distribution, trends and habitat use within 6 provinces. Data in Overberg goes back to 1993 and is now collected over 18 400 km.
The compilation of a clear action plan for the conservation of the BC in southern Africa.	My knowledge and experience of this species in the Free State.
To go back to my place and be able to use these methods alone and come up with the accurate results.	It will depend on the situation. I can't decide now but when the time goes on I will contribute.
Where the BC is now status and where it will go in the future (what research, if any, still needs to be determined). What I can do, if anything to help it.	Anything I can. And use facilitation skills learned at CBSG.
An assessment of the status of the BC in South Africa - an understanding of the threats to its continued existence and their relative importance - and finally - plans / projects to ensure its future existence.	I am not a botanist / zoologist or similar professional but a concerned citizen with a strong interest in conservation of our environment and local involvement with projects. I can contribute from a perspective of a retired person with experience in industry - with skills in facilitating and policy development - problem solving and so on.
To address the threat of the change in the crop use in our main area for Blue Cranes, The preserve our national bird in the rest of the country and to broaden its range.	The knowledge of what I have earned about Blue Cranes whilst working in the field and captivity.
To find a way to make sure that our Blue Crane population will still be there for generations to that follow to see.	Give input in the threats, especially agriculture together with poisoning, which kills a lot of these birds with little effort.
That a firm plan for the management and conservation of the Blue Crane will emerge. One that is practical and capable of being carried out for the stipulated period.	Whatever I can, using the skills and experience which I have, I am a retired industrial chemist with many years experience in organic and analytical chemistry. At present I help the HCG and the IBA with their projects and of course, have a great interest in birds.
A viable Crane model. Habitat assessment for the Overberg.	Knowledge ad experience from the Overberg.
A Population and Habitat Viability Assessment for the Blue Crane in order to prioritise conservation actions - with such large numbers in the Overberg we need to focus actions in terms of changing conditions.	Knowledge of the Blue Crane in the Overberg. Knowledge of human influences on the BC in the Overberg. 10 Years of experience in conservation in this field - as a founder of the Overberg Crane Group.
Better conservation for the Blue Crane.	Whatever information I may have towards the survival of the Blue Crane.

To gain more knowledge on the canes.	Whatever I can
A sharing of all perceptions on Crane conservation and the formation of a common goal from that - using collective information from this group.	The little bit I know of Cranes in the Overberg and the way landowners contribute to creating a suitable habitat in this area. Use farmers as managers of the Cranes - it is their business, they do need help from experts.
A plan of action to prioritise our Blue Crane conservation, education and research efforts in South Africa. A conservation action which will ultimately serve the long term conservation of the Blue Crane in South Africa. All activities must have a sound scientific basis.	My knowledge of the Blue Crane in the Northern Cape's Eastern Karoo - threats, research projects, conservation and awareness initiatives.
A conservation action plan for the Blue Crane, a common understanding amongst all participants of the PHVA workshop process, improved support in South Africa for the PHVA in conservation planning and information on where the IBA (Important Birding Areas) conservation programme can contribute to Blue Crane conservation.	My perspectives, information on the IBA conservation programme in South Africa and how it contributes to Blue Crane conservation. Birdlife South Africa, support to SACWG and the process of PHVA planning conservation action for the Blue Crane.
Develop a useful conservation action plan for the Blue Crane, to gain an understanding of the process for use in management of other populations and to feed into other processes. Knowledge of how to take the process forward.	Knowledge on trade issues.
To have an action plan for the future conservation of the Blue Crane. To have research priorities to aid in BC conservation, To have all SACWG people on the same page.	My experience with BC, especially from the Dullstroom area, my studies on the BC.
Giving details of what has been done so far as far as Cranes are concerned and also other new techniques and strategies that can be done by the working group in order to conserve our Cranes.	I wish to work with the group in sharing ideas and discussing various issues concerning the conservation of Cranes.
Better understanding of the critical issues that will determine the continued existence of the Blue Crane. How important an impact are powerline collisions?	Information regarding powerline moralities.
A management plan for the conservation, monitoring and regulating of the Blue Cranes, wild or in captivity in S.A. Document of national status to protect, conserve, monitor and regulate the Cranes.	Contributions from my knowledge and experience with Blue Cranes in the North West province and in the region where I currently work. Contributions also, of my knowledge and experience as a law enforcement officer.
To share knowledge about Blue Cranes and to get more information about BC's. To draw up a management plan to manage and protect our BC's better.	Give my little knowledge about BC's and our conditions in the North West province to the group as part of the process.
Better co-operation between NGO's, Govt. Departments and the public, workable strategies and policies on conservation and management of the Blue Crane populations.	My knowledge and experience on management and protection of animals held in captivity.
Determine priorities with regard to BC conservation. Determine what is known about the species.	My knowledge of the species.
Development of a detailed conservation management plan with explicit management	A fair amount of field experience in understanding the Blue Crane. The development of the final PHVA

actions, for the conservation of Blue Cranes in SA.	document and assistance with the difficult working group discussions which will guide all future actions in this species.
To gain a better understanding of the current conservation status of the Blue Crane with specific reference to the Western Cape. To also gain a better insight into the long term effects of the possible change in current landuse (e.g. wheat farming) on the future status of the Blue Crane.	I am able to offer a local "hands on" input specifically to Cranes in the Overberg. Also able to give management input from a conservation organisation's perspective.
BC conservation priority areas and focus and methods. Is existing and previous work benefiting the population? Improvements.	Knowledge gained regarding BC in the field (current)
That we may be able to find some way of ensuring a future for our national bird.	Support and any input that could be relevant to conserving the Blue Crane.
An implementable conservation plan for the Blue Crane. It should be region specific yet nationally effective.	Experience that I have obtained from field work. Ideas that the layman can identify with.
I hope we will learn more about the habitat and population of the Blue Crane. I hope that we can do more to let the Blue Crane population grow.	As a first-timer, I don't really know what to contribute but I will share the knowledge and experience that I have.

BLUE CRANE

(Anthropoides Paradiseus)

Population and Habitat Viability Assessment Workshop

1 – 4 October 2001

Villiersdorp, South Africa

FINAL REPORT

SECTION 7

APPENDICES

POPULATION AND HABITAT VIABILITY ANALYSIS (PHVA) OF THE SOUTH AFRICAN BLUE CRANE POPULATION (*Anthropoides paradiseus*)

PHVA WORKSHOP INVITATION

INVITATION TO :

THE BLUE CRANE POPULATION AND HABITAT VIABILITY ANALYSIS WORKSHOP (PHVA)

FROM THE SOUTH AFRICAN CRANE WORKING GROUP, A WORKING GROUP OF THE ENDANGERED WILDLIFE TRUST

THE WORKSHOP WILL BE RUN BY DR ONNIE BYERS OF THE CONSERVATION BREEDING SPECIALIST GROUP – USA

Arrival in the Overberg

30 September (Sunday): The Overberg Crane Group, as part of their 10th year anniversary, will host the dinner.

Blue Crane PHVA

Monday 1 October:	8 am – 5 pm and evenings
Tuesday 2 October:	8 am – 5 pm and evenings
Wednesday 3 October:	8 am – 5 pm and evenings
Thursday 4 October:	8 am – 1 pm

Field trip

Thursday 4 October: 2 pm – 5 pm

SACWG Administration Meeting

Friday 5 October: 8 am – 12 am

Wattled Crane Recovery Programme Meeting

Friday 5 October: 2 pm – 5 pm

Leave the Overberg

Saturday 6 October

South African Crane Working Group
REGISTRATION FORM FOR 1 – 5 Oct 2001 FOR THE:

- **BLUE CRANE PHVA**
- **SACWG ADMINISTRATION MEETING**
- **WATTLED CRANE RECOVERY PROGRAMME MEETING**

Name: ______________________________________ Tel: __________________
____

Fax: _____________________________ E-mail: __________________________
_____

Postal Address: ____
____ Code :
____

Name(s) of all participants attending: _________________________________
____
____
_____

Special meal requirements: ____
____
____

Day	Accommodation @ R45	Breakfast @ R23	Lunch @ R25	Dinner @ R25	Tea @ R3	TOTAL
Sunday 30 Sept.		NOT APPLICABLE	NOT APPLICABLE	OCG will host dinner	NOT APPLICABLE	
Monday 1 Oct.						
Tuesday 2 Oct.						
Wednesday 3 Oct.						
Thursday 4 Oct.						
Friday 5 Oct.						
Saturday 6 Oct.	NOT APPLICABLE		NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	
A copy of the PHVA document and hall fees						R140

TOTAL						R

- ☐ Cheque/Postal order enclosed (Cheques must be made out to the Endangered Wildlife Trust)
- ☐ Please debit my Master/Visa/Diners card: __ __ __ __ __ __ __ __ _ __ __ __ __ __

  Expiry date: __ __ __ __ Signature: ______________________________
- ☐ I have paid by a direct transfer. The deposit slip is attached.

Account Name:	Endangered Wildlife Trust	Bank:	First National Bank
Account Number:	5037 156 4219	Branch:	Rosebank (Code: 253305)

Blue Crane PHVA programme: workshop timetable

Task one:	Current situation and issues	) day one
Task two:	Root causes and problem statements	)
Task three:	Goals	) day two
Task four:	Action steps	) day three
	Wrap-up	) day four

Monday 1st October 2001:

8:30 – 9:00:	Open workshop – Kevin McCann Introduction of participants
9:00 – 10:00:	Introduction to CBSG and CBSG South Africa Workshop design, ground rules etc. Working group member roles
10:00 – 10:30:	Tea Break
10:30 – 11:00:	Donella Young: Coordinated Avi-fauna Road Counts Project: UCT / ADU
11:00 – 13:00:	Group session: Mind Mapping of issues, identification of key issues, formation of working groups
13:00 – 14:00:	Lunch
14:00 – 14:20:	Overview of problem statements
14:20 – 15:30:	Working groups: Issues and problem statement development
15:30 – 16:00:	Tea Break
16:00 – 18:00:	Working groups: Issues and problem statement development Prioritised problem statements

Tuesday 2nd October 2001:

8:30 – 9:00:	Workshop survey
9:00 – 10:30:	Plenary session on problem statements and issues
10:30 – 11:10:	Tea Break and group photos
11:10 – 11:45:	Presentations by two local farmers
11:45 – 12:30:	Group discussion on goals / solutions and filters
12:30 – 13:30:	Lunch break
13:30 – 15:15:	Working groups: Development of goals using filters
15:15 – 15:30:	Tea Break
15:30 – 16:00:	Working groups: Development of goals using filters
16:00 – 16:30:	Group discussion on prioritising goals using paired ranking
16:30 – 18:00:	Working groups meet to prioritise goals using paired ranking
18:00:	Dinner break
19:30:	Open Mike Night ▪ Steven Evans: IBA and Blue Swallow project ▪ David Gaynor: Dullstroom and HCG ▪ Claire Patterson: New education system ▪ Wicus Leeuwner: OCG cranes ▪ Chris van Rooyen: Eskom / EWT partnership

Wednesday 3rd October 2001:

8:00 – 10:00:	Plenary on goals / solutions: presentation of WG lists
10:00 – 10:30:	Group pair ranking of combine list of solutions (20)
10:30 – 11:00:	Tea Break
11:00 – 12:30:	Vortex presentation and group session: Kevin McCann
12:45 – 13:30:	Lunch break
13:30 – 14:00:	Discussion of Action Steps
14:00 – 18:00:	WG Action step development
15:00 – 15:30:	Optional Tea Break
18:30 – 19:30:	Dinner break
19:45: - 20:30:	Wicus Leeuwner presentation on cranes, Richtersveld, De hoop and Namaqualand flowers

Thursday 4th October 2001:

8:30 – 10:45:	Plenary on Action steps
10:45 – 11:00:	Tea Break
11:00 – 11:45:	Plenary on Action steps
11:40: - 12:10:	Vortex presentation on modelled scenarios
12:10 – 12:30:	WG wrap up final recommendations and amendments to reports
12:30 – 12: 45:	Workshop survey and closure
12:45 – 13:15:	Lunch
13:15 – 18:30:	Field trip to see blue cranes and whales

The South African Crane Working Group (SACWG)

The South Crane Working Group (SACWG) of the Endangered Wildlife Trust was established in 1995 and has since grown to become one of the Trusts most successful working groups. Since its inception, SACWG has developed unique community-based conservation programmes that are attracting international accolades and attention for the creative solutions they are developing. The group's most recent accolade is the Natural Resources Award received at The Green Trust Awards 2001 in association with the Mail & Guardian and Nedbank.

The SACWG is a national body whose mission is to ensure the long-term survival of South Africa's three crane species and their habitats through active participation of all communities, and to co-operate with other institutions and like-minded people, for the benefit of all people and cranes. The SACWG aims to co-ordinate and initiate crane and habitat conservation efforts in South Africa. A National Crane Habitat and Action Plan has been established and acts as a guideline for crane conservation. The main objectives set by SACWG are networking, education and awareness, habitat conservation, crane population management, research and monitoring, community involvement and fundraising.

To address its primary goal of education and awareness, each of the crane regions around South Africa have set up programmes to create awareness with landowners, school children and farm workers. In particular, farm workers are a very important part of the community for crane conservation. They are the people who are on the farm each day, and often witness things that the farmer does not. It is also the farm workers who have become increasingly responsible for the poisoning of wildlife for food and the capture of cranes from the wild for the illegal trade market. It is for this reason that SACWG has placed such an emphasis on this target group. Over the past year, SACWG has realised that the main issue underlying some of the problems that our wildlife is experiencing has not been addressed in the workshops, i.e. poverty. It is for this reason that we are now looking at partnering with poverty alleviation organisations. In this way, the group hopes to identify the basic needs of the communities that it is working with and, through these partnerships, begin to address these needs. In addition to this, SACWG has started identifying individuals who have shown a keen interest in cranes and the environment within each of the communities within which we work. The group has found that, in general, the farm workers respond better to someone of their own culture, and hence the need to identify suitable individuals and the necessity to build their capacity. As suitable local individuals are found, SACWG is employing them as Assistant Field Officers to help with farm worker and school education programmes. The capacity of these young black people is being built and their future careers in conservation being encouraged.

SACWG is made up of a network of regional and national crane conservation projects and working groups, and a number of scientists and experts in the field closely aligned with crane conservation have been co-opted into the group. The combined efforts of the participants has resulted in SACWG achieving a reputation as one of the most dynamic, motivated and successful conservation NGOs working at a local and national level.

Since becoming a working group of the EWT, SACWG has established crane conservation initiatives in all key crane regions in the country. These include the Western Cape, Eastern Cape, Northern Cape, KwaZulu Natal, Free State, North West Province, and Mpumalanga.

Conservation Breeding Specialist Group

Species Survival Commission
IUCN -- The World Conservation Union

U.S. Seal, CBSG Chairman

Introducing: The Conservation Breeding Specialist Group

Web site at http://www.cbsg.org

Introduction

There is a lack of generally accepted tools to evaluate and integrate the interaction of biological, physical, and social factors on the population dynamics of the broad range of threatened species. There is a need for tools and processes to characterize the risk of species and habitat extinction, on the possible effects of future events, on the effects of management interventions, and on how to develop and sustain learning-based cross-institutional management programs.

The Conservation Breeding Specialist Group (CBSG) of IUCN's Species Survival Commission (SSC) has 10 years of experience in developing, testing and applying a series of scientifically based tools and processes to assist risk characterization and species management decision making. These tools, based on small population and conservation biology (biological and physical factors), human demography, and the dynamics of social learning are used in intensive, problem-solving workshops to produce realistic and achievable recommendations for both *in situ* and *ex situ* population management.

The mission of the Conservation Breeding Specialist Group is *"to conserve and establish populations of threatened species through conservation breeding programs and through intensive protection and management of these plant and animal populations in the wild."*

What does the Conservation Breeding Specialist Group do?

Wildlife and governmental officials invite the Conservation Breeding Specialist Group (CBSG) to help with their conservation efforts. CBSG uses numerous processes and tools it has developed to carry out its globally recognized program. (For the purposes of this document only details of the PHVA are given)

Population and Habitat Viability Assessments (PHVAs)

Trying to save the all the world's biodiversity at one time is impossible. A more realistic approach, however, is to save a single threatened species and its corresponding habitat. Population and Habitat Viability Assessment Workshops attempt to bring together biologists and other professionals with relevant expertise in a collaborative effort to assess the extinction risk and develop better management strategies for particular endangered species. Computer modeling tools, using all available data for the species in question, are utilized for this process. These workshops are held in the countries which the plants and animals inhabit. Moreover, decisions are made by the corresponding country's wildlife officials allowing practical and expedient implementation of the resulting management plan.

Integration of Science, Management, and Stakeholders

The CBSG Population and Habitat Viability Assessment (PHVA) Workshop process is based upon biological and sociological science. Effective conservation action is best built upon a synthesis of available biological information, but is dependent on actions of humans living within the range of the threatened species as well as established national and international interests. There are characteristic patterns of human behaviour that are cross-disciplinary and cross-cultural which affect the processes of communication, problem-solving, and collaboration: 1) in the acquisition, sharing, and analysis of information; 2) in the perception and characterization of risk; 3) in the development of trust among individuals; and, 4) in 'territoriality' (personal, institutional, local, national). Each of these has strong emotional components that shape our interactions. Recognition of these patterns has been essential in the development of processes to assist people in working groups to reach agreement on needed conservation actions, collaboration needed, and to establish new working relationships.

Frequently, local management agencies, external consultants, and local experts have identified management actions. However, an isolated narrow professional approach which focuses primarily on the perceived biological problems seems to have little effect on the needed political and social changes (social learning) for collaboration, effective management and conservation of habitat fragments or protected areas and their species components. CBSG workshops are organized to bring together the full range of groups with a strong interest in conserving and managing the species in its habitat 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 to needed management actions. We have found the decision-making driven workshop process with risk characterization tools, stochastic simulation modelling, scenario testing, and deliberation among stakeholders are powerful tools 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 more 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'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. Modelling is an important tool as part of the process and provides a continuing test of assumptions, data consistency, and of scenarios. CBSG participants recognize 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 Workshop process essentially provides a means for designing management decisions and programs on the basis of sound science while allowing new information and unexpected events to be used for learning and to adjust management practices.

CBSG Workshop and Training Processes

Information on Capabilities of Conservation Breeding Specialist Group (CBSG/SSC/IUCN)

Introduction

There is a lack of generally accepted tools to evaluate and integrate the interaction of biological, physical, and social factors on the population dynamics of the broad range of threatened species. There is a need for tools and processes to characterize the risk of species and habitat extinction, on the possible effects of future events, on the effects of management interventions, and on how to develop and sustain learning-based cross-institutional management programs.

The Conservation Breeding Specialist Group (CBSG) of IUCN's Species Survival Commission (SSC) has 10 years of experience in developing, testing and applying a series of scientifically based tools and processes to assist risk characterization and species management decision making. These tools, based on small population and conservation biology (biological and physical factors), human demography, and the dynamics of social learning are used in intensive, problem-solving workshops to produce realistic and achievable recommendations for both *in situ* and *ex situ* population management.

Our Workshop processes provide an objective environment, expert knowledge, and a neutral facilitation process that supports sharing of 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 remarkably successful in unearthing and integrating previously unpublished information for the decision making process. Their proven heuristic value and constant refinement and expansion have made the CBSG CAMP and PHVA processes two of the most imaginative and productive organizing forces for species conservation today (Conway, 1995).

Integration of Science, Management, and Stakeholders

The CBSG Population and Habitat Viability Assessment (PHVA) Workshop process is based upon biological and sociological science. Effective conservation action is best built upon a synthesis of available biological information, but is dependent on actions of humans living within the range of the threatened species as well as established national and international interests. There are characteristic patterns of human behavior that are cross-disciplinary and cross-cultural which affect the processes of communication, problem-solving, and collaboration: 1) in the acquisition, sharing, and analysis of information; 2) in the perception and characterization of risk; 3) in the development of trust among individuals; and, 4) in 'territoriality' (personal, institutional, local, national). Each of these has strong emotional components that shape our interactions. Recognition of these patterns has been essential in the development of processes to assist people in working groups to reach agreement on needed conservation actions, collaboration needed, and to establish new working relationships.

Frequently, local management agencies, external consultants, and local experts have identified management actions. However, an isolated narrow professional approach which focuses primarily on the perceived biological problems seems to have little effect on the needed political and social changes (social learning) for collaboration, effective management and conservation of habitat fragments or protected areas and their species components. CBSG workshops are organized to bring together the full range of groups with a strong interest in conserving and managing the species in its habitat 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 to needed management actions. We have found the decision-making driven workshop process with risk characterization tools, stochastic simulation modelling, scenario testing, and deliberation among stakeholders are powerful tools 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 more 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 participants have learned a host of lessons in more than 100 workshop experiences in 40 countries. Traditional approaches to endangered species problems have tended to emphasize our lack of information and the need for additional research. This has been coupled with a hesitancy to make explicit risk assessments of species status and a reluctance to make immediate or non-traditional management recommendations. The result has been long delays in preparing action plans, loss of momentum, dependency on crisis-driven actions or broad recommendations that do not provide useful guidance to the managers.

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. Modelling is an important tool as part of the process and provides a continuing test of assumptions, data consistency, and of scenarios. CBSG participants recognize 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 Workshop process essentially provides a means for designing management decisions and programs on the basis of sound science while allowing new information and unexpected events to be used for learning and to adjust management practices.

Workshop Processes and Multiple Stakeholders

Experience: The Chairman and three Program Officers of CBSG have conducted and facilitated more than 100 species and ecosystem Workshops in 40 countries including the USA during the past 6 years. *Reports from these workshops are available from the CBSG Office*. We have worked on a continuing basis with agencies on some taxa (e.g., Florida panther, Sumatran tiger) and have assisted in the development of national conservation strategies for other taxa (e.g., Sumatran elephant, Sumatran tiger, Indonesia). Our *Population Biology Program Officer (Dr. P. Miller)* received his doctoral training with Dr. P. Hedrick and has experience with the genetic and demographic aspects of a range of vertebrate species. He has worked extensively with VORTEX and other population models.

Facilitator's Training and Manual: A manual has been prepared to assist CBSG workshop conveners, collaborators, and facilitators in the process of organizing, conducting, and completing a CBSG workshop. It was developed with the assistance of two management science professionals and 30 people from 11 countries with experience in CBSG workshops. These facilitator's training workshops have proven very popular with 2 per year planned for 1996 and 1997 in several countries including the USA. *Copies of the Facilitator's Manual are available from the CBSG Office.*

Scientific Studies of Workshop Process: The effectiveness of these workshops as tools for eliciting information, assisting the development of sustained networking among stakeholders, impact on attitudes of participants, and in achieving consensus on needed management actions and research has been extensively debated. We initiated a scientific study of the process and its long term aftermath three years ago in collaboration with an independent team of researchers (Vredenburg and Westley, 1995). A survey questionnaire is administered at the beginning and end of each workshop. They have also conducted extensive interviews with participants in workshops held in five countries. *Three manuscripts on CBSG Workshop processes and their effects are available from the team and the CBSG office.* The study also is undertaking follow up at one and two years after each workshop to assess longer-term effects. To the best of our knowledge there is no comparable systematic scientific study of conservation and management processes. *We will apply the same scientific study tools to the workshops in this program and provide an analysis of the results after each workshop.*

CBSG Workshop Toolkit

Our basic set of tools for workshops include small group dynamic skills, explicit use in small groups of problem restatement, divergent thinking sessions, identification of the history and chronology of the problem, causal flow diagramming (elementary systems analysis), matrix methods for qualitative data and expert judgements, paired and weighted ranking for making comparisons between sites, criteria, and options, utility analysis, stochastic simulation modelling for single populations and metapopulation and deterministic and stochastic modelling of local human populations. Several computer packages are used to assist collection and analysis of information with these tools. We provide training in several of these tools in each workshop as well as intensive special training workshops for people wishing to organize their own workshops.

Stochastic Simulation Modelling

Integration of Biological, Physical and Social Factors: The Workshop process, as developed by CBSG, generates population and habitat viability assessments based upon in-depth analysis of information on the life history, population dynamics, ecology, and history of the populations. Information on demography, genetics, and environmental factors pertinent to assessing population status and risk of extinction under current management scenarios and perceived threats are assembled in preparation for and during the workshops. Modelling and simulations provide a neutral externalisation focus for assembly of information, identifying assumptions, projecting possible outcomes (risks), and examining for internal consistency. Timely reports from the workshop are necessary to have impact on stakeholders and decision makers. Draft reports are distributed within 3 weeks of the workshop and final reports within 60 days.

Human Dimension: We have collaborated with human demographers in 4 CBSG workshops on endangered species and habitats. They have utilized computer models incorporating human population characteristics and events at the local level in order to provide projections of the likely course of population growth and the utilization of local resources. This information was then incorporated into projections of the likely viability of the habitat of the threatened species and used as part of the population projections and risk assessments. We have prepared a draft manual on the human dimension of population and habitat viability assessment. It is our intention to further develop these tools and to utilize them as part of the scenario assessment process.

Risk Assessment and Scenario Evaluation: A stochastic population simulation model is a kind of model that attempts to incorporate the uncertainty, randomness or unpredictability of life history and environmental events into the modelling process. Events whose occurrence is uncertain, unpredictable, and random are called stochastic. Most events in an animal's life have some level of uncertainty. Similarly, environmental factors, and their effect on the population process, are stochastic - they are not completely random, but their effects are predictable within certain limits. Simulation solutions are usually needed for complex models including several stochastic parameters.

There are a host of reasons why simulation modelling is valuable for the workshop process and development of management tools. The primary advantage, of course, is to simulate scenarios and the impact of numerous variables on the population dynamics and potential for population extinction. Interestingly, not all advantages are related to generating useful management recommendations. The side-benefits are substantial.

- Population modelling supports consensus and instils ownership and pride during the workshop process. As groups begin to appreciate the complexity of the problems, they have a tendency to take more ownership of the process and the ultimate recommendations to achieve workable solutions.
- Population modelling forces discussion on biological and physical aspects and specification of assumptions, data, and goals. The lack of sufficient data of useable quality rapidly becomes apparent and identifies critical factors for further study (driving research and decision making), management, and monitoring. This not only influences assumptions, but also the group's goals.
- Population modelling generates credibility by using technology that non-biologically oriented groups can use to relate to population biology and the "real" problems. The acceptance of the computer as a tool for performing repetitive tasks has led to a common ground for persons of diverse backgrounds.
- Population modelling explicitly incorporates what we know about dynamics by allowing the simultaneous examination of multiple factors and interactions - more than can be considered in analytical models. The ability to alter these parameters in a systematic fashion allows testing a multitude of scenarios that can guide adaptive management strategies.
- Population modelling can be a neutral computer "game" that focuses attention while providing persons of diverse agendas the opportunity to reach consensus on difficult issues.
- Population modelling results can be of political value for people in governmental agencies by providing support for perceived population trends and the need for action. It helps managers to justify resource allocation for a program to their superiors and budgetary agencies as well as identify areas for intensifying program efforts.

Modelling Tools: At the present time, our preferred model for use in the population simulation modelling process is called *VORTEX®*. This model, developed by Lacy et al., is designed specifically for use in the stochastic simulation of the small population/extinction process. It has been developed in collaboration and cooperation with the CBSG PHVA process. The model simulates deterministic forces as well as demographic, environmental, and genetic events in relation to their probabilities. It includes modules for catastrophes, density dependence, metapopulation dynamics, and inbreeding effects. The *VORTEX* model analyses a population in a stochastic and probabilistic fashion. It also makes predictions that are testable in a scientific manner, lending more credibility to the process of using population-modelling tools.

There are other commercial models, but presently they have some limitations such as failing to measure genetic effects, being difficult to use, or failing to model individuals. *VORTEX* has been successfully used in more than 90 PHVA workshops in guiding management decisions. *VORTEX* is general enough for use when dealing with a broad range of species, but specific enough to incorporate most of the important processes. It is continually evolving in conjunction with the PHVA process. *VORTEX* has, as do all models, its limitations, which may restrict its utility. The *VORTEX* model analyses a population in a stochastic and probabilistic fashion. It is now at Version 7.3 through the cooperative contributions of dozens of biologists. It has been the subject of a series of both published and in-press validation studies and comparisons with other modelling tools. More than 2000 copies of *VORTEX* are in circulation and it is being used as a teaching tool in university courses.

We use this model and the experience we have with it as a central tool for the population dynamic aspects of this project. Additional modules, building on other simulation modelling tools for human population dynamics (which we have used in 3 countries) with potential impacts on water usage, harvesting effects, and physical factors such as hydrology and water diversion will be developed to provide input into the population and habitat models which can then be used to evaluate possible effects of different management scenarios. No such composite models are available.

CBSG Resources as Unique Asset

Expertise and Costs: The problems and threats to endangered species everywhere are complex and interactive with a need for information from diverse specialists. No agency or country encompasses all of the useful expert knowledge. Thus, there is a need to include a wide range of people as resources and analysts. It is important that the invited experts have reputations for expertise, objectivity, initial lack of local stake, and for active transfer of wanted skills. CBSG has a volunteer network of more than 700 experts with about 250 in the USA. More than 3,000 people from 400 organizations have assisted CBSG on projects and participated in workshops on a volunteer basis contributing tens of thousands of hours of time. We will call upon individual experts to assist in all phases of this project.

Indirect cost contributions to support: Use of CBSG resources and the contribution of participating experts provide a matching contribution more than equalling the proposed budget request for projects.

Manuals and Reports: We have manuals available that provide guidance on the goals, objectives, and preparations needed for CBSG workshops. These help to reduce start-up time and costs and allow us to begin work on organizing the project immediately with proposed participants and stockholders. We have a process manual for use by local organizers, which goes into detail on all aspects of organizing, conducting, and preparing reports from the workshops. Draft reports are prepared during the workshop so that there is agreement by participants on its content and recommendations. Reports are also prepared on the mini-workshops (working groups) that will be conducted in information gathering exercises with small groups of experts and stakeholders. We can print reports within 24-48 hours of preparation of final copy. We also have CD-ROM preparation facilities, software and experience.

CONSERVATION BREEDING SPECIALIST GROUP

SOUTH AFRICA

The Endangered Wildlife Trust (EWT) is one of the largest non-governmental conservation organisations in Southern Africa and was established in 1973. The EWT conserves biodiversity through the hands-on conservation of species and their habitats, in a sustainable and responsible manner. Coordinating more than 100 field-based conservation projects and 11 working groups operating in Southern Africa, EWT programmes cover a wide variety of species and eco-systems and play a pivotal role in the conservation of Southern African wildlife.

Eight CBSG regional networks exist worldwide, including CBSG Indonesia, India, Japan, Mesoamerica, Mexico, Sri Lanka and South Asia. Regional CBSG networks are developed in regions requiring the most conservation action and each network operates in a manner best suited to the region and local species. Tools are adapted according to the needs and requirements of the stakeholders and species utilising local expertise and developing a unique regional conservation identity. The Endangered Wildlife Trust with its access to a rich and diverse range of conservation expertise, initiated CBSG South Africa in partnership with the CBSG the year 2000.

CBSG South 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 South Africa through the provision of training courses, PHVA and CAMP workshops, communication networks and Masterplanning processes for species and or ecosystems. CBSG South Africa can be contacted on + 27 (01) 22 701 3811 or **cbsgsa@wol.co.za**

Small Population Biology and Population and Habitat Viability Assessment

Robert Lacy, Tom Foose, John Ballou and Jan Eldridge

January 1992

Many wildlife populations that were once large and continuous have been reduced to small, fragmented isolates in remaining natural areas. The final extinction of these populations usually is a matter of chance, resulting from one or a few years of bad luck – even if the causes of the original decline were quite preventable, such as over-hunting and habitat destruction. Few endangered species have recovered adequately and some have gone extinct in spite of protection. This reveals the acute risks faced by small populations and the need for a more intensive, systematic approach to recovery. The purpose of the Population and Habitat Viability Analyses (PHVA's) is to help managers understand the risks facing small populations, to identify the relative importance of the factors that put a small population at risk, and to evaluate the effectiveness of various management strategies.

When populations get very small, evolutionary and ecological processes change. All of the things we know about general population management no longer apply. The classic approach to understanding a large population is a life table analysis. The problem with using life tables for small populations is that even if the population is growing (in good shape according to the life table analysis), it will fluctuate wildly, so it could still go extinct at any time. The stochasticity in small populations is categorized according to four causes: demographic fluctuation, environmental variation, catastrophic events, and genetic drift.

1. Demographic Fluctuation – luck of the draw. Flux in all populations occurs even if the environment is constant, and all animals have the same chance. This means that the probability of being male and female, alive or dead, is a coin toss. In a large population this kind of variation all evens out in the end and doesn't really matter, but in small populations it could be important. It is possible, by bad luck, to have every animal happen to die in one year. A classic example of this kind of bad luck is the dusky seaside sparrow where all six of the last birds were male.

2. Environmental Variation – flux in demographic probabilities. This is the externally imposed variation in the probability of birth and death. In one year, mortality may be 10%, the next year because of drought, 90%. The same environmentally induced variance may occur in reproductive rates, mortality rates, or carrying capacity.

3. Catastrophic Events – the extreme of environmental variation. We consider it separately for a couple of reasons. If you look at the typical distribution of environmental flux, catastrophes are outliers. You wouldn't predict hurricanes by studying average weather patterns. It is usually so far out, it doesn't fit the normal day to day, year to year variation. The impact on the population may be very sever. The population could be adapted to year to year "normal" variation but not to catastrophe. Often catastrophes will wipe out the species. A species may hang on and then get hit by a catastrophe. We think of them as aberrant events but over a long time period, they are predictable, hurricanes hit one out of every 30 years, forest first hit with some probability. Catastrophes include storms, fires, disease, and The Unexpected.

4. Genetic Drift and Inbreeding. Small populations fluctuate genetically just as they do in numbers. It is a sampling problem. In a large population each generation is a good sample of the one that existed before. In a small population each generation is a poor example of the others. Genes that are in flux could hit 0 and so alleles are lost, over time there is a significant loss of genetic diversity. So, the longer the population is small, the greater the loss. Inbreeding also increases as populations become smaller. Loss of genetic diversity has been associated with an increase in vulnerability and susceptibility to environmental problems, reproductive difficulties, and disease – it affects each species differently. Genetic drift can decrease and worsen the demographic situation. In general Environmental Variation – flux in demographic probabilities. This is the externally imposed variation in the probability of birth and death. In one year, mortality may be 10%, the next year because of drought, 90%. The same environmentally induced variance may occur in reproductive rates, mortality rates, or carrying capacity.

5. Catastrophic Events – the extreme of environmental variation. We consider it separately for a couple of reasons. If you look at the typical distribution of environmental flux, catastrophes are outliers. You wouldn't predict hurricanes by studying average weather patterns. It is usually so far out, it doesn't fit the normal day to day, year to year variation. The impact on the population may be very sever. The population could be adapted to year to year "normal" variation but not to catastrophe. Often catastrophes will wipe out the species. A species may hang on and then get hit by a catastrophe. We think of them as aberrant events but over a long time period, they are predictable, hurricanes hit one out of every 30 years, forest first hit with some probability. Catastrophes include storms, fires, disease, and The Unexpected.

6. Genetic Drift and Inbreeding. Small populations fluctuate genetically just as they do in numbers. It is a sampling problem. In a large population each generation is a good sample of the one that existed before. In a small population each generation is a poor example of the others. Genes that are in flux could hit 0 and so alleles are lost, over time there is a significant loss of genetic diversity. So, the longer the population is small, the greater the loss. Inbreeding also increases as populations become smaller. Loss of genetic diversity has been associated with an increase in vulnerability and susceptibility to environmental problems, reproductive difficulties, and disease – it affects each species differently. Genetic drift can decrease and worsen the demographic situation. In general, in mammals al, in mammals 1% loss of genetic diversity means 1% loss in reproductive fitness. Loss of genetic diversity will also limit the ability of populations to adapt as environments change.

   All of these characteristics feed back on each other in a nasty way – in what is called an extinction vortex. External force (hunting, habitat loss), cause the original decline but when a population becomes very small, you set into motion a series of problems that can spiral down into an extinction vortex. The fluctuation of population size makes inbreeding worse than if size were constant, the demographic fluctuations can negatively impact the population and cause further stochasticity, etc. The spiral is fast unless management is very aggressive. Part of the management problem is to keep populations out of the vortex. The size below which a population is likely to get sucked into the extinction vortex has been called the Minimum Viable Population size (or MVP).

Recently, techniques have been developed to permit the systematic examination of many of the processes that put small populations at risk. By a combination of modelling techniques, the probability of a population persisting a specified time into the future can be estimated. The population models used in PHVA's allow you to do "what-if" scenarios by looking at the data, and management schemes, to try and mitigate the probability of loss.

There are several approaches to modelling the variability of population extinction. One approach is to develop mathematical formula, based on various population parameters; two examples of this approach are Goodman (1987), and Dennis et al. (in prep). There are advantages to a mathematical formula – it looks precise because you get a number at the end. The disadvantage is that the number may not mean much. Usually the models have a very limited number of factors (exponential growth rate, variance, maximum population size). They suffer from being too simple; they do not include important factors; for example, Dennis et al., assumes no carrying capacity, exponential growth, no genetic events, and no catastrophes. All models make assumptions, it is important to think about those assumptions.

The approach used in a stochastic model such as *VORTEX* is to try to understand the extinction vortex. It doesn't depend on a complicated mathematical formula; instead, the program makes the computer think it is the population. Computers are very good at flipping coins, determining the probability is "x" of something happening. The model combines information on life history, distribution, genetics, estimates of disease and catastrophic events (natural and man induced) in a computer simulation that allow rapid evaluation of critical factors for small population recovery. *VORTEX* was developed by Robert Lacy of the Chicago Zoological Park, based on original programs written by James Grier of North Dakota State University (Grier 1980a, 1980b, Grier and Barclay 1988).

The driving questions behind the model are: How small is critical, how big is enough? These are important questions and the strategy for using the model requires that managers select some goals. For example:

Goal 1. The probability of survival desired for the population (e.g., managers may want 95% probability of survival, or they may settle for a 50% chance)

Goal 2. The percentage of the genetic diversity to be preserved (managers can predetermine what level of diversity they are willing to tolerate, for example, 90%, means that they will only tolerate a loss in heterozygosity of 10%).

Goal 3. The period of time over which demographic security and genetic diversity are to be sustained (e.g., 50 years, 200 years).

An example of a management strategy for an endangered species could start with the question; What is the minimum population size necessary to ensure 95% probability of survival for 200 years with 95% of the average genetic heterozygosity retained?

The advantage of simulation models like *VORTEX* is that they get bigger and bigger by adding things on. The model asks the user to input a lot of population parameters. The model is dependent on knowledge, you need to know sex ratios, birth and death rates, etc.: without this information, you can't do anything. You must recognize where data are weak so you can test the sensitivity of the model. This indicates where you need more data.

The primary use of the model in developing conservation strategies is in conducting "what if" analyses. For example, what if survival were decreased in the wild population as a result of a disease outbreak? How would that effect the extinction of the population and retention of genetic diversity. These "what if" analyses can also be used to evaluate management recommendations. For example, how would probability of population extinction change if the carrying capacity of the reserve holding the animals were increased by 10%.

The key to success of the PHVA approach is that it is accessible. The PHVA workshops conducted by CBSG bring management and expertise together to form a consensus on the priorities for species recovery. It is done in a way that makes information and assumptions explicit. The technique does not rely on "intuition" and it is valuable because everyone has access to the information that is used for management recommendations.

DEFINITIONS

Population and Habitat Viability Analysis. A systematic evaluation of the relative importance of factors that place populations at risk. It is an attempt to identify the most important factors for the survival of the population. In some cases, this may be easy – habitat destruction is often a critical factor for most endangered species. But at other times, the effects of single factors, and the interaction between factors, are more difficult to predict. To try and gain a more quantitative understanding of the effects of these factors, computer models have been developed that apply a combination of analytical and simulation techniques to model the populations over time and estimate the likelihood of a population going extinct.

Demographic Fluctuation – luck of the draw. Flux in all populations occurs even if the environment is constant, and all animals have the same chance. This means that the probability of being male and female, alive or dead, is a coin toss. In a large population this kind of variation all evens out in the end and doesn't really matter, but in small populations it could be important. It is possible, by bad luck, to have every animal happen to die in one year. A classic example of this kind of bad luck is the dusky seaside sparrow where all six of the last birds were male.

Environmental Variation – flux in demographic probabilities. This is the externally imposed variation in the probability of birth and death. In one year, mortality may be 10%, the next year because of drought, 90%. The same environmentally induced variance may occur in reproductive rates, mortality rates, or carrying capacity.

Catastrophic Events – the extreme of environmental variation. We consider it separately for a couple of reasons. If you look at the typical distribution of environmental flux, catastrophes are outliers. You wouldn't predict hurricanes by studying average weather patterns. It is usually so far out, it doesn't fit the normal day to day, year to year variation. The impact on the population may be very sever. The population could be adapted to year to year "normal" variation but not to catastrophe. Often catastrophes will wipe out the species. A species may hang on and then get hit by a catastrophe. We think of them as aberrant events but over a long time period, they are predictable, hurricanes hit one out of every 30 years, forest first hit with some probability. Catastrophes include storms, fires, disease, and The Unexpected.

Genetic Diversity. Expected heterozygosity (proportion of individuals in the population that carry functionally different alleles at a locus) in progeny produced by random matings.

Genetic Drift. Small populations fluctuate genetically just as they do in numbers. It is a sampling problem. In a large population each generation is a good sample of the one that existed before. In a small population each generation is a poor example of the others. Genes that are in flux could hit 0 and so alleles are lost, over time there is a significant loss of genetic diversity. So, the longer the population is small, the greater the loss. Inbreeding also increases as populations become smaller. Loss of genetic diversity has been associated with an increase in vulnerability and susceptibility to environmental problems, reproductive problems, and disease – it affects each species differently. Genetic drift can decrease and worsen the demographic situation. In general, in mammals 1% loss of genetic diversity means 1% loss in reproductive fitness. (Refer to figures 1-2).

Inbreeding and Inbreeding Depression – mating between relatives. When number of breeding animals become very low, inbreeding becomes inevitable and common. Inbred animals often have a higher rate of birth defects, slower growth, higher mortality, and lower fecundity (inbreeding depression). Inbreeding depression results from two effects: 1) the increase in homozygosity allows deleterious recessive alleles in the genome to be expressed (whereas they are not in non-inbred, more heterozygous individuals); and 2) in cases where heterozygotes are more fit than homozygotes simply because they have two alleles, the reduced heterozygosity caused by inbreeding reduces the fitness of the inbred individuals. In both cases, the loss of genetic variation doe to inbreeding has detrimental effects on population survival.

Extinction Vortex. The genetic and demographic processes that come into play when a population becomes small and isolated feed back on each other to create what has been aptly but depressingly described as an extinction vortex. The genetic problems of inbreeding depression and lack of adaptability can cause a small population to become even smaller – which in turn worsens the uncertainty of finding a mate and reproducing – leading to further decline in numbers and thus more inbreeding and loss of genetic diversity. The population spirals down toward extinction at an ever accelerated pace.

The following are important biological factors for Minimum Viable Population Size:

Effective Population Size (N_e). The effective population size is a measure of the way animals reproduce and transmit genes to the next generation. It is important when you need to calculate the rate of genetic loss from generation to generation. Populations where all males and females reproduce are "effectively" larger and lose genetic diversity at a slower rate than a population where only some reproduce even though the census size of both populations is the same. As unequal sex ratio of breeding animals, greater that random variance in lifetime reproduction, and fluctuating population sizes all cause more rapid loss of variation than would occur in a randomly breeding population, and thus depress the effective population size. There is extensive literature on how to estimate a population's effective size; however, the number of animals contributing to the breeding pool each generation can be used as a very rough estimate of the effective size. The effective size of the population is usually much less than the actual number of animals; estimates suggest that N_e is often only 10 to 30% of the total population. Seemingly large populations will lose significant levels of genetic diversity if their effective sizes are small. As a consequence, if the genetic models prescribe an N_e of 500 to achieve some set of genetic objectives, the MVP might have to be 2000.

Generation Time. Genetic diversity is lost generation by generation, not year by year. Hence, species with longer generation times will have fewer opportunities to lose genetic diversity within the given period of time selected for the program. As a consequence, to achieve the same genetic objectives, MVP's can be smaller for species with longer generation times. Generation time is qualitatively the average age-specific survivorships and fertilities of the population which will vary naturally and which can be modified by management, e.g., to extend generation time.

The Number of Founders. A founder is defined as an animal from a source population that establishes a derivative population. To be effective, a founder must reproduce and be represented by descendants in the existing population. Technically, to constitute a full founder, an animal should also be unrelated to any other representative of the source population and non-inbred. Basically, the more founders, the better, i.e., the more representative the sample of the source gene pool and the smaller the MVP required for genetic objectives. There is also a demographic founder effect; the larger the number of founders, the less likely is extinction due o demographic stochasticity. However, for larger vertebrates, there is a point of diminishing returns, at least in genetic terms. Hence, a common objective is to obtain 20-30 effective founders to establish a population. If this objective can not be achieved, then a program must do the best with what is available.

Growth Rate. The higher the growth rate, the faster a population can recover from small size, thereby outgrowing much of the demographic risk and limiting the amount of genetic diversity lost during the so-called “bottleneck”. It is important to distinguish MVP’s from bottleneck sizes.

Metapopulations and Minimum Areas

MVP’s imply minimum critical areas of natural habitat, that may be difficult or impossible to maintain single, contiguous populations of the thousands required for viability.

However, it is possible for smaller populations and sanctuaries to be viable if they are managed as a single larger population (a meta-population) whose collective size is equivalent to the MVP. Actually, distributing animals over multiple “subpopulations” will increase the effective size of the total number maintained in terms of the capacity to tolerate the stochastic problems. Any one subpopulation may become extinct or nearly so due to these causes; but through recolonisation or reinforcement from other subpopulations, the meta-population will survive. Meta-populations are evidently frequent in nature with much local extinction and recolonisation of constituent subpopulations occurring.

Simulation Modelling and Population Viability Analysis

A model is any simplified representation of a real system. We use models in all aspects of our lives, in order to: (1) extract the important trends from complex processes, (2) permit comparison among systems, (3) facilitate analysis of causes of processes acting on the system, and (4) make predictions about the future. A complete description of a natural system, if it were possible, would often decrease our understanding relative to that provided by a good model, because there is "noise" in the system that is extraneous to the processes we wish to understand. For example, the typical representation of the growth of a wildlife population by an annual percent growth rate is a simplified mathematical model of the much more complex changes in population size. Representing population growth as an annual percent change assumes constant exponential growth, ignoring the irregular fluctuations as individuals are born or immigrate, and die or emigrate. For many purposes, such a simplified model of population growth is very useful, because it captures the essential information we might need regarding the average change in population size, and it allows us to make predictions about the future size of the population. A detailed description of the exact changes in numbers of individuals, while a true description of the population, would often be of much less value because the essential pattern would be obscured, and it would be difficult or impossible to make predictions about the future population size.

In considerations of the vulnerability of a population to extinction, as is so often required for conservation planning and management, the simple model of population growth as a constant annual rate of change is inadequate for our needs. The fluctuations in population size that are omitted from the standard ecological models of population change can cause population extinction, and therefore are often the primary focus of concern. In order to understand and predict the vulnerability of a wildlife population to extinction, we need to use a model which incorporates the processes which cause fluctuations in the population, as well as those which control the long-term trends in population size (Shaffer 1981). Many processes can cause fluctuations in population size: variation in the environment (such as weather, food supplies, and predation), genetic changes in the population (such as genetic drift, inbreeding, and response to natural selection), catastrophic effects (such as disease epidemics, floods, and droughts), decimation of the population or its habitats by humans, the chance results of the probabilistic events in the lives of individuals (sex determination, location of mates, breeding success, survival), and interactions among these factors (Gilpin and Soulé 1986).

Models of population dynamics which incorporate causes of fluctuations in population size in order to predict probabilities of extinction, and to help identify the processes which contribute to a population's vulnerability, are used in "Population Viability Analysis" (PVA) (Lacy 1993/4). For the purpose of predicting vulnerability to extinction, any and all population processes that impact population dynamics can be important. Much analysis of conservation issues is conducted by largely intuitive assessments by biologists with experience with the system. Assessments by experts can be quite valuable, and are often contrasted with "models" used to evaluate population vulnerability to extinction. Such a contrast is not valid, however, as *any* synthesis of facts and understanding of processes constitutes a model, even if it is a mental model within the mind of the expert and perhaps only vaguely specified to others (or even to the expert himself or herself).

A number of properties of the problem of assessing vulnerability of a population to extinction make it difficult to rely on mental or intuitive models. Numerous processes impact population dynamics, and many of the factors interact in complex ways. For example, increased fragmentation of habitat can make it more difficult to locate mates, can lead to greater mortality as individuals disperse greater distances across unsuitable habitat, and can lead to increased inbreeding which in turn can further reduce ability to attract mates and to survive. In addition, many of the processes impacting population dynamics are intrinsically probabilistic, with a random component. Sex determination, disease, predation, mate acquisition -- indeed, almost all events in the life of an individual -- are stochastic events, occurring with certain probabilities rather than with absolute certainty at any given time. The consequences of factors influencing population dynamics are often delayed for years or even generations. With a long-lived species, a population might persist for 20 to 40 years beyond the emergence of factors that ultimately cause extinction. Humans can synthesize mentally only a few factors at a time, most people have difficulty assessing probabilities intuitively, and it is difficult to consider delayed effects. Moreover, the data needed for models of population dynamics are often very uncertain. Optimal decision-making when data are uncertain is difficult, as it involves correct assessment of probabilities that the true values fall within certain ranges, adding yet another probabilistic or chance component to the evaluation of the situation.

The difficulty of incorporating multiple, interacting, probabilistic processes into a model that can utilize uncertain data has prevented (to date) development of analytical models (mathematical equations developed from theory) which encompass more than a small subset of the processes known to affect wildlife population dynamics. It is possible that the mental models of some biologists are sufficiently complex to predict accurately population vulnerabilities to extinction under a range of conditions, but it is not possible to assess objectively the precision of such intuitive assessments, and it is difficult to transfer that knowledge to others who need also to evaluate the situation. Computer simulation models have increasingly been used to assist in PVA. Although rarely as elegant as models framed in analytical equations, computer simulation models can be well suited for the complex task of evaluating risks of extinction. Simulation models can include as many factors that influence population dynamics as the modeller and the user of the model want to assess. Interactions between processes can be modelled, if the nature of those interactions can be specified. Probabilistic events can be easily simulated by computer programs, providing output that gives both the mean expected result and the range or distribution of possible outcomes. In theory, simulation programs can be used to build models of population dynamics that include all the knowledge of the system which is available to experts. In practice, the models will be simpler, because some factors are judged unlikely to be important, and because the persons who developed the model did not have access to the full array of expert knowledge.

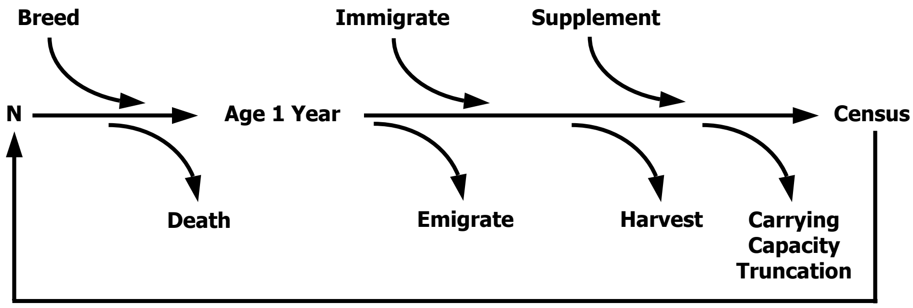
Although computer simulation models can be complex and confusing, they are precisely defined and all the assumptions and algorithms can be examined. Therefore, the models are objective, testable, and open to challenge and improvement. PVA models allow use of all available data on the biology of the taxon, facilitate testing of the effects of unknown or uncertain data, and expedite the comparison of the likely results of various possible management options.

PVA models also have weaknesses and limitations. A model of the population dynamics does not define the goals for conservation planning. Goals, in terms of population growth, probability of persistence, number of extant populations, genetic diversity, or other measures of population performance must be defined by the management authorities before the results of population modelling can be used. Because the models incorporate many factors, the number of possibilities to test can seem endless, and it can be difficult to determine which of the factors that were analysed are most important to the population dynamics. PVA models are necessarily incomplete. We can model only those factors which we understand and for which we can specify the parameters. Therefore, it is important to realize that the models probably underestimate the threats facing the population. Finally, the models are used to predict the long-term effects of the processes presently acting on the population. Many aspects of the situation could change radically within the time span that is modeled. Therefore, it is important to reassess the data and model results periodically, with changes made to the conservation programs as needed.

The *VORTEX* Population Viability Analysis Model

For the analyses presented here, the *VORTEX* computer software (Lacy 1993a) for population viability analysis was used. *VORTEX* models demographic stochasticity (the randomness of reproduction and deaths among individuals in a population), environmental variation in the annual birth and death rates, the impacts of sporadic catastrophes, and the effects of

VORTEX Simulation Model Timeline



Events listed above the timeline increase N, while events listed below the timeline decrease N.

inbreeding in small populations. *VORTEX* also allows analysis of the effects of losses or gains in habitat, harvest or supplementation of populations, and movement of individuals among local populations.

Density dependence in mortality is modelled by specifying a carrying capacity of the habitat. When the population size exceeds the carrying capacity, additional morality is imposed across all age classes to bring the population back down to the carrying capacity. The carrying capacity can be specified to change linearly over time, to model losses or gains in the amount or quality of habitat. Density dependence in reproduction is modelled by specifying the proportion of adult females breeding each year as a function of the population size.

VORTEX models loss of genetic variation in populations, by simulating the transmission of alleles from parents to offspring at a hypothetical genetic locus. Each animal at the start of the simulation is assigned two unique alleles at the locus. During the simulation, *VORTEX* monitors how many of the original alleles remain within the population, and the average heterozygosity and gene diversity (or "expected heterozygosity") relative to the starting levels. *VORTEX* also monitors the inbreeding coefficients of each animal, and can reduce the juvenile survival of inbred animals to model the effects of inbreeding depression.

VORTEX is an *individual-based* model. That is, *VORTEX* creates a representation of each animal in its memory and follows the fate of the animal through each year of its lifetime. *VORTEX* keeps track of the sex, age, and parentage of each animal. Demographic events (birth, sex determination, mating, dispersal, and death) are modelled by determining for each animal in each year of the simulation whether any of the events occur. (See figure below.) Events occur according to the specified age and sex-specific probabilities. Demographic stochasticity is therefore a consequence of the uncertainty regarding whether each demographic event occurs for any given animal.

VORTEX requires a lot of population-specific data. For example, the user must specify the amount of annual variation in each demographic rate caused by fluctuations in the environment. In addition, the frequency of each type of catastrophe (drought, flood, epidemic disease) and the effects of the catastrophes on survival and reproduction must be specified. Rates of migration (dispersal) between each pair of local populations must be specified. Because *VORTEX* requires specification of many biological parameters, it is not necessarily a good model for the examination of population dynamics that would result from some generalized life history. It is most usefully applied to the analysis of a specific population in a specific environment.

Further information on *VORTEX* is available in Miller and Lacy (1999) and Lacy (2000).

Dealing with Uncertainty

It is important to recognize that uncertainty regarding the biological parameters of a population and its consequent fate occurs at several levels and for independent reasons. Uncertainty can occur because the parameters have never been measured on the population. Uncertainty can occur because limited field data have yielded estimates with potentially large sampling error. Uncertainty can occur because independent studies have generated discordant estimates. Uncertainty can occur because environmental conditions or population status have been changing over time, and field surveys were conducted during periods which may not be representative of long-term averages. Uncertainty can occur because the environment will change in the future, so that measurements made in the past may not accurately predict future conditions.

Sensitivity testing is necessary to determine the extent to which uncertainty in input parameters results in uncertainty regarding the future fate of the pronghorn population. If alternative plausible parameter values result in divergent predictions for the population, then it is important to try to resolve the uncertainty with better data. Sensitivity of population dynamics to certain parameters also indicates that those parameters describe factors that could be critical determinants of population viability. Such factors are therefore good candidates for efficient management actions designed to ensure the persistence of the population.

The above kinds of uncertainty should be distinguished from several more sources of uncertainty about the future of the population. Even if long-term average demographic rates are known with precision, variation over time caused by fluctuating environmental conditions will cause uncertainty in the fate of the population at any given time in the future. Such environmental variation should be incorporated into the model used to assess population dynamics, and will generate a range of possible outcomes (perhaps represented as a mean and standard deviation) from the model. In addition, most biological processes are inherently stochastic, having a random component. The stochastic or probabilistic nature of survival, sex determination, transmission of genes, acquisition of mates, reproduction, and other processes preclude exact determination of the future state of a population. Such demographic stochasticity should also be incorporated into a population model, because such variability both increases our uncertainty about the future and can also change the expected or mean outcome relative to that which would result if there were no such variation. Finally, there is “uncertainty” which represents the alternative actions or interventions which might be pursued as a management strategy. The likely effectiveness of such management options can be explored by testing alternative scenarios in the model of population dynamics, in much the same way that sensitivity testing is used to explore the effects of uncertain biological parameters.

Results

Results reported for each scenario include:

Deterministic r -- The deterministic population growth rate, a projection of the mean rate of growth of the population expected from the average birth and death rates. Impacts of harvest, inbreeding, and density dependence are not considered in the calculation. When r = 0, a population with no growth is expected; r < 0 indicates population decline; r > 0 indicates long-term population growth. The value of r is approximately the rate of growth or decline per year.

The deterministic growth rate is the average population growth expected if the population is so large as to be unaffected by stochastic, random processes. The deterministic growth rate will correctly predict future population growth if: the population is presently at a stable age distribution; birth and death rates remain constant over time and space (i.e., not only do the probabilities remain constant, but the actual number of births and deaths each year match the expected values); there is no inbreeding depression; there is never a limitation of mates preventing some females from breeding; and there is no density dependence in birth or death rates, such as a Allee effects or a habitat "carrying capacity" limiting population growth. Because some or all of these assumptions are usually violated, the average population growth of real populations (and stochastically simulated ones) will usually be less than the deterministic growth rate.

Stochastic r -- The mean rate of stochastic population growth or decline demonstrated by the simulated populations, averaged across years and iterations, for all those simulated populations that are not extinct. This population growth rate is calculated each year of the simulation, prior to any truncation of the population size due to the population exceeding the carrying capacity. Usually, this stochastic r will be less than the deterministic r predicted from birth and death rates. The stochastic r from the simulations will be close to the deterministic r if the population growth is steady and robust. The stochastic r will be notably less than the deterministic r if the population is subjected to large fluctuations due to environmental variation, catastrophes, or the genetic and demographic instabilities inherent in small populations.

P(E) -- the probability of population extinction, determined by the proportion of, for example, 500 iterations within that given scenario that have gone extinct in the simulations. "Extinction" is defined in the *VORTEX* model as the lack of either sex.

N -- mean population size, averaged across those simulated populations which are not extinct.

SD(N) -- variation across simulated populations (expressed as the standard deviation) in the size of the population at each time interval. SDs greater than about half the size of mean N often indicate highly unstable population sizes, with some simulated populations very near extinction. When SD(N) is large relative to N, and especially when SD(N) increases over the years of the simulation, then the population is vulnerable to large random fluctuations and may go extinct even if the mean population growth rate is positive. SD(N) will be small and often declining relative to N when the population is either growing steadily toward the carrying capacity or declining rapidly (and deterministically) toward extinction. SD(N) will also decline considerably when the population size approaches and is limited by the carrying capacity.

H -- the gene diversity or expected heterozygosity of the extant populations, expressed as a percent of the initial gene diversity of the population. Fitness of individuals usually declines proportionately with gene diversity (Lacy 1993b), with a 10% decline in gene diversity typically causing about 15% decline in survival of captive mammals (Ralls et al. 1988).

Impacts of inbreeding on wild populations are less well known, but may be more severe than those observed in captive populations (Jiménez et al. 1994). Adaptive response to natural selection is also expected to be proportional to gene diversity. Long-term conservation programs often set a goal of retaining 90% of initial gene diversity (Soulé et al. 1986). Reduction to 75% of gene diversity would be equivalent to one generation of full-sibling or parent-offspring inbreeding.

LITERATURE CITED

Gilpin, M.E., and M.E. Soulé. 1986. Minimum viable populations: processes of species extinction. Pages 19 – 34 in: Soulé, M.E. (ed.). *Conservation Biology: The Science of Scarcity and Diversity*. Sunderland, MA: Sinauer Associates.

Jiménez, J.A., K.A. Hughes, G. Alaks, L. Graham, and R.C. Lacy. 1994. An experimental study of inbreeding depression in a natural habitat. *Science* 266:271-273.

Lacy, R.C. 2000. Structure of the *VORTEX* simulation model for population viability analysis. *Ecological Bulletins* 48:191-203.

Lacy, R.C. 1993b. Impacts of inbreeding in natural and captive populations of vertebrates: implications for conservation. *Perspectives in Biology and Medicine* 36:480-496.

Lacy, R.C. 1993/1994. What is Population (and Habitat) Viability Analysis? *Primate Conservation* 14/15:27-33.

Miller, P.S., and R.C. Lacy. 1999. *VORTEX: A Stochastic Simulation of the Extinction Process. Version 8 User's Manual*. Apple Valley, MN: Conservation Breeding Specialist Group (SSC/IUCN).

Ralls, K., J.D. Ballou, and A. Templeton. 1988. Estimates of lethal equivalents and the cost of inbreeding in mammals. *Conservation Biology* 2:185-193.

Shaffer, M.L. 1981. Minimum population sizes for species conservation. *BioScience* 1:131-134.

Soulé, M., M. Gilpin, W. Conway, and T. Foose. 1986. The millennium ark: How long a voyage, how many staterooms, how many passengers? *Zoo Biology* 5:101-113.

Population monitoring results for the Blue Crane, Anthropoides paradiseus, from Coordinated Avifaunal Roadcounts(CAR)

Donella J. Young and James A. Harrison

Avian Demography Unit, University of Cape Town, Rondebosch, 7701.

Introduction

The Coordinated Avifaunal Roadcounts(CAR) project has been monitoring large terrestrial birds, with particular focus on the Blue Crane, since 1993. This project was initiated by David Allan in the Overberg and has since spread to six provinces (Fig.1). A standardised method is used for counting along fixed routes to enable comparisons to be made between areas and seasons. This method and results from the Overberg, Swartland and Karoo are discussed in the Proceedings of the 12th South African Crane Working Group Workshop (Young & Harrison 2000). A seven-year report, which will summarise all the results, is being prepared for publication in 2002.

In this presentation, the results are arranged in an order reflecting the three populations distinguished in the literature provided for the PHVA on Blue Crane (McCann 2001). The southern population has recently become established in the fynbos biome due to the transformation of this area by agriculture. Large tracts of the fynbos biome have come to resemble grasslands owing to the effects of crop agriculture and pastures (Allan 1994). The areas occupied by the north-eastern population were previously a major stronghold for this species. The results presented here were collected during biannual roadcounts between July 1993 and January 2001.

Results

Fig. 2 shows the mean density of birds per 100 km, in summer and winter, for each precinct. The precincts are arranged from the southern precincts northward to the north-eastern precincts. Some of the higher densities were found in the south, in particular in the Overberg where a wheat/pasture system operates. The densities of the central population were much higher than those of the north-eastern population.

The practical question that needs to be asked is whether more conservation attention should be focused on the areas where densities are high, or on areas where densities are now relatively low.

Figs. 3-5 show the summer densities of Blue Crane per 100 km in the more established CAR precincts, which have also been grouped according to the three population ranges. As explained by Young & Harrison (2000), the summer densities give a more reliable indication of population trends in this species.

For some precincts it is still too early to identify trends. However, the increase in densities in the Overberg and Swartland is clear (Fig. 3). The Overberg population is more than double what it was when monitoring by CAR began, and the Swartland population has almost doubled. The eastern Karoo population seems stable; this is an important area as Blue Cranes still occupy natural habitat in this region (Fig. 4). It should be noted that the densities are relatively very low in the Free State, KwaZulu-Natal and Eastern Cape (northeastern region), and therefore even slight changes in density appear as proportionately large changes in the plots (Figs. 4 & 5).

Fig. 6 shows the percentage of Blue Cranes occupying each habitat type, within each precinct. (The precincts are arranged as in Fig. 2. It is evident that in some precincts (OV, SW, WK, WU, CR, FN and SR), cultivated agricultural habitats are used much more extensively than in the rest of the precincts where natural veld is used predominantly, especially in summer. Natural veld includes uncultivated range lands. A seasonal change in habitat use is also evident in most precincts, apart from the Karoo (NK), southern Free State (FS) and northeastern region of Eastern Cape. In these three precincts most Blue Cranes are in natural veld in summer and winter. The use of habitat by Blue Cranes in the Overberg is discussed by Young & Harrison (2000).

The mean densities per 100 km of Blue Cranes per quarter-degree grid cell in summer (Fig. 7) and winter (Fig.8) was calculated using the number of birds in each sighting within a grid cell. The position of sightings was obtained by a geographical information system (GIS) which allocated coordinates to each sighting based on the distance (i.e. km reading) along a given route, where all routes were plotted into the GIS.

The diameters of the dots in the grid maps are directly proportional to the density of birds. A medium-sized dot represents the mean overall density of Blue Cranes for that season, with higher and lower densities represented by proportionately larger and smaller dots, respectively.

The distribution shown in the background shade of grey is derived from the bird atlas map (Harrison et al. 1997). The dotted outlines indicate the grid cells containing CAR routes. Atlas data were collected in the 1980s and early 1990s.The differences in densities between the three population ranges are obvious in these distribution maps. The high densities are striking throughout the Overberg. Although the eastern Karoo population seems stable (Fig. 4), the densities are markedly variable from cell to cell.

Reason(s) for contrasting densities may include availability of roost sites, availability of favourable feeding and/or breeding habitats, or other factors such as disturbance, predation, persecution and the presence of dangerous structures such as overhead powerlines. Trend analyses help to reveal whether such factors are having an ongoing effect or not. For a species such as the Blue Crane which regularly exploits altered habitats and still occurs in relatively large numbers, the conservation challenge lies in identifying the relevant negative factors and ameliorating their impacts. In this endeavour the cooperation of landowners will be especially important.

Conclusion

CAR is beginning to show trends in numbers of Blue Cranes in precincts that have been monitoring the longest. A distinct advantage of the CAR approach to monitoring is that comparisons can be made between regions as relative abundance is measured using a standardized method in all regions. Such comparisons are less reliable when there are differences in topography between areas as this affects the proportions of populations visible during counts, but this does not affect the trend analyses - trends still emerge reliably because topography does not vary between counts. In addition, important information about use of habitat is emerging from the results, and the current distribution of the Blue Crane is being monitored.

The three different populations identified by McCann (2001) are facing different situations and pressures. Major threats within the grassland biome, where Blue Crane densities are generally low, have been poisoning, loss of habitat to afforestation, urbanisation and crop farming (Allan 1997). In contrast, the populations in the southwestern Cape appear to be benefiting from current farming practices in the Overberg and Swartland agricultural areas. In the Karoo, Blue Cranes exploit relatively unaltered rangelands. Ongoing monitoring of all three population centres will provide information key to geographical prioritization of conservation action, the planning of effective conservation measures, as well as provide a tool for monitoring and assessing the effectiveness of those measures.

The collection of data for this project is made possible by the voluntary participation of observers and Precinct Organisers. However, specific funding for the project is lacking and essential if the Avian Demography Unit is to be able to continue data capture, analysis and coordination functions.

Acknowledgements

We would like to acknowledge the important role played by many members of South African Crane Working Group(SACWG) who participate in this project. Brian Colahan, of Free State Department of Tourism and Environmental Affairs, and Mark Anderson, of Northern Cape Nature Conservation, in particular coordinate large areas. We would like to thank all CAR participants and Precinct Organisers who give of their time, skills and petrol in counting routes regularly. Those involved are members of bird clubs, farming communities, schools, Conservancies, provincial Nature Conservation authorities, Overberg Crane Group, Steven Evans (Project Manager of the Important Bird Area project) and concerned members of the public. We acknowledge, with thanks, financial support from BirdLife South Africa, the Tony and Lisette Lewis Foundation South Africa and the Mazda Wildlife Fund.

References

Allan, D.G. 1994. Haven for Blue Cranes in the southern Cape. African Wildlife 48(4): 8-14.
Allan, D.G. 1997. Blue Crane Anthropoides paradiseus. In: Harrison J.A., Allan D.G., Underhill L.G., Herremans M., Tree A.J., Parker V. & Brown C.J. (eds). The Atlas of southern African birds. Vol. 1: Non-passerines. Birdlife South Africa, Johannesburg. pp. 314-315.
Harrison, J.A., Allan D.G., Underhill L.G., Herremans M., Tree A.J., Parker V. & Brown C.J.(eds). 1997. The atlas of southern African birds. Vol.1: Non-passerines. Birdlife South Africa. Johannesburg.
McCann, K. 2001. Distribution, population status and trends - Blue Crane (Anthropoides paradiseus). In: Blue Crane PHVA Briefing Document. South African Crane Working Group. pp.60-67. McCann, K. 2001. Distribution, population status and trends - Blue Crane (Anthropoides paradiseus). In: Blue Crane PHVA Briefing Document. South African Crane Working Group. pp.60-67.
Young, D.J. & Harrison, J.A. 2001. The CAR technique for censusing cranes. Proceedings of the 12th South African Working Group Workshop, 22-23 November 2000:62-72.

Figure captions

Fig. 1: Map showing the routes covered by the CAR project (excluding the new Uniondale and Little Karoo routes). SW=Swartland, OV=Overberg, WK=Little Karoo, WB=Beaufort West, WU=Uniondale, CR=Eastern Cape-coastal region, KR=Eastern Cape-Karoo region, NE=Eastern Cape-northeastern region, NK=eastern Karoo, FS=Free State-southern region, FW=Free State-western region, FN=Free State-northern region, SR=KwaZulu-Natal(KZN)-southern region, MD=KZN-mid-western region, NR=KZN-northern region, MW=Wakkerstroom, MP=Middelburg & Steenkampsberg.

Fig. 2: Mean density of Blue Crane per 100 km in each precinct for summer and winter. Note: WK (Little Karoo) precinct consists of two routes only.

Fig. 3: The summer density of Blue Crane per 100 km in the Overberg and Swartland.

Fig. 4: The summer density of Blue Crane per 100 km in the more established central precincts.

Fig. 5: The summer density of Blue Crane per 100 km in the more established north-eastern precincts.

Fig. 6: Percentage of Blue Crane found in each habitat type within each precinct. Percentages are based on precinct totals for three summer (1999-2001) and three winter (1998-2000) counts. The Karoo percentage is based on two summer (2000-2001) and two winter (1999-2000) counts. The black bars indicate the percentage in summer, white bars indicate the percentage in winter. Definitions of habitat types appear in Appendix 3. SW=Swartland, OV=Overberg, WK=Little Karoo, WB=Beaufort West, WU=Uniondale, CR=Eastern Cape-coastal region, KR=Eastern Cape-Karoo region, NE=Eastern Cape-northeastern region, NK=eastern Karoo, FS=Free State-southern region, FW=Free State-western region, FN=Free State-northern region, NR=KZN-northern region, MD=KZN-mid-western region, SR=KwaZulu-Natal(KZN)-southern region, MW=Wakkerstroom, MP=Middelburg & Steenkampsberg.

Fig. 7: Map showing the density per 100 km of Blue Crane per quarter-degree grid cell in summer.

Fig 8: Map showing the density per 100 km of Blue Crane per quarter-degree grid cell in winter.

Appendix captions

Appendix 1: Mean density and standard deviation of Blue Crane per 100 km in summer.

Appendix 2: Mean density and standard deviation of Blue Crane per 100 km in winter.

Appendix 3: Definition of habitat types.

a) wetland: includes dams, pans, rivers, vleis etc..
b) veld/natural vegetation: includes all types of indigenous natural vegetation, e.g. natural grasslands (applicable to the grassland biome, e.g. parts of the Free State, KwaZulu-Natal), natural fynbos/renosterveld (applicable in the southwestern Cape) and natural Karooveld.
c) fallow land: land which is not being actively cultivated, but has been ploughed in the past. Weeds and some pioneer indigenous vegetation may be evident, and there may be a few remnants of stubble if the land has been fallow for only a year or two. This category is distinct from natural vegetation in that there is not the same diversity of indigenous plants, the structure of the vegetation is obviously not the same as unploughed veld, and signs of past ploughing are evident (e.g. run-off lines, ridging, piles of stones). Fallow land may also be used for grazing, but is distinct from pasture as defined below.
d) pasture: a field of broad-leaved pasture(e.g. lucerne, clover, medics, etc) or ‘unnatural’ grassland which has been planted specifically for grazing purposes. A pasture is neither a natural grassland nor the remnants of a cultivated crop. Pastures are usually monocultures of one type of plant, and often appear lush. Natural grasslands, on the other hand, have a diverse mix of plant species.
e) mown pasture: field which is usually green, with cut grass or lucerne, which may be lying on the ground or may have been baled and removed. The field is clearly grass, not a cereal crop, and has clearly been mown. This category is usually applicable in the grassland biome only.
f) stubble: a field in which the crop has been cut or harvested which is characterised by thick, cut dry stalks.
g) crops: a field of growing crops, e.g. maize, wheat, oats, barley.
h) bare ground: a recently ploughed field in which crops have not yet sprouted.

i) burnt grassland: recently burnt and still black.
j) agricultural land: category used when participant has specified that land is agricultural, but no further detail is given.
k) other: any habitat that does not fall into any of the above categories.

indeterminate: category used when bird is flying and it is not possible to establish habitat type.