CHAPTER 6: THE POST CULLING ERA (1995-1999)

PRELUDE

This chapter has been structured into two parts, each of which was compiled from a published paper which examined elephant management issues after the moratorium had been placed on the culling of elephants in 1995. The first of these two papers (Part 1) focused on the broader issues of the management of elephants and models the logistics of implementing a contraception programme (Whyte *et al.* 1998), and gives a brief overview of the local and global dilemmas of managing elephants. Part 2 examines management concerns surrounding the two contraception techniques which have received research attention in the KNP and their potential as a means of managing elephant (Whyte & Grobler, 1997).

Although a moratorium had been placed on the culling of elephants in 1995, this did not mean that SANP had altered its opinion on the necessity of limiting elephant numbers in confined national parks. The process of developing a new management policy (see next chapter) and inability to implement population limiting management, brought the dilemmas into clearer focus. These dilemmas were examined by Whyte (2001 In press).

Post moratorium, SANP maintained its right to manage the KNP population through non-lethal means. It developed its capacity to translocate elephants of all sizes and encouraged research in contraception techniques. Although Fayrer-Hosken *et al.* (2000) suggested that porcine zona pellucida (pZP) immunocontraceptive vaccine is a practical tool for controlling elephant populations, the technology is not yet considered to be logistically at a level where it can be used to control large elephant populations (Whyte & Grobler 1997; Whyte *et al.* 1998). However, SANP may continue supporting research that may lead to an ethically acceptable alternative to culling.

CHAPTER 6: PART 1:
MANAGING THE ELEPHANTS OF THE KRUGER NATIONAL PARK

INTRODUCTION

Dilemmas of elephant management

The problems of managing the elephant population in KNP (and in most of southern Africa) are different from those of most of the rest of Africa. On the continental scale, space previously available to elephants is increasingly being occupied by Africa's burgeoning human population (Parker & Graham, 1989; personal observations) and elephant populations have suffered major declines due to excessive illegal killing for their ivory (Barnes *et al.* 1998). Yet within southern African countries, the opposite has been true – here many conservation areas have too many elephants. In KNP, over the last three decades, culls removed an average of 7% of the population per year (up to 1 800 animals in a single year). Without such intervention, the numbers might have doubled in as little as ten years (see Chapter 5: Calef 1988).

Experiences in a variety of relatively dry landscapes show that high numbers of elephants can change species-rich woodlands to species-poorer grasslands (see Cumming *et al.*, 1997; Western & Gichohi 1989). Until 1994, when a moratorium was placed on culling, the policy had been to prevent such changes through the limiting of the elephant population (Joubert, 1986). Management interventions that prevent nature from taking its course (such as elephant culling) will always be controversial, as they raise social and economic issues that transcend national parks' boundaries. This further constrains management options and leads to yet more controversy (Sugg & Kreuter 1994).

Another view is that income from elephant products and hunting might benefit local people living next to KNP, some of whom make only a subsistence living (Bond 1994). Such income might engender a view of the elephant as a resource, rather than a competitor, but such local actions may have unintended global consequences (Hutton & Chitsike 1999). Across most of Africa, elephants are in a rapid decline, usually attributed to poaching and the illegal ivory trade (Lewis, 1984; Douglas-Hamilton, 1987; Barnes & Kapela, 1991; Caughley *et al.* 1990). It has been suggested by some who oppose the trade in elephant products that selling ivory where elephant populations are protected and increasing creates an unregulated market that will probably lead to poaching and possible subsequent extinction elsewhere (Kenya Wildlife Service 2000).

Ethical issues also compound elephant management problems. Many people, including those who might never visit the KNP, object to the killing of large wild mammals which may have economic consequences. Tourists who visit national parks may feel offended that the animals they have travelled so far to see are locally considered pests and shot. Tourist boycotts or unwillingness to visit such national parks as a consequence might lead to a loss of revenue. Hunting is another management option which could yield considerable revenue (Bond 1994), but finding common ground between those for whom hunting is a passion and for those who passionately oppose it, may be impossible.

These issues raise two fundamental sets of questions. The more difficult of the two is: why should elephants be controlled, while the second is how such control should be conducted?

"Playing God" is the frequent criticism (Sheldrick 1993) - including by an anonymous reviewer of the original paper - of wildlife managers who intervene in the natural course of things. In this sense, the elephant problem in KNP is self-imposed, but the decision to control elephants is based on the acceptance of the responsibility of not allowing the consequences of an uncontrolled increase in the elephant population (Joubert 1986; Whyte *et al.* 1999). The obvious experiment of letting the elephants increase could have unfortunate consequences to the ecosystem and the other species that are dependent upon it. Such "experiments" elsewhere in Africa have demonstrated some of the consequences for biodiversity (Cumming *et al.* 1997; Herremans 1995; Leuthold 1996; Western & Gichohi 1989).

These consequences raise more questions. Did elephants effect such ecosystem changes in the past? If so, should they be allowed do so now? What processes regulated elephant numbers in the past? And what is 'natural' today in an Africa with a large and rapidly growing human population and few well-protected parks?

Given the choice of controlling elephant numbers, does KNP's management have effective alternatives to killing elephants? The use of contraceptives has been considered a promising solution (Short, 1992; The Economist, 1996). Consequently, much effort has been spent investigating the endocrinology of elephants and to evaluate the potential use of substances such as RU 3486 that may block implantation (Greyling *et al.* 1997; Greyling *et al.* 1998). Other methods based on either immunocontraception or slow-releasing oestrogen implants have received research attention in KNP (Fayrer-Hosken *et al.* 2000; Part 2 of this chapter).

Some of the potentially serious and unpredictable consequences to the individuals of these methods are discussed later in this chapter. These include changes in behaviour, social status within the breeding herd, possible changes to the structure of social units and the population itself (Whyte In Press), and in the steriogenic activities of the ovary and uterus. Cows treated with oestrogen implants may remain in an extended state of oestrus (Whyte *et al.* 1998). The prediction of the effects that these may have on their behaviour, or the consequences that this may have for the Park's male elephants is not possible (Whyte *et al.* 1998).

Finally, the question is asked: what is the smallest number of animals one could kill or sterilize if the goal is to control population growth? The answer to this identifies the age and sex group where natural processes (mortality or survival rates) would make the largest difference to whether the elephant population increased or decreased.

Why control elephant numbers?

In some dry forests, increasing numbers of elephants have progressively converted woodlands into more open habitats (Laws, 1970; Barnes, 1980, 1983; Douglas-Hamilton, 1987; Dublin, 1995; Dublin *et al.* 1990; Jachmann & Croes, 1991; Leuthold, 1996; see Lawton & Gough 1970, Guy 1982 and Ben-Shahar 1996 for alternative explanations). By comparing ecosystems on either side of an elephant fence in Miombo woodlands, Cumming *et al.* (1997) demonstrated significant reductions in the species richness of birds, ants and other taxa, where elephants have removed the tree canopy. In KNP, elephants also suppress the rejuvenation of selected woodland trees (Viljoen 1988; Trollope *et al.* 1998).

There are several reasons why the prevention of these changes are desirable. Biodiversity considerations have been used to justify the maintenance of low elephant numbers (Joubert 86). On the African continent where so little protected habitat remains, there may be the need to conserve a set of species more localized and thus more vulnerable to extinction than elephants (Hoeft & Hoeft 1995). This justification explicitly recognizes that restoring nature to its original state or states on the original scale is now impossible.

Alternatively, the target size that the population must not exceed may be historically justified. It is reasonably sure that elephant densities in KNP are now different from the recent past (see Chapters 3 and 4). Evidence suggests that KNP held only low numbers of elephants at the turn of the century (Bryden 1903; Stevenson-Hamilton 1903a; Vaughn Kirby 1896). Whether these were naturally low numbers or, as Spinage (1973) has argued, the consequences of the ivory trade, will continue to be debatable.

If the latter explanation is correct, then elephants should naturally have been abundant which raises the question: why there were any areas originally with extensive woodlands? Elephants might increase over century long time scales, destroying the woodlands in the process, and thus causing their own decline (Caughley 1976). Elephants and woodlands could therefore only have co-existed over very large temporal and spatial scales that permitted large mosaics of woodland habitats in various stages of elephant-induced decline or recovery. Finely resolved palynological data might elucidate such changes, but no references to such studies over sufficiently large areas could be located.

In current times, where most national parks and reserves constitute islands in man-modified landscapes, even KNP's 20 000 km^2 may be too small to allow such cycles to operate. The idea of trans-frontier conservation areas (TFCAs) - huge protected areas that stretch across international barriers - may ameliorate some problems of geographic scale, but the realization of such parks in elephant range is still in the future (Braack 2000).

If the explanation that elephants were always at low numbers is correct, then what were the probable reasons for this and what has changed? The answers lie in elephant demography – a high pre-breeding mortality rate in cows could limit a population.

MATERIALS AND METHODS

Parameters

A simple spreadsheet model was constructed to explore the options for contraception and other forms of management in the KNP elephant population. Demographic parameters for the model came from data collected at routine culling operations in KNP. All elephant culled during the years 1976, 1977, 1978, 1979, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994 and 1995 were examined (n= 4 739).

Relevant data collected from all culled animals were age (after the method of Laws 1966), sex, reproductive status of cows (pregnancy, lactation), and foetal mass and sex.

Inter-calving period was calculated from the period of anoestrus using the formula (after Hanks 1972):

$$X\ (\textit{Period of anoestrus}) = \frac{\textit{Gestation time * No. adult cows non-pregnant}}{\textit{No. adult cows pregnant}}$$

Mean calving interval (MCI) = Period of anoestrus + gestation time.

Population growth and mortality rates used in the model

Annual mortality was estimated from the numbers culled and population growth despite it. Only two factors can contribute to population growth – births and immigration from areas outside the KNP. Between 1976 and 1994, KNP was fenced in its entirety (see Chapter 5), and thus immigration would have been negligible.

Between 1973 to 1994 inclusive, the population was stabilised through culling as it ended this period at much the same size (7 800) as it started (7 600), but showed some fluctuation in between. During this time the population always increased when the cull was less than 5%, making this (5%) a reasonable estimate of the population's growth rate. Given the estimated parameters of age at first parturition and subsequent inter-calving period, the model was used to calculate mortality through the difference between the potential growth rate and the actual population growth of 5% as estimated above.

The spreadsheet model

The model (Whyte *et al.*1998) assumes constant survivorship up to 60 years (and no survivors beyond that age), and specifies the age of first calving, and calving interval. In nature, these parameters are not independent: poor food conditions and high elephant densities will probably affect all three (see van Aarde *et al.* 1999). In particular, Dobson (1993) summarizes data showing how the age at first calving declines with increasing elephant densities. The effect of density on inter-calving period is less obvious. The model assumed no marked changes in numbers - for that is the management objective - and so, for simplicity, each parameter was fixed at a given value.

The foetal sex ratio for elephants in KNP is 1:1 - culls yielded a sample of 311 male to 313 female foetuses. This concurred with the findings of Smuts (1975). This ratio persists until 14 years old, when the young males leave the breeding herds and join bachelor groups. The mortality of bulls in bachelor groups is unknown. It is likely to be slightly higher than in adult cows, but still low, as KNP has recorded few natural deaths of adult bulls. In the model, it was assumed only that there were sufficient males in the population to permit the cows to produce young whenever they were able to do so.

Growth rates under the combinations of maximum and minimum values of the three reproductive parameters discussed so far were explored (survivorship up to 60 years, the age of first calving, and calving interval). The objective was to find the parameter in which change would have the greatest effect on KNP's elephant numbers.

RESULTS AND DISCUSSION

Elephant demography

It takes only a simple demographic model to show that elephants can increase rapidly in numbers. Female elephants have a life span of ~60 years, with between 2.5 and 5% of the population dying each year (Laws & Parker 1968; Laws *et al.* 1975; Jachmann 1980;

Dunham 1988 and references therein) have summarized these and other demographic parameters. They have a mean age of first calving from 11 to 20 years old. Gestation is 22 months (Kenneth & Ritchie 1953; Lang 1967), and the inter-calving interval can be as short as three years or as infrequent as nine years. They remain fertile into their late fifties.

In KNP, some cows have given birth in their 12th year and most have given birth by the time they are 13 years old (Smuts 1975; see Chapter 4). A culled sample of 966 adult cows shows an almost exact equality in the numbers of those pregnant (484) and non-pregnant (482). This means that, on average, a cow is pregnant for half of her adult life. Thus the calving interval will be twice the gestation time of 22 months. After the method of Hanks (1972), the inter-calving period was estimated at 43.9 months or 3.65 years.

There is no long-term, cohort-based study of survivorship so annual mortality was estimated from the size of the cull itself and how fast the numbers grew despite it. Only two factors can contribute to an increase in the population: births and immigration from areas outside the park. Immigration from Mozambique was probably a major cause of increase prior to 1976. It is less likely to explain the changes in the last two decades due to the fencing of KNP (Walker et al., 1987; see Chapter 4). There were few elephants in the conservation and agricultural areas to the west, and KNP was fenced along northern and southern boundaries in 1970 and on the eastern boundary by 1976. Immigration could only have made a small contribution to the population's growth rate after 1972, but whatever its contribution, it was included in the calculations as if it were a birth rate.

From 1973 to 1994 inclusive, the cull averaged 6.7% of KNP's elephants. The population ended this period at much the same size (7 800) as it started (7 600) and numbers fluctuated between a low of 6 900 and a high of 8 700 animals. From year to year, the population always increased when the cull was less than 5%. It increased from one year to the next in nine different years when the cull was 0, 4, 4, 4, 4, 5, 5, 5 and 6% of the population respectively. Given the inevitable uncertainties in counting animals, increases may reflect under-counting in one year followed by over-counting, in the following year. The single high value of 6% was discounted because of this possibility. The consistent increases in population when between 4 and 5% of the animals are killed thus makes 5% a reasonable estimate of the population's growth rate. Using the parameters of each cow calving for the first time in their 12th year and at 3.6 years thereafter, the model estimated population growth at 6.5%. The difference between this and the estimated 5% growth rate, allows the calculation of annual mortality rate at 1.5%. These parameters differ from those calculated at a later time (see Chapter 5, Part 2)

If these rapidly growing elephant populations are not typical of KNP's original state, then what has changed?

With this model, the elephant population can increase when mortality rate is as high as 5% per year and when age at first calving is as late as 20 years. In contrast, when the inter-calving interval is as long as nine years, the population can only grow slowly under the best circumstances of low mortality and early age at first breeding. Given the natural range of parameters, the inter-calving period played the major role in driving the population changes. This conclusion is similar to that of Dobson (1993) and Hanks & McIntosh (1973).

Changes in the calving interval are probably the main reason for the numbers of elephants now being higher than in the past. This difference in numbers may also be the result of short calving intervals combined with high pre-breeding mortality (which is demographically equivalent to long calving intervals). The interval between a cow producing a youngster of breeding age is long in both circumstances. Various factors could have influenced this parameter.

Juvenile (i.e. pre-breeding) mortality might have been consistently higher in the past. Hunting by Stone- or Iron-age cultures might have been responsible. So, too, might the long distances between water sources - for young elephants are prone to die during droughts (Dunham 1988). More recently, KNP's extensive network of artificial water holes may have positively influenced pre-breeding survival as the droughts in the early 1980's and 1990's had little effect on the growth rate of KNP's elephants, though Walker *et al.* (1987) reported elephants doing unusual amounts of damage to trees at the time.

The demographic model suggests that juvenile mortality caused by droughts could be episodic and still slow growth rates to near zero. One episode in every 11 years would be enough to severely impact all the pre-breeding age classes.

The parameters for KNP's elephants (age at first calving, inter-calving interval, and annual survival) are close to, or exceed the maximum observed elsewhere. Calef (1988) suggests 8% as the theoretical maximum growth rate for elephants. Age-structured models similar to those of Dobson (1993) were employed and the results produced by the model agree with Dobson that this seems to be too high. KNP's particular problem is to regulate elephants at a density at which resource limitation is minimal. The management problem is how to achieve this. Broadly, there are only three options – contraception, translocation, culling or a combination of these. The model allows some insights into contraception and culling options.

Contraceptive options for managing elephants

Contraceptives allow the extension of the inter-calving interval and so offer a potentially effective way of controlling population numbers. Using the demographic model introduced above, the proportion of KNP's roughly 3 000 reproductively active female elephants that would require contraceptive treatment was calculated. To ensure zero population growth, the average calving interval would have to be reduced to about 12 years, or about 75% of all cows >12 years (n = about 2 250) would have to be under treatment. Furthermore, a zero population growth rate will only be attained after 11 years of treatment because in that 11-year interval, females born before the use of the contraceptives are steadily recruited into the breeding population. Indeed, 11-year-olds are the largest breeding class, since there cannot be more 12-year-olds than 11-year-olds, 13-year-olds than 12-year-olds, and so on. Consequently, the breeding population increases at about 4% per year to over 5 000 adult cows before zero population growth is attained. Thus, the final effort would require ≅4 000 animals to be under treatment - not the initial number of 2 250 (75% of 3 000).

The parameter for which there is the least confidence is annual survival. It is a back calculation that assumes a particular growth model and further assumes how the population would have grown without the cull. If the annual mortality rate is increased from the 1.5% employed in the previous paragraph to 2.5%, then the required fraction of cows treated with contraceptives declines only from 75% to 61%. Simply, it is the very short inter-calving interval of KNP's elephants that compounds the management problem.

The model also confirms Dobson's result that using contraceptives to delay the age at first calving, is an even less effective strategy than changing the inter-calving interval.

Consequences of contraception for the individual

Contraceptive use aims to control the elephant population without the killing of animals that some people find objectionable (Landman 1978; Sheldrick 1993). It also holds the desirable promise of being reversible. Were some natural event to greatly reduce the population, the contraceptive programme could be stopped and the population could recover quickly. In spite of limited information, some of the physiological and behavioural consequences of the substances presently on trial as contraceptives may be predicted. These consequences may thwart the promise of contraception as both humane and reversible (see Part 2 of this chapter).

Studies on endocrine correlates of elephant reproduction show that blood levels of both oestrogens and progestins are relatively low in the African elephant (Plotka *et al,* 1975; de Villiers *et al.* 1989). In contrast to most other mammals, relatively high concentrations of the 5-reduced metabolites of progesterone (rather than progesterone itself) appear to maintain pregnancy in the elephant (Hodges *et al.* 1994; Hodges *et al.* 1997; Greyling *et al.* 1997), but as yet, the role of progesterone in the maintenance of pregnancy can not be discounted. Elephants may be extremely sensitive to this steroid, resulting in extremely low concentrations being sufficient to support pregnancy. This may also be true for the interactions between oestrogens and ovarian function.

Circulating concentrations of oestradiol-17 are extremely low (Plotka *et al.* 1975; McNeilly *et al.* 1983) and endometrial receptor affinity is highly specific (Greyling *et al.* 1997; Greyling *et al.* 1998). Oestrogens in the elephant, as in other mammals, probably originate from developing ovarian follicles. Ovulation and incidences of oestrus may be associated with a surge in their plasma concentrations but circulating levels are extremely low (Hess *et al.* 1983).

Slow-releasing capsules implanted in ten lactating elephants in KNP apparently resulted in continued high concentrations of oestradiol-17. The consequences may have been an impairment of lactation and a subsequent increase in calf mortality (Whyte & Grobler 1998). Moreover, the treated cows remained in a continuous state of sexual heat. They appeared to have been continuously harassed by bulls (Whyte & Grobler 1998; see Part 2 of this chapter) which resulted in separation from their breeding groups and even their calves. This may also have contributed to the reduction in calf survival.

Considering the influence of sexually associated aggression in bulls on calves, the high incidence of cows in heat, may also have major consequences for the unsuspecting tourist. At any given time at least some 2000 cows will be experiencing this condition should oestradiol contraception be employed (see below). In addition, the potential for continued high levels of oestrogens to induce the carcinomic growths that have developed in other species (Li *et al.* 1983; Li *et al.*, 1988) can not be discounted.

Results of recent research in immunizing elephant cows with porcine zona pellucida antibody (pZP) in KNP suggest that animals will have to be given an initial vaccination and two subsequent two-weekly boosters to raise antibody titres to effective levels, and at yearly intervals thereafter to ensure contraceptive effectiveness (Fayrer-Hosken *et al.* 2000). Immunocontraception is effective in several free-ranging mammal species (Miller *et al.* 1998 and references quoted therein). The method's protagonists (see Bertschinger et *al.*, 1996) claim minimal effects and even reversibility (Kirkpatrick *et al.* 1992; Kirkpatrick *et al.* 1996; Fayrer-Hosken *et al.* 2000; Turner *et al.* 1992). Others claim evidence to the contrary in some species (see Mahi-Brown *et al.* 1989; Paterson *et al.* 1992; Paterson *et al.*

1996). Active immunization with the zona glycoprotein induces infertility. It also causes ovarian dysfunction and ovarian pathology characterized by a lack of folliculogenesis and depletion of the primordial follicle population (Paterson *et al.* 1996). If this proves to be the case for elephants, such sterilized individuals would be removed permanently from the gene pool - an effect similar to that achieved through culling. However, ongoing research in KNP has now suggested reversibility in at least some of the previous research animals (Fayrer-Hosken *et al.* 2000).

In summary, all of the methods currently under test have serious known or predicted possible consequences to the health of the cows, their behaviour, and those animals around them. This is not the only problem with contraceptives.

The necessity of boostering antibody titres through repeated injection means that all animals under treatment must be treated according to a schedule. In order to achieve this, it would be necessary to locate the animal as and when its booster was due. The only way to do this would be to fit the animal with a radio collar. The logistics and expense of this for 4 000 elephant cows would be prohibitive. From a tourism point of view, 4 000 elephant cows with radio collars would be unacceptable.

Other management options

Another option is translocation or the removal of live animals from the KNP to other reserves elsewhere. In its effect on the population, it is the same as culling as individuals are permanently removed from the gene pool. Like contraception, translocation would be favoured as it is a non-lethal option. But while KNP has developed its capacity to move entire family units and even the largest of adult bulls, the markets for such animals are extremely limited. Current demand is in the order of 60 animals a year which could not serve as an alternative to larger scale methods. However, the establishment of the proposed large TFCA in the Coutada 16 area of Mozambique (which borders on KNP's eastern boundary) would offer considerable translocation options in future (Braack 2000).

The model offered a numerically simpler solution to the KNP's elephant management problems. Rather than kill hundreds (even thousands) of elephants each year, or contracept several thousand cows, the killing of a much smaller number of cow elephants just prior to their first pregnancy would achieve the same aim. The culling of a mere 300 carefully selected animals each year would drive the population to extinction, for no breeding cows would enter the population. Culling 250 would stabilize the population.

The words 'sterilize' or 'translocate' can be substituted for 'cull' in the previous paragraph and its conclusions would be unchanged. Translocation of juveniles is not possible, as live removal of juveniles not in family units has been specifically precluded as a management option (Whyte *et al.* 1998; 1999).

Contraception and sterilization are not usually considered synonymous. Indeed, the efforts discussed above aim to find reversible contraceptives and to avoid sterilization, but for some individual research animals this might be the unintended consequence of our ignorance of how the contraceptives function. If sterilization, and not contraception, is to be an *intended* objective, then it should be stated as such. The ethical issues this raises will then have to be scrutinised and the research programme focused on deliberate sterilization.

CONCLUSIONS

There are four options for the management of KNP's elephant population. Since 1967 the choice was to cull excess elephants to maintain the population at around 7 000 (up to 1 850 in a year) to protect against loss of biodiversity. The other three options are to let elephants increase (with probable negative consequences for biodiversity), to cull or sterilize 250 pre-breeding cows, or to administer contraceptives to 75% of all breeding cows.

There is nothing sacrosanct about keeping the elephant population at its current level. There could be a choice of any combination of the four options, including higher elephant numbers, likely higher inter-calving intervals and so a proportionately smaller number of animals culled, contracepted or sterilized, but with more damage to the woodlands. The optimal balance between elephant numbers and woodland is not easy to determine without long-term, large-scale experimentation. Moreover, with larger numbers of elephants, the absolute numbers to be killed, contracepted or sterilized would also be larger.

There is still a debate about whether or not woodland - and the low elephant numbers that permit its existence - was naturally the permanent or even an episodic state of this region. What is certainly not natural is the small fraction of protected land in Africa (and elsewhere), the consequent rates of global extinction, and the loss of ecological processes across the landscape. Protecting woodland may be essential to preserve a representative sample of species and processes for the future, whatever the past may have been.

If there were few elephants in the past, then the first question is why? The second is how do we keep elephant numbers low? The numerical targets required for zero growth range from selectively killing or sterilizing a few hundred 11-year-old cows to indiscriminately culling many hundreds of animals, to using contraceptives on several thousand adult cows. There will also be some individuals who find killing, any elephants an anathema. Unfortunately, the use of contraceptives on this scale is completely impractical and they are likely to have severe behavioural, physiological and demographic side effects. Should elephants be unnaturally culled or sterilized prior to calving for the first time, or be left to die naturally of thirst or starvation in dry years? This is an ethical issue that scientists are not solely equipped to judge. Such a decision should be a collective value judgement distilled from the public at large.

Identifying the smallest numerical target for controlling elephant numbers is not just a practical convenience. It is the most likely target for how the vagaries of nature limit elephant numbers. The high mortality of juvenile elephants may explain why some populations have remained at numbers that do not lead to the destruction of woodlands. In this sense, the smallest target for control is also likely to be the most natural one. Whatever the ethical issues of sterilizing female elephants, it does provide the smallest numerical target and it avoids killing animals.

CHAPTER 6: PART 2:
ELEPHANT CONTRACEPTION RESEARCH
IN KRUGER NATIONAL PARK

INTRODUCTION

Part 2 of this chapter was compiled from a paper examining the status of research into elephant contraception in KNP (Whyte & Grobler 1998). Two contraception techniques received research attention in the KNP over the past 4 years. The first of these was the "immunocontraception" method conducted jointly by the Science and Conservation Biology Program, Montana, the Faculty of Veterinary Sciences at the University of Pretoria and the Humane Society of the USA. Immunocontraception uses porcine zona pellucida immunocontraceptive vaccine (pZP) to stimulate the target animal's immune system to prevent sperm penetration of the ovum (Kirkpatrick *et al.* 1992; 1996).

The other technique used hormonal control through the surgical subcutaneous insertion of oestradiol-17ß implants and was conducted by the Institute for Zoo and Wildlife Research, Berlin.

Both of these projects had certain potential problems associated with them which were either addressed in the project protocols or were expressed by members of SANP's Department of Scientific Services (DSS) at the time the projects were initiated. These were social disruption, threats to the health and welfare of the treated animals and/or their calves, and behavioural aberrations. It was the intention of the paper (Whyte & Grobler 1998, and this part of this chapter) to put the findings of the research groups into a management perspective, and to report on the behavioural data collected by SANP staff.

Management concerns

Immunocontraception

i. Possible permanent damage to the cows' ovaries resulting in sterility (see Mahi-Brown *et al.* 1989; Paterson *et al.* 1992; Paterson *et al.* 1996).

ii. During courtship in elephants, oestrous cows can be extensively chased by bulls (Moss 1988). If the cow is not ready to mate, she will try to prevent him from mounting by running away. The chasing continues until she does become receptive. This causes a certain amount of disturbance to other members of the family unit. Normally copulation and conception would result, and this disturbance would not be repeated until her next oestrous period after her calf was born (3.8 – 4 years). Under pZP treatment, the cow would mate normally but would not conceive, and would then "cycle" and return to oestrus in about 15 weeks (Kapustin *et al.* 1996; Plotka *et al.* 1988). The frequency of mating and its accompanying disturbances would be far more frequent.

Oestradiol-17ß implants

i. Oestrogen is a known carcinogenic in some species (Li *et al.* 1983; Li *et al.* 1988) when used in the dosages required to prevent conceptions. No information is available on the potential effects on elephants.

ii. Oestrogen is an agent which may induce abortions. Abortion of a near full-term foetus could have serious consequences for an elephant cow. The research group used an ultrasonic scanner to determine reproductive status of the proposed research animals prior to insertion of implants. Only adult cows which had recently calved would be non-pregnant, and all ten of the cows selected as study animals had very young calves at foot. In spite of this, there was some concern as to whether the scanner would be a reliable indicator of pregnancy, and that there thus existed a possibility of mistakenly treating pregnant cows with oestradiol.

iii. As the treated cows would pass the metabolised oestradiol out through their urine, it was suspected that this might incorrectly signal to bulls that they were sexually receptive. Cows in this condition could be continually chased or harassed by the bulls, and this could last for as long as the implants remained active. This would be stressful for the cows and even more so for their calves. Calves of less than a year old are very seldom to be found more than a few metres from their mothers (Moss 1988). If these cows were continually harassed by attendant bulls, the calves would be in danger of:

- Being trampled by bulls (or by the mothers themselves in their efforts to avoid the bulls).
- Being unable to suckle adequately as a result of the disturbance, possibly resulting in malnutrition and death from starvation.

iv. High levels of oestrogen are known to have a suppressive effect on milk production in some species (Lammers *et al.* 1999). If this occurs in elephants this may also lead to malnutrition and possible death of the calves.

v. High levels of oestradiol may cause permanent damage to the ovaries and thus permanent sterility.

vi. High levels of oestrogen in horse females is known to induce diarrhoea in foals through ingestion through the milk - another possible health risk to elephant calves.

vii. Concerns were expressed over the possible effects that elephant cows in false oestrus may have on bulls and on their behaviour such as heightened aggression (Whyte *et al.* 1998; Scott, In litt.[1]).

METHODS & MATERIALS

Immunocontraception

A sample of 21 non-pregnant adult cows was immobilised and fitted with radio-collars to facilitate relocation and identification of each animal. Each was given an initial inoculation of pZP vaccine at the time of immobilisation. Treated animals were remotely given a "booster" inoculation six weeks later. This was delivered remotely by darts fired from a capture gun from a helicopter into the rump area of target animals. A second booster was administered six months later, and thereafter cows were immobilised at six-monthly intervals for ultrasonic examination of their reproductive status (Fayrer-Hosken *et al.* 2000).

[1] Mr P. Scott, Senior Ranger, Kruger National Park.

Two of the collars malfunctioned leaving a research sample of 19 animals. Another 21 cows were immobilised and radio-collared to serve as controls.

Due to a high proportion of these cows conceiving after treatment, a second group of ten research cows were treated under a revised vaccination schedule (Fayrer-Hosken *et al.* 2000). Behaviour of these animals was not monitored. Results of this research receive some attention under "Discussion".

Oestradiol-17ß implants

A second sample of 10 adult cows was immobilised and fitted with radio-collars to facilitate relocation and identification of each animal. As with the pZP treated cows, they were selected by having a small calf at foot. These cows each received five slow-release oestradiol-17ß "negative feedback" implants, inserted sub-cutaneously behind the ear in the neck area (Meyer *et al.* Undated).

After six months, when oestrogen levels were expected to decline, these cows were supposed to receive a second implant. This second phase was not implemented and the project was suspended due to behavioural aberrancies which were induced by the high levels of oestrogen. These cows were also subsequently examined at six-monthly intervals for ultrasonic examination of their reproductive organs. These results also receive brief attention in the discussion.

Behaviour

No provision was made for behavioral monitoring in either of the projects' research protocols, but SANP were alerted to the possibility of adverse behavioural and other negative side effects of the oestradiol implants (van Aarde In litt.). Monitoring was instituted in haste after the animals had already received their initial treatments. It was not initially expected that the immunocontraception vaccine would have any significant adverse effects on behaviour, but once the monitoring program had been instituted for the oestradiol implanted animals, the behaviour of pZP treated animals was also monitored.

Behavioural monitoring had not been foreseen during the planning phase, and most of the research animals were selected close to Skukuza (the administrative centre for KNP) for logistical convenience. Unfortunately this proved to be in areas largely unsuitable for this monitoring due to thick bush and mountainous terrain, which complicated data collection. Research animals could not always be observed due to the danger of approaching them on foot in the thick bush.

A flaw in the methodology identified later was that behaviour of the control groups was not also monitored. As it had been assumed that the pZP-treated animals' behaviour would not be affected, data was only collected for comparison of the animals treated with pZP and oestradiol respectively. Data collection focused on the presence (or not) of bulls and any behaviour directed at treated cows, and survival of calves.

Treated animals were tracked regularly from the ground for a six-month period after treatment for attempted data collection. Aerial tracking from a Cessna 182 was also occasionally also used when ground tracking had been unsuccessful.

Data on calf survival and condition of the cows' reproductive organs were collected by the contraception researchers when their animals were subsequently immobilised for ultrasound examination.

RESULTS

Only the results of the behavioural monitoring are discussed here. Results of the contraception research receive some attention later in the chapter, as they are relevant to the conservation management of KNP's elephants.

Behaviour

Immunocontraception

Research animals could only be observed on 23 (40.4%) of the 57 times these animals were tracked from the ground. In 56 of the 57 attempts (98.2%), it could be determined that the cow was with the herd (had not been separated from the herd). Their calves were recorded with them on all of the 23 occasions when the treated cows were seen. Bulls were recorded with the herds only nine times (15.8% of the 57 tracking attempts).

No behavioural abberancies such as harassment or attempted matings by bulls were recorded from the pZP treated animals.

Oestradiol-17ß implants

On 112 of the 122 tracking attempts (91.8%), it could be determined that the cow was with the herd, but due to the nature of the terrain, the target animals were seen on only 67 (59.4%) of these occasions. Their calves were seen with them 60 times (89.6%). Bulls were recorded with the herds on all of these tracking attempts, and harassment of cows by these bulls was observed 15 times of the 67 occasions (22.4%) that the cows were seen.

Evidence for harassment of cows by bulls was obtained on video tapes by the students conducting the observations. Recordings were made of bulls with penis erect following the treated cows, and of red mud smears on a cows back which were clearly from the front feet of bulls trying to mate with her.

There were clear differences between the data collected from the two groups of research animals, particularly with respect to the relative number of times that calves were absent from their treated mothers, the number of times that bulls were recorded in attendance with these cows, and the number of times that "harassment" was recorded (Table 15).

Calf mortality

Six months after the insertion of the Oestradiol implants, one of the 10 calves had disappeared. This project was terminated at this point, but ultrasound examination of the treated animals continued at six-monthly intervals for a further three years, when the collars were removed. At this time another two of the calves were no longer with their mothers. This was significantly different to the pZP treated cows who had lost none of their cows after the same period ($\chi 2 = 7.94$; $p < 0.005$).

Table 15: A statistical comparison of behavioural parameters recorded for free ranging African elephant cows exposed to two different contraceptive treatments.

Variable	Treatment				Chi-square value	p
	pZP vaccinations		Oestradiol-17 implants			
	Yes	No	Yes	No		
Treated cow noted within herd	56	1	112	10	4.02	<0.05
Calf noted present with cow	23	0	60	7	4.27	<0.05
Bulls present in the herd	9	14	67	0	43.77	<0.001
Bull harassing the treated cow	0	23	15	52	4.67	<0.05

Aggression by bulls

A report was received from Scott (In litt.) expressing concern over an increased incidence of aggression by elephant bulls towards tourists in the Boesman Wilderness Trails Area subsequent to the commencement of this research. This he attributed to an increase in the number of "musth" bulls attracted to the area utilised by oestradiol treated cows.

DISCUSSION

Immunocontraception

The results of the tracking of the cows vaccinated with pZP were as would have been expected from cows whose behavioural patterns were not affected by the treatment. The calves were always with their mothers and, although bulls were occasionally recorded with these herds, this is normal as bulls do enter the herds to investigate the possibility of cows being in oestrus or for other social reasons (Moss 1988).

The efficacy of this method was initially somewhat under question, as after 12 months, nine of the 19 cows were pregnant. This was attributed to the vaccination schedule with long inter-booster periods which resulted in these cows conceiving before antibody titres had achieved levels high enough to prevent conception.

The second project used a revised vaccination schedule which was significantly more effective as only two of the ten treated cows conceived (Fayrer-Hosken *et al.*2000).

This treatment has also shown that it is reversible and that vaccination of a pregnant cow has no effect on gestation, the foetus or parturition (Fayrer-Hosken *et al.*2000).

Oestradiol-17ß implants

The cows treated with the slow-release oestradiol-17ß implants showed definite behavioural differences to those treated with pZP. Cows became completely separated from their matriarchal groups on 10 of the 122 occasions that they were tracked. On one occasion, the cow was tracked by fixed wing aircraft and was found on her own in the company of seven bulls with no other cows or calves anywhere nearby. Bulls were recorded with the herds in a far greater proportion of times, and harassment of the cows was recorded in about 25% of all observations. Bulls were recorded trying to mate with cows during darting and video material also showed overt courtship behaviour. Cows do become separated from matriarchal groups during courtship and mating (Moss 1988), but this lasts only for a few days during which time the cow is receptive and willing to mate, and the calf is old enough to be separated from its mother for short periods. With the oestrodiol treated animals, the "false" sexual heat appears to last for the full duration of the treatment. The cows were not receptive and willing to mate, and under these conditions, the attentions of the bulls must be considered to be harassment, particularly with the added stress of being separated from their young calves.

Separation of small calves from their mothers is highly unusual (Moss 1988). One of the ten calves disappeared within six months and two more within three years. Although this could not be directly attributed to the oestradiol treatment, the results suggest that this was likely as none of the pZP treated animals' calves disappeared.

Elephant cows appear to be highly sensitive to oestradiol. At the dosage rates used, ultrasonic scans showed that after three years, all of the 10 cows showed no sign of ovarian activity and that the treatment had probably caused permanent sterility (D.G. Grobler personal observations).

CONCLUSIONS

It is the stated objective of SANP to reduce numbers of elephants in the designated "Low-impact Zones" and to stabilise them in the "Botanical Reserves" (Whyte *et al.* 1999; see Chapter 7). Various methods of achieving this are at the disposal of KNP managers (Whyte *et al.* 1998), but the ultimate objective is to do this by non-lethal means. Only two methods comply with this objective – translocation and contraception. Whyte (In press) examined the advantages and disadvantages of these two methods, and neither are likely to offer any long-term solution.

Translocations are expensive , markets are limited and ultimately, areas receiving translocated KNP elephants will be faced with the same biodiversity concerns. The proposed TFCA in the Coutada 16 area of Mozambique (Braack 2000) may offer a considerable opportunity to dispose of excess KNP elephants through translocations, but once this area has been stocked, further translocations out of KNP seem very unlikely.

Contraception is clearly not yet at the technological level where it would be usable as a management tool for large populations in large conservation areas, but the pZP method shows considerable promise for small populations such as have arisen recently in many parts of South Africa through translocations. The method needs further research to determine the reasons for some of the cows conceiving while under treatment.

This study could show no evidence to suggest that the immunocontraception technique had any adverse effects on the behaviour of either the treated cows, their matriarchal groups or the bulls. Other management concerns such as the possibility of causing permanent sterility and the long-term effects of cows not conceiving and continuously returning to breeding condition will require some attention. Also the impacts of contraception on matriarchal group size may raise some other ethical concerns.

The physiological and behavioural side effects experienced by the oestradiol treated cows are be considered unacceptable as they must have placed severe stress on the treated cows and their calves, and the project was terminated on both humane and ethical grounds. It would also seem that the oestradiol has caused permanent damage to the ovaries of treated cows, which in itself is likely to render the method unusable as reversibility is a requirement. A population stabilised through sterilisation of the majority of breeding females would be at risk from disease as an epidemic would be less capable of recovery without a breeding nucleus.

Finally, the implications of sterilising young females of a species with a highly developed sense of family and depriving of the opportunity of participating fully in their matriarchal groups should deserve sincere ethical consideration.