Towards an adaptive management approach for the conservation of rare antelope in the Kruger National Park—outcome of a workshop held in May 2000

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A precipitous drop in rare antelope numbers specifically roan (*Hippotragus equinis*) sable (*Hippotragus niger*) and tsessebe (*Damaliscus lunatus*) since 1986 has become one of the main concerns of management. The zebra (*Equus burchelli*) population in the preferred habitats of these species had increased with the development of artificial waterpoints especially in the areas occupied by roan and tsessebe, and these events are hypothesised to be the main cause of the decline. Closure of artificial waterpoints resulted in moving the high-density, water-dependent zebra from the northern basalt plains, the preferred roan habitat. However, the expected responding increase in the rare antelope populations did not materialise. This lack of response over six years necessitated a critical re-evaluation of the management of rare antelope in the Kruger National Park. Subsequently, a workshop was held at Skukuza during May 2000. The options for adaptive management of the declining rare antelope populations, which was discussed at the workshop, is the subject of this manuscript. The participants felt that the removal/closure of artificial waterpoints was the most unintrusive management tool available to move high density grazers from the habitats preferred by rare antelope. Waterpoints to be closed should be carefully evaluated, and time allowed for rare antelope to respond to habitat changes. Boosting populations of roan and tsessebe by supplementing animals was seriously considered, with the proviso that it should be done under favourable circumstances. Small patch fires that could provide green grazing over extended periods were recommended. Predator control was discussed but could not obtain general support as a viable option in the Kruger National Park.

Key words: rare antelope, roan, sable, tsessebe, management, enclosures, artificial waterpoints.

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Introduction

Since 1986, roan antelope populations in the Kruger National Park (KNP) have dropped steadily from a peak of 452 to about 44 animals in 1993. The tsessebe population that peaked at 1163 in 1986 had dropped to 419 in 1993. During the same period, the sable antelope population that numbered 2240 in 1986 dropped to 1232 animals in 1993 (Fig. 1). In response to the decline in the roan numbers, artificial water points were closed during 1994 in the prime roan habitat on the northern basalt plains in the north eastern corner of the KNP. A research programme was initiated to track the changes in habitat, vegetation and rare antelope numbers.

The motivation for management action to conserve rare antelope is the objective that

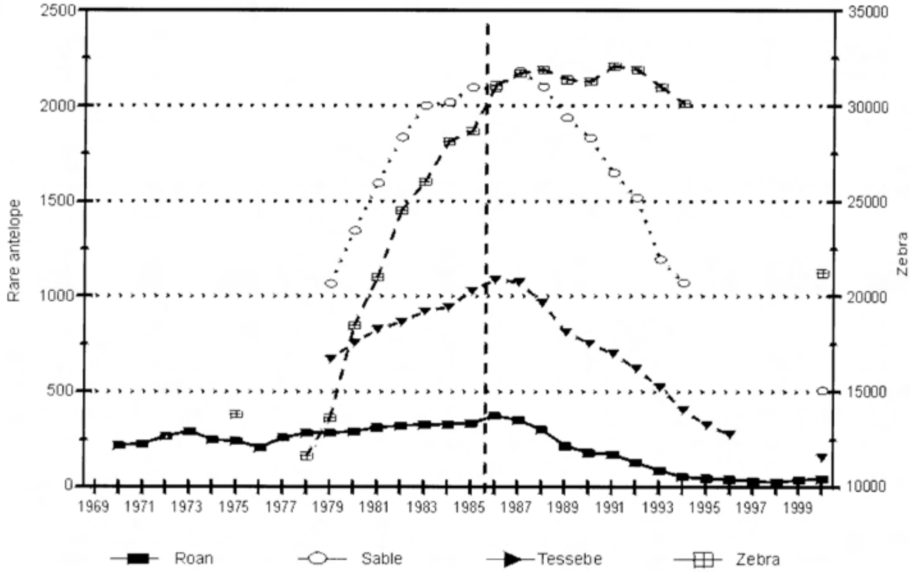

Fig. 1. Three year running average of tsessebe, roan, sable and zebra populations in the Kruger National Park

states that the conservation and restoration of terrestrial biodiversity should be ensured by allowing natural processes to operate. Where human influence, alone or in conjunction with natural events, poses a significant threat to biodiversity, appropriate intervention may be used to restore or protect biodiversity (Braack 1997). The adaptive management approach, adopted by management and research during 1996 is aimed at achieving such set goals (Rogers & Biggs 1999). This approach ensures that the result of changes in management are monitored and that management is re-adjusted when indicated. As part of adaptive management, a system with threshold(s) of potential concern (TPC) was developed to determine when intervention is needed. In the absence of detailed population viability models for each species, a set of rule-of-thumb TPCs for rare antelope was agreed on by the scientists of the KNP, depending on population numbers and the rate of decrease. The TPCs for rare antelope are defined as follows:

- if a population of a 1000 or more drops 50 % or more over a period of ten years or less;
- if a population of 750 or more drops by 40% or more over a period of five years or less;
- if a population of 500 or more drops by 30% or more over a period of three years or less; and
- the total population is less than 100.

Between 1993 and 1999, the sable population of 1232 in 1993 dropped by 59 %, and the tsessebe population of 419 in 1993 dropped by 62 %, while the roan population was still below 100. On the northern basalt plains, where the artificial waterpoints were closed, the situation was very similar. Even though the closure of artificial waterpoints was followed by a drop in zebra numbers from 2239 in 1993 to 874 in 1999, the rare antelope numbers declined steeply in spite of the grass species composition and biomass increasing significantly in the areas where windmills were closed (Grant 1999). The population of 60 sable that were recorded on the plains during 1993 decreased to a few singletons. The tsessebe that numbered 70 in 1993 decreased to about 21 animals, and the roan stabilised at about 20 animals.

Conservation status of rare antelope elsewhere in Southern Africa

The conservation status of rare game in the other national and provincial parks in Southern Africa was considered to determine whether the decline in rare antelope experienced in the KNP was a part of more general phenomenon in Southern Africa.

There was a stepwise decline in the roan population in Namibia since 1980 (Killian, W). In the Kaudom area of north-eastern Namibia, roan declined from 250 in 1980 to about 150 in 1999. In the drier Karos area in north-western Namibia, roan numbers fell from 240 in 1979 to about 15 in 1999 after their release from an enclosed area due to drought.

The conservation status of sable in Zimbabwe was reported as not entirely satisfactory (Du Toit, R. F.) Of the 22 000 sable recorded in the 1990s (Du Toit, 1992) there were about 11 000 on private land, 10 000 on state land and the remainder in Communal Lands. The Hwange-Matetsi-Gwaai region of north-western Matabeleland with about 8000 sable was the most important area for that species. Recent aerial surveys by the World Wildlife Fund indicated a possible decline in the sable population in this region to a about 6500, but this figure requires confirmation. This region with about 200–300 roan, also holds most of the country's population of this antelope. This species has declined virtually to extinction in the Sebungwe region, where it was formerly present in both Parks Estate and Communal Lands. The national total is probably between 450 and 500 if the a few small breeding groups on private land (mainly imported from Zambia and Malawi) are included. Zimbabwe's largest tsessebe population lives on a couple of private ranches owned by the de Beers Corporation, in the Shangani area (north-east of Bulawayo). The species has a scattered distribution elsewhere on private land and there are over 300 in the Matetsi-Hwange-Gwaai region. The national population total is about 3000.

The tsessebe population was stable at about 2000 until 1995 on Shangani Ranch (450 km²) declining to about 1000 in 1997 with an even sharper decline to between 400 and 500 by 1999 (Dunham, K.M. and Robertson, E.F.). Research on the ranch suggested that a high juvenile mortality rate accounted for the decline with only 12 % of adult females accompanied by their year-old calves during the 1999 dry season, while about 96 % of females were assessed to be pregnant. Predation by cheetah that were established on the Ranch in 1995, was also considered as contributing to the decline, but observations showed that cheetah tended to concentrate more on impala and kudu. This led to the hypothesis that the primary cause of the tsessebe decline was habitat deterioration associated with the cattle management system as well as a shift in the seasonality of rainfall.

Fifty-seven tsessebe and a total of 67 sable were introduced in the early 1980s in the Pilanesberg National Park (Brockett, B.H.). Initial management strategies supported a small increase in the tsessebe population while the sable did not increase. During 1989 a patch-mosaic burning system was initiated with point-ignited fires from early on in the season providing green forage for a longer period. This was followed by an increase in zebra (to more than 1500), sable (to 130), and tsessebe (to 140) during the early 1990s. Building of dams in 1994/95 supported a further increase in zebra numbers to 2500 in 1996. In spite of the subsequent removal of some waterpoints during 1998, sable declined further from 120 in 1996 to about 60 in 1999 (with 19 animals translocated), and tsessebe declined from 120 in 1996 to about 80 animals in 1999 (with 30 animals translocated).

In the Northern Province rare antelope are more closely managed with supplementary feeding being given when neccessary. The roan population in the Nylsvlei floodplain area has been successfully maintained at 60 in the 31 km² since 1991 (Nel, G.).

Postulated causes of the decline in the KNP

Based on the work done by Harrington *et al.* (1999) four hypotheses for the roan decline in the KNP were proposed (Owen-Smith, N.).

- Three series of drought years which led to progressive aridity of the habitat with below average rainfall during the eighties and early nineties following years of above average rainfall in the seventies. The years 1982/3, 1986/7 and 1991/92 represented severe drought periods.
- An increase in competition for grazing by zebra that increased from about 7000 in 1977 to about 33 000 in 1986. This increase in zebra changed the grassland composition and worsened the effects of the desiccation.
- High adult mortality rate due to an increase in predators with predators increasing form 10 sightings per year by rangers in 1980–1985 and 100 per year in 1986 (Harrington 1995).
- Anthrax outbreaks during 1959, 1960, 1970 and 1990/91 led to the death of about 95 animals. During 1970 alone, about 15 % of the roan (37 of 250 animals) died of anthrax.

Presentation by workshop participants also indicated that the general tendency for a decline in rare antelope in Southern Africa seems to be associated with a decline in rainfall and management induced habitat alteration. Management was often associated with a high density of artificial waterpoints resulting in large populations of high density grazers such as cattle or zebra.

Contributing factors to be considered

Ecological considerations for the conservation of rare ungulates, based on a review of macroecological relationships between species geographical range and local abundance among large mammals, drew on a recent analysis by Johnson (1998) (Du Toit, J.T.). Essentially, species are at most risk of extinction if they occur in small distributions or at low local abundance. It is highly unlikely that a species will persist for long on an evolutionary time scale if it has both a low local abundance and a small geographical range. For African savanna ungulates this is demonstrated by the finding that species' geographical ranges increase with increasing body mass (Du Toit & Cumming 1999). Large species naturally occur at relatively low densities and if they also had small species geographical ranges they would face high probabilities of extinction. Conversely, species with large geographical ranges have relatively high probabilities of persistence. The relevance of this (to concerns about rare antelopes in South Africa) is that roan, for example, still occur over a large distribution covering most of the African savanna biome. Consequently, although the roan population could become extinct in the southern extremity of its range in the KNP, this should not be viewed as a disastrous numerical loss for the species as a whole. It should rather be viewed as a potential loss of genetic variability within the species.

Restricted availability of suitable habitat could thus have played a role in the decline of the rare antelope in the KNP, as the movement of rare antelope have been restricted by fences since 1957. Anecdotal evidence that tsessebe and sable were common in the area between the KNP and the Drakensberg foothills at the turn of the century, with roan sparsely distributed across the same zone indicates a restriction of suitable habitat for the KNP rare antelope (Williams, J.). However, due to the provision of water and high herbivore densities in the areas to the west of KNP this area can probably no longer currently contribute to an increase in habitat for these rare species if fences are taken down.

The area to the east (Mozambique) could however be important.

Another aspect that was stressed is the need to consider the relationship between population size and resource abundance as being governed by stochastic "crunch" events. (Du Toit, J.T.) These events, of which severe droughts are the most common, might occur with intervals of as often as from one to 20 years. Ungulate populations recover much more slowly than their food resources, so that studies (particularly postgraduate university projects) on the nutritional ecology of a rare antelope species to understand the reasons for changes in population numbers may generate data that are irrelevant to the problem. This is because the population could still be recovering from a crunch event that occurred a decade previously. Furthermore, if a population has suffered a severe reduction it may not be able to recover at all, regardless of available resources, due to the Allee effect (Stephens & Sutherland 1999). This is because certain species (e.g., roan) derive benefits from group living, such as shared vigilance, without which they cannot survive when exposed to even normal challenges in the wild, such as predation.

Genetic threats to small populations include the loss of genetic variation and inbreeding which may or may not lead to inbreeding depression and reduced fitness (Alpers, D.L. and Robinson, T.J.). Reduced fitness can be measured as reduced fertility or fecundity, or an increased disease susceptibility and parasite loads. It is not possible to generalise about, or to predict how a population will respond genetically to reduced population size. There is also no universal minimum sustainable population size. When animals are bred in enclosures, hidden long-term genetic effects, such as the loss of ability of populations to respond to environmental pressures, may become a problem, especially with long term breeding programmes. The decision to translocate animals from elsewhere in order to augment small populations may be taken because of non-genetic threats, but such management decisions should take the genetic ramifications into account. It is essential that source populations outside the KNP be tested for genetic compatibility. Preliminary data based on mitochondrial DNA control region sequences show that the roan antelope populations are geographically partitioned and that their phylogeography corresponds well with subspecific boundaries (Mathee & Robinson 1999). This has led to recommendations that roan be translocated only within the currently defined subspecies boundaries.

Options for adaptive management in the KNP

The general tendency for a decline in rare antelope in Southern Africa has not been reversed in any area in spite of a general increase in rainfall. From the above discussions it is however clear that rare antelope respond slowly to changes in habitat. The recovery of the population would thus be expected to lag behind the recovery of the habitat by several years. One option is therefore to monitor the populations and to determine whether they are capable of recovery without any interference.

Evaluation of suitability of habitat

Rare antelope have very specific habitat requirements, and the success of their conservation is dependent on the quality of the habitat. Criteria which could be developed into TPCs for the evaluation of the suitability of a habitat for rare antelope can be summarised as follows (Peel, M.J.S.):

- There should be sufficient grass, representing species which are palatable to rare antelope (grass biomass is also important where fire is used to maintain a satisfactory bush-grass ratio)
- To ensure maximum interception of raindrops and subsequent moisture infiltration, an average of a quarter of a sample quadrate should be covered by the grass tuft canopies.

- The optimal grass height for the rare antelope is 25–45 cm, but not less than between six and eight cm.
- The integrity of vleis and seeplines should be intact.

Management of artificial waterpoints

In spite of the poor response thus far to the closure of waterpoints on the northern plains of the KNP, the selective provision of artificial water still seemed to be one of the most promising unintrusive management tools. This allows for long term management requiring the least direct intervention. Water distribution can be related to competition for grazing, and selective grazers such as sable, roan and Lichtenstein's hartebeest are poor competitors where rangeland is heavily utilised (Clegg, S.B.). The redistribution of artificial perennial waterpoints to create refugia of relatively lightly utilised rangeland appears to be essential to maintain these selective grazers. It is recommended that artificial perennial water should be moved away from hydromorphic grasslands, which are preferred habitats for selective grazers.

The biggest disadvantage of this approach is that if overemphasised, it may have a negative effect on water dependent low-density species and force these animals to compete for water at the few remaining waterpoints. The zebra that move to other water sources may also have an impact on other species and the conservation implications of such movements should be taken into account when waterpoints are closed. The predators associated with high-density grazers may not follow the high density grazers, which would make the resident low-density species more vulnerable.

Management of high density species

Zebra are probably a determinant of the herbivore dynamics of many savanna systems such as that of the Pilanesberg National Park (Brockett, B.T.). There is evidence of declines of all rare antelope species associated with changes brought about by high density grazers such as zebra. This is usually associated with a time lag in the rare species' responses, with species like sable responding slowly to changes in habitat. To avoid such negative interactions, population numbers of competing species should be monitored and controlled in areas where the conservation of rare antelope is a stated priority.

Fire

Early dry season patch burning by point-ignited fires proved beneficial in Pilanesberg National Park to sable and tsessebe populations by providing short green grass over a longer period. Territories of various bulls can be targeted to support the specific species. Even if zebra move onto these burnt patches there should still be enough grazing for the rare antelope to benefit.

Breeding in enclosures

The advantage of this approach is that the rare antelope breed well in enclosures, which makes this an attractive method of preserving the genetic pool and to increase the chance of the survival of the population. It also provides the possibility of breeding sufficient animals to allow the release of larger, more viable groups. This is however, a very time consuming method of boosting the natural population and the time needed to reach sufficient numbers for release could decrease the chances of the small natural populations to survive. Rates of increase of sable and roan under such intensively managed systems are between 1.1 and 1.4 (Table 1).

Conscientious management of enclosed populations is essential. The initial population should be closely monitored, and all aspects of the population dynamics and social structure should be given attention, ensuring that intra and inter-species competition is reduced. For example the intense aggression shown by dominant roan bulls towards other bulls, complicates the management of roan. Antelope populations that saturates the available habitat are thus more important than carrying capacity in regulating animals numbers in enclosed areas. Supplementary feeding might also be needed to avoid loss of condition and well planned burning programmes should be aimed at improving grazing conditions.

There are several disadvantages to breeding animals in enclosures of which the cost of maintaining and erecting large enough enclosures is a major one. The stress associated with a high density of animals increases their susceptibility to disease, and costly parasite control measures may need to be implemented. Due to the concentration of animals in one area there is also an increased risk of losing the entire population. Another disadvantage is the possible loss of genetic fitness of the population if they are kept in captivity for very long periods. Captive animals also become physically unfit in the enclosures and are more prone to predation when they are released. To ensure that animals bred in captivity have a chance of survival, they need to be trained in their captive environment in a similar way to their wild counterparts (Soorae, P.S.). The released groups should also simulate the natural social structure of the species and such groups should be established in the enclosure before release.

Table 1
Satisfactory rates of increase of sable and roan on the intensively managed Madrid Game (Peel, M.J.S.)

Species	Year 1	Year 2	1998/99
Sable	1.17	1.27	1.37
Roan	1.19	1.23	1.10

Acquiring animals from other conservation areas

The building of expensive new enclosures can be avoided if rare antelope can be acquired from other areas. Free ranging populations could be boosted immediately giving them a better chance of survival. This new genetic material may broaden the genetic base and prevent effects of inbreeding. The possibility of outbreeding depression should however, be kept in mind. However, such augmentations are expensive, success is not guaranteed, and there is also a possibility of introducing foreign diseases and parasites. To ensure the survival of newly introduced animals in the KNP, these animals should preferably come from other wild populations that have been exposed to predators. Such animals may prove difficult and very expensive to acquire. Introduced animals should also be selected from habitats that are as similar to the KNP habitat as possible. If animals from outside are introduced, the genetic suitability of these animals must be ensured. Translocated animals should be slowly weaned from supplementary feed and only bigger herds of about 70 should be translocated to improve the success rate of reintroductions.

Predator control

Controlling predators is a consideration where the rare antelope population stays stable or decreases due to predatation. The purpose of decreasing predator numbers is to give the calves of rare antelope a better chance of survival. However, encounter rates between lion and roan were reported to be very low (Funston, 1997) and even by halving the number of lions in an area, it is unlikely to have a significant impact on the rare predation event by lions. The possibility that other predators may be involved can also not be ruled out (Mills, G.). With such very low rare antelope populations, almost all encounters have to be avoided as even if only occasional kills take place this can have disastrous effects on the population. This issue is further complicated by the fact that the process of decreasing predators is very resource-intensive and unlikely to be effective in an open system. Predator control is thus only really a viable option in an area where all predators can be excluded. In the KNP the predator control approach also contradicts the objective of allowing natural processes to operate (Braack, 1997), and may have severe negative effects on other aspects of the ecosystem. The question then remains whether rare antelope numbers will in fact increase given current predator numbers in the KNP. This contradiction in conservation of rare species and system integrity will have to be addressed specifically, with carefully structured adaptive management options that balance the established priorities.

Discussion of immediate management actions decided on

The general consensus was that the current free ranging roan are the most valuable animals and these herds should be strengthened as soon as possible. Both the roan and tsessebe populations have reached a threshold where recovery of the population without boosting is highly unlikely. At this stage resources will be concentrated on the use and expansion of existing enclosures allowing the roan and tsessebe in the enclosures to increase sufficiently to supply a large group to be released simultaneously. Before animals are released the habitat and available forage will be evaluated to determine whether the environment into which these rare antelope will be released is ideal. To improve the success of this type of augmentation of the population, suggestions of the IUCN re-introduction specialist group will be taken into account, and a supplementation strategy formulated.

A population model to help with the understanding of the lower population limits to growth will be developed for roan and tsessebe. Such a model will support decisions on the numbers needed for boosting of populations.

Patch burning using the point-burning method will be applied from early on during the dry season in the preferred roan and tsessebe habitat to ensure that green grass is available over an extended period.

The closure of strategic artificial waterpoints and dams will be implemented as a priority, but tactical management of specific waterpoints for rare antelope will be considered. The development of a waterpoint for rare antelope that would in some way exclude the high-density herbivores will be investigated to ensure that rare antelope are supplied with sufficient water.

The current ground census technique for rare antelope will be strengthened and a database of population numbers and structure created. This information will be used to make recommendations for the future management of rare antelope (roan, tsessebe and sable). Sable populations will receive specific attention to determine whether they are capable of recovery without any interference.

Zebra populations will be managed by the closure of waterpoints. Their subsequent movement from areas where water has been closed will be monitored. The response of the rare antelope especially sable to the presence of large numbers of zebra in areas where they did not occur before, will be investigated.

To decrease predator pressure on newly released antelope, predators will be satiated by feeding them for a period before and after the release of rare antelope from the enclosures.

The workshop decided that in spite of limited resources the KNP management is obliged to conserve rare antelope even at huge costs. To ensure successful adaptive management strategies, links will be created between research and management to solve the conflicts between rare antelope and system management and to evaluate resource needs for the different options. Due to the limited financial and human resources, prioritisation of the different management and research options will be very important.

Conclusion

In spite of the long delay responding to this crisis after the first evidence appeared in the mid 70s, the management approach has been increasingly adaptive and more specific goals have been set. Research and monitoring projects have also been initiated to examine and report on the effect of the adaptations in management. Where specific changes, such as the closure of waterholes have not achieved the set goals, these procedures were re-evaluated. This workshop, part of such a re-evaluation procedure, helped to direct future management approaches and to indicate further monitoring needs.

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