

## SYMPOSIUM ON THE KALAHARI ECOSYSTEM — SUMMARY AND CONCLUSIONS

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### *Introduction*

This symposium has dealt largely with the Kalahari Gemsbok National Park (KGNP), an area which has been under the control of the National Parks Board of Trustees since 1931. The park, which covers some 9 600 km<sup>2</sup> is part of an international conservation area which includes the adjoining 26 600 km<sup>2</sup> Gemsbok National Park in Botswana and adjoining wildlife management areas. Together these two national parks form the largest single conservation area in southern Africa and one of the largest on the continent. These parks and the surrounding area are known as the southern Kalahari, though it is not an ecologically separable region.

The southern Kalahari is waterless, rainfall is erratic and low, and the human population is small. It is therefore, one of the few areas in the world where the impact of modern man has been slight. In keeping with an arid system in which food resources may vary spatially and with the vagaries of rainfall, the large mammal component, and especially the large ungulates, depend upon being able to make extensive movements in search of food. Human impact on the system, originally limited to the minimal impact of the hunting/gathering San or Bushmen, has, however, been accelerating in recent years.

The international boundary fence between Botswana and South West Africa/Namibia, the fence between the KGNP and Namibia, the southern boundary fence of the KGNP and the settlements along the lower Nossob and Molopo Rivers have for some years defined the western and southern boundaries of the ecosystem as far as large mammals are concerned. Fortunately the international boundary which runs up the Nossob River separating South Africa and Botswana, and separating the two Gemsbok parks, has never been fenced. Ungulates from the KGNP have thus had free access to all the southern Kalahari lying east of the Namibian boundary and north of the Molopo although they are not protected south of Twee Rivieren. However, modern borehole technology is opening up areas of the southern Kalahari outside of the conservation areas for the cattle industry, an inevitable

consequence of the development of the Botswanan economy. These developments will to some extent, displace the large mammals, which at present are utilised as a natural resource by means of both subsistence and sport hunting. The southern Kalahari ecosystem as it has functioned in the past, if not ecologically managed, could face drastic changes in the future such as those presently seen south of the parks in settled areas.

This symposium shows clearly how little is known of the functioning of this extensive system. Unlike the situation in some rain forests where the tragedy is that much, or even most of the system, has been lost before there was a chance to find out how it functioned under natural conditions, the southern Kalahari can still be studied and we have time to understand this arid, yet immensely rich ecosystem.

### *The Symposium*

It is fitting that this symposium has been arranged to honour Professor F. C. Eloff. Not only is Professor Eloff the Chairman of the National Parks Board of Trustees, the guardians of the Kalahari Gemsbok National Park, but he was one of the first scientists of the modern era to publish on the mammals of the area (see De Graaff). His own research interests, as shown in his list of publications have been well served by the KGNP. In both his academic position, and his position on the Board, Professor Eloff has initiated and promoted research in the KGNP among his students and colleagues. It is not by chance, therefore, that no fewer than 16 of the 24 papers in this volume are authored or co-authored by colleagues or former students of Professor Eloff.

This symposium provides an introduction to the southern Kalahari ecosystem as represented in the KGNP, but gives little information on ecosystem processes. This shortcoming is clearly acknowledged by Eloff himself in his overview of the Kalahari. The purpose of the symposium, however, was also defined by Mr A. M. Brynard, Chief Director of National Parks, in his welcoming address, as being to review the state of our knowledge of the park and its environs, so as to suggest guidelines for the future research effort. •

### *Symposium Contents*

A scientific approach to the management and custodianship of a national park requires as a basic necessity, some kind of inventory of its contents, both biotic and abiotic. At an elementary level one requires check lists of all the components of the various biotic communities forming the ecosystem. This need has been partially catered for, as the literature of the area (Van Rensburg & De Graaff) and some of the papers presented at this symposium attest. However, there are several striking shortcomings particularly among the invertebrates (see De Graaff).

## The environment

Geology (Malherbe) and soils (Van Rooyen) are fairly well known, but although data are available the climate has not been reported on in these proceedings. Soil features (Van Rooyen) which are of consequence to the rest of the system are their sandy nature, low nutritional status (particularly low  $PO_4$ ) and high permeability to water. These factors, as well as the wide daily temperature fluctuations, place severe demands on the flora so that only specially adapted plants are able to thrive and be productive. The monitoring work on the vegetation of the Kalahari (Van Rooyen, Van Rensburg, Theron & Bothma) contributes to our botanical knowledge of this region and provides an essential base-line for future work. While descriptions of the plant communities of the Kalahari are to be found in the literature no detailed report has yet appeared on the dynamics of the flora, or on the role of fire. The paper on fire (Van der Walt & Le Riche) dealt only with the impact of a single fire on the *Acacia erioloba* community of the Nossob riverbed. Their data show that fire only significantly affected large, old trees and had virtually no impact on young trees. Little is known of the effect of fire on germination of trees in the Kalahari environment, or even to what extent occasional fires (presumably only after periods of high rainfall) may influence the low level of plant cover normally found. In another paper (Van der Walt, Retief, Le Riche, Mills & De Graaff) there is an indication that burnt areas are sought out by red hartbeest *Alcelaphus buselaphus* and gemsbok *Oryx gazella*. The role of plants, e.g. the tamma melon *Citrullus lanatus* and gemsbok cucumber *Acanthosicyos naudinianus* as a source of water to ungulates is referred to in several papers, yet no quantitative studies on this source of water and its utilisation by animals has yet been published.

The paper on pans and rivers of the Kalahari (Parris) goes a long way towards synthesising current knowledge. The dynamic nature of the process of pan maintenance involving both biotic and abiotic elements is emphasised. Parris points out that man-made waterholes are not essential for any element of the Kalahari fauna. Other papers frequently made the same point (e.g. Eloff, Van der Walt *et al.*, Mills & Retief). However, it is apparent that many species utilise borehole water when available and also use sources of highly mineralised water for salts, as an alternative to natural licks on pans and along riverbeds. Springbok *Antidorcas marsupialis* and gemsbok were not found to be affected by windmill closures, but wildebeest *Connochaetes taurinus* showed significant tendencies to move out of areas in which windmills were closed (Mills & Retief). These results agreed with the earlier findings of Eloff that the provision of potable water resulted in the permanent occupation of some areas by wildebeest, a species whose water requirements differ from those of the other ungulates of the area.

The work of Mills & Retief on ungulate responses to rainfall also strongly suggests that water is of little consequence to the movements of ungulates, other than some wildebeest, and that food quality and availability is a more critical factor. The paper on habitat selection (Van der Walt *et al.*) shows that food quality and factors other than water availability are most critical determining habitat

suitability to most ungulates in the Kalahari. The contentious issue of the provision of water from boreholes as a management practice is not directly addressed in this symposium, yet sufficient data are provided to seriously suggest that it is of no consequence to the functioning of the Kalahari ecosystem. Several avenues of investigation of the role of water are therefore suggested as future research projects.

#### Ungulate movements

Of far greater consequence to the Kalahari ecosystem is the ability of ungulates to move in search of the habitat conditions which suit them best (Van der Walt *et al.*). In this paper too, there is a strong appeal for the maintenance of the *status quo* between the two national parks so as to allow the vital movement of animals. The rapid response of plants to rainfall, and the subsequent movements of ungulates in search of such areas of better food sources lie at the core of understanding the ecosystem. Ungulate movements and the mechanisms involved, therefore, are suggested as the most important research topics for the Kalahari. Subjects which, judging by the contents of this symposium and the literature, have long been recognised as important, but on which little effort has yet been expended.

#### Ungulate adaptations and diet

Van Hoven, Boomker & De Beer exposed one of the adaptations of the ungulates to their arid environment showing that through diet selection they were able to maintain relatively high digestibility of their food intake throughout the year. However, detailed information on the composition of the diet and its seasonal variation are still lacking, and this again is suggested as a useful topic to pursue.

#### Invertebrates

The contribution on the coleopterous fauna by Holm and co-workers emphasises the dearth of information on the insects, as not even a check list exists. Despite this shortcoming Holm & Scholtz were able to come to some conclusions regarding the zoogeographical status of the Kalahari. What they showed was that the Kalahari coleopteran fauna is an extension of the savanna colepteran fauna to the north of it. The paper of Louw emphasised the differences between the Namib beetle fauna and the Kalahari, and Penrith highlights the evidence of endemism among Kalahari tenebrionid beetles. The contribution of De Graaff on the other invertebrates shows how rudimentary is our state of knowledge with only a few studies having been done on ticks, tampans, solifugids, scorpions and nemopterids.

#### Herpetofauna

Haacke in his survey of the herpetofauna comes up against the issue raised by Holm, that the Kalahari is not a well-defined zoogeographical region. Rather, it is a transition zone, yet it has some endemic sand adapted species (a parallel situation to that discussed by Penrith). Haacke finds that the 300 mm rainfall isohyet is a reasonable boundary for the herpetofauna for what is generally regarded as the 'Southern Kalahari'. His check list, with ecological notes, is a valuable contribution to our knowledge of this area.

## Avifauna

The paper on avian adaptations to the Kalahari (Maclean), like many of the papers in this volume, is largely a review. It clearly identifies some aspects of the local environment which are of importance to birds and provides elegant data and reasoning to show how well the avifauna can cope. Maclean also touches on the consequences of man-made water sources to some birds, indicating that they are able to make better use of food resources due to the availability of this water. Throughout the paper the role of the food supply in determining the movements and breeding of birds is a recurring theme.

## Small mammals

Unlike many other of the larger conservation areas in Africa, the small mammals of the Kalahari have been fairly well studied. The review by Nel, Rautenbach, Els & De Graaff on the rodents and other groups is comprehensive, and these authors also propose a number of lines of research which may be profitably pursued on small mammals. Of particular interest would be the dynamics of population fluctuations as it relates to range utilisation, and also as it affects the dynamics of raptors and smaller carnivores. The review of the smaller carnivores (Mills, Nel & Bothma) is informative as it clearly relates to the ecological processes which influence the diversity of the species present *e.g.* range of available habitats, habitat and diet selection, activity budgets and social organisation, all of which contribute to an efficient separation of niches.

## Large carnivores

The large carnivores of the Kalahari have been more intensively studied than any other component of the system. This is because the emphasis of research by Eloff and his colleagues (Bothma, Nel) and students (Mills) has largely fallen on this group. This has given a picture of how the carnivores co-exist and interact as a community.

The papers on the brown hyaena *Hyaena brunnea* and spotted hyaena *Crocuta crocuta* (Mills), lion *Panthera leo* (Eloff) and leopard *Panthera pardus* (Bothma & Le Riche) are all based on reviews of previous publications combined with new data. These are all long-term projects and the work of Mills in particular has been most intensive. The work on the lion and leopard, based largely on tracking of the animals and drawing conclusions about activities based on spoor interpretation, highlights the value of this research method in this environment and attests to the skill of the San (Bushman) trackers. These methods have produced data on movements, feeding habits, water use and other activities of these species.

The work on the brown and spotted hyaenas by Mills was more intensive and involved following the animals as well as tracking. Mills has shown clearly how these two closely related species are able to co-inhabit the region by exploiting essentially different food sources.

This places demands on social organisation and behaviour and a functional socio-biological interpretation of a large mass of highly credible data is presented. This is of particular relevance to the conservation status of these carnivores, whose ultimate survival in large, viable populations depends upon the availability of large ranges for them.

A further contribution by Mills on prey selection of the large hunters corroborates the conclusions of Eloff and Bothma & Le Riche. This study looks at the sex and age of the prey animals and is able to draw some interesting conclusions on the ecological separation achieved by the four large predators (lion, spotted hyaena, leopard and cheetah *Acinonyx jubatus*). Selection for different species of ungulates, and for different age classes serves to eliminate a large degree of potential competition between the predators. Mills concludes, as does Eloff in his paper on lions, that predation plays little role in regulating ungulate members. One of the mechanisms by which predation on a species is buffered is the strong selection shown, for example, by lions, leopards and cheetahs for old springbok and in particular males — animals that are surplus to the breeding population.

### *Conclusions*

The proceedings of this symposium have clearly indicated several shortcomings in the research effort in the KGNP. It should, however, be noted that no attempt has ever been made to co-ordinate ecosystem research in the Kalahari and all credit must be accorded to the various scientists who have built up the impressive amount of information now available. However, we must look to the future. The research section of the National Parks Board in particular should have clearly defined goals and a programme to achieve them, both by using its own scientists as well as in co-ordinating the efforts and interests of visiting scientists. Future research should be of two kinds: that which adds to a more complete understanding of the functioning of the Kalahari ecosystem and that which is of direct relevance to the present management of the KGNP.

Research aimed at getting a more complete understanding of the functioning of the Kalahari ecosystem would include the modelling of energy flow through the various components of the ecosystem and the tackling of certain sociobiological issues. For example, the nature and extent of competition and co-existence between and among the diverse carnivore community, as life styles and strategies of carnivores may be more easily studied here than in most other parts of Africa.

For management purposes, and in particular for assessing the potential human impact on the system through fencing, boreholes, roads, alien plant introduction, utilisation of animals and plants, livestock production and the ultimate survival of the conservation areas in their present form, the following issues should be addressed:

1. *Ungulates*: The movements of large ungulates and the mechanisms involved must be thoroughly investigated. The influence of rainfall (acting *via* food) as well as other features of diet (*e.g.* nutritional value and water content of food)

and the size of the range over which KGNP populations move must be defined. Adaptations of the species to survive under arid conditions and their use of natural and man-made water supplies should also be studied.

2. *Vegetation dynamics*: The monitoring of plant communities and plant production relative to rainfall, fire and herbivore use (ungulates, small mammals, birds and insects) should be expanded.
3. *Carnivores*: The dispersal of carnivores from the KGNP into the rest of the system and *vice versa* should be investigated. As the KGNP remains one of the few refuges for large carnivores within the Republic of South Africa the factors controlling their populations should be clarified.