ing, so dispersion has not occurred. The cheetah have increased and in all three reserves have exerted some pressure on the prey species. The population in Suikerbosrand has been best documented (by Howard Pettifer). Here the population reduced the springbuck and blesbuck populations to such an extent that, despite repeated removal of animals by capture, the population had to eventually be removed entirely.

In Itala, cheetah predation has prevented the breeding nucleus of tsessebe from becoming established. Here in Pilanesberg their predation had a significant effect on our 1981 waterbuck calf crop and the population is estimated to be responsible for the deaths of some 700 herbivores *per annum*. Significant in these last examples is that the densities of cheetah are far higher in Itala, Suikerbosrand and Pilanesberg than in any natural population previously described. For example in Pilanesberg it is at least 1:45 sq. km as opposed to 1:72 sq. km in Kruger National Park and 1:102 sq. km in the Serengeti.

What are the reasons for this? The likely answer is that in all these reserves, there are no predators which prey on cheetah *i.e.* lion and spotted hyena. In the Hluhluwe/Umfolozi Complex both these species are present, and the cheetah population has remained stable and at a reasonable level. In S.W.A./Namibia, in the farming areas around the Etosha Game Reserve, cheetah are a problem species and their densities are higher than in Etosha itself. The habitat and prey availability are similar, but lion and spotted hyena are not tolerated in the farming areas.

In a previous issue of Tshomarelo News the problem of the introduced cheetah population was described. In August our Board agreed to our proposal to control their numbers and since then we have tried to recapture the animals. This capture operation has proved unsuccessful and we now have no alternative but to cull selectively in those areas where our rarer antelope are resident. These are our sable (16), tsessebe (8) and waterbuck (*c.*50). We do this in the knowledge that we may attract severe criticism from members of the public. However, to put the situation in perspective, we have recently been offered 50 cheetah delivered here at R 150 each, yet during May the current prices for sable were R 5 250 each, tsessebe R 2 200 and waterbuck R 1 000 each.

To answer the question, whether cheetah can be conserved in small reserves the answer must be "Yes, but ....". Yes, but it must be accepted that in the absence of lion and spotted hyena, cheetah numbers will have to be artificially controlled.

In the long run it must be accepted that it is not cheetah which are endangered, it is cheetah habitat which is limited.

J. Anderson.

R E S E A R C H :

THE PILANESBERG GRAZING SYSTEM - HABITAT USE AND CARRYING CAPACITY WITH SPECIAL REFERENCE TO THE WHITE RHINOCEROS.

The Pilanesberg vegetation has been classified as Sour Bushveld which implies that a majority of the grasses are unpalatable, tufted

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and wiry species. The soils are of high alkalinity with shallow pediment rock. This results in the Pilanesberg vegetation having a number of obviously undesirable characteristics when compared with surrounding Sweetveld areas;

1) A large percentage of the herbaceous vegetation is unpalatable for herbivore consumption.
2) The recovery rate after disturbance, whether by human intervention or overgrazing is predicted to be slow, and
3) The annual primary production is low.

When attempting to estimate the carrying capacity of Pilanesberg, the above important factors must be considered and it is unwise to extrapolate findings from Sweetveld areas.

Over 200 white rhinos (*Ceratotherium simum*) will have been introduced into the reserve by the end of June this year. This amounts to over 300 000 kg of live biomass out of a total of approximately 950 000 kg, *i.e.* just under 30% of the total live biomass is white rhino. Because the impact of the white rhinos on the habitat is substantial, this species is of great importance where management and conservation are concerned. This results because, being relatively inefficient digesters of grass material, their offtake is probably much greater per unit biomass than indicated by their metabolic demands. Consequently, the white rhino numbers in relation to population structure and their impact on the habitat need to be carefully monitored in order to arrive at more refined estimates of carrying capacity.

The concept of carrying capacity has been given much consideration in recent literature and, is defined as an equilibrium between animals and vegetation. We index the position of that equilibrium

by its characteristic density of animals. But, an animal population at carrying capacity should not be thought of as one with a stable or constant level, but rather, as one that is fluctuating between boundaries - no system is static. Therefore, an alternative definition is that a population is at equilibrium or carrying capacity if it can persist while fluctuating within certain limits in that environment over a long period of time.

In order to calculate carrying capacity the following points must be considered;

1) Habitat spatial heterogeneity (*i.e.* the number of habitat types per unit area) is a factor usually omitted, and it has been predicted that a change in habitat diversity results in a change in not only the herbivore diversity, but also the overall carrying capacity.
2) Interactions between different species of grazers, whether positive (facilitation) or negative (competition) must also be considered. For example, two species may forage not only in identical habitats, but also on similar grass species. Therefore, the stocking density of the first species would be dramatically influenced by the presence of the second. Facilitation, although not as important as competition, occurs when the presence of one species enables another species, previously absent, to move in.

The overall objective of this study is therefore to determine the carrying capacity of the reserve for white rhinos at various stocking densities of associated grazers. In order to meet this objective there are a number of prerequisites;

1) To record the spatial distribution and habitat selection, on a seasonal basis, of all the grazers in Pilanesberg. This will enable one to determine 'Habitat Overlap' coefficients of the various grazers with respect to white rhino.
2) To analyze the diet of the various grazing species in order to calculate 'Diet Overlap' coefficients.
3) To record herbaceous composition in the various habitat types.
4) To measure the primary productivity under varying grazing pressures.

The two approaches used in the calculation of carrying capacity of white rhino will be briefly summarized. The first approach is a modification of the standard method used by Collinson and Goodman (refer to the first issue of Inkwe) which categorizes the grazing herbivores into three feeding types. The steps used are as follows. Firstly, the grazing species permissible in the reserve, whether as a result of habitat potential or ease of availability, is reviewed. Once the potential species mix has been established, the carrying capacity of the white rhino, given various stocking densities of other grazers and their respective overlap coefficients, can be calculated. It should be noted that with the use of both Diet and Habitat Overlap coefficients, the division of the herbivores into feeding types, and the reserve into habitat types, as in Collinson and Goodman's method, is now unnecessary.

The following major grazing ungulates at Pilanesberg, in addition to white rhino, are considered to have the greatest impact on the habitat;

1) wildebeest (*Connochaetes taurinus*)
2) hartebeest (*Alcelaphus buselaphus*)

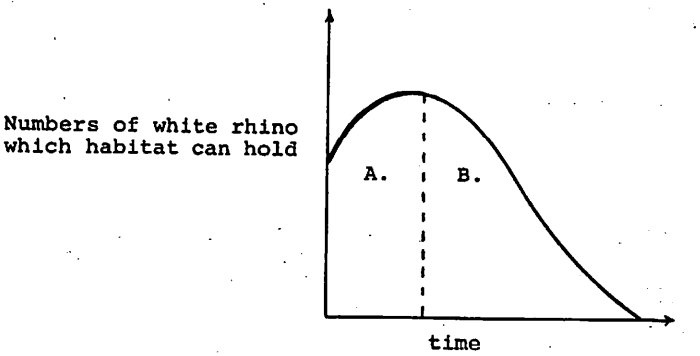
3) zebra (*Equus burchelli*)
4) impala (*Aepyceros melampus*)

A formula similar to the one described below will be used;

$$Q = \left[T - \left[\sum_{i=1}^{n} \left(\frac{Ni \times Ci}{Ai} \right) \right] \right] \times 0.41$$

where, Q = carrying capacity of the white rhino
T = total permissible grazing animal units
i = grazing species, 1.....n
N = number of individuals of species i
C = total overlap coefficient (mean of the Diet and Habitat Overlap coefficients)
A = animal unit equivalents.

The figure below depicts the expected trend over time as associated grazers increase in numbers.



During period A there is a steady increase in the habitat potential for white rhinos as a result of facilitation by other grazers. As the overall density starts increasing further (B), competition plays a major role and fewer rhinos are capable of surviving in the reserve.

A hypothetical example will best illustrate the use of this method. First, let us consider a multi-species system with a total permissible grazing animal units of 1 200. The three associated grazers and their respective stocking densities are 500 zebra, 400 wildebeest and 650 hartebeest. Their respective animal unit equivalents are 1,86, 2,14 and 2,64. The various overlap coefficients of the species relative to the white rhino are;

zebra : habitat = 0,6 (*i.e.* 60% overlap)
diet = 0,5
wildebeest : habitat = 0,8
diet = 0,8

hartebeest : habitat = 0,4
diet = 0,5

Therefore under the above stocking densities the carrying capacity of white rhino would be approximately 325 animals. This value would obviously change if either the animal numbers or the species mix changes.

In the above method it is assumed that the total carrying capacity for an area is known, but in a majority of cases this is not true. The next step is therefore to use a more sophisticated technique which calculates this equilibrium value more accurately than the previous, largely subjective methods. In order to do this a mathematical model will be developed, making use of a number of environmental parameters and their respective interactions. The obvious advantage of using a simulation model is that the affects of applying different management options, *e.g.*culling,hunting, *etc.* can be analyzed.

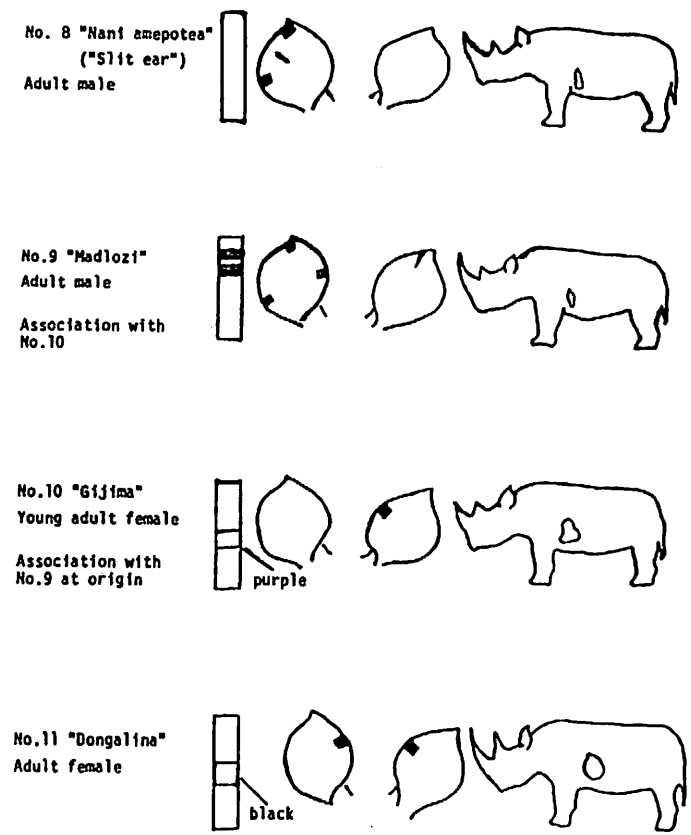
It should finally be noted that although the model will not predict actual trends in the system, it will simulate the behaviour of the parameters modelled and thus lead to a better understanding of the relative importance of different factors in determining carrying capacity. Ultimately, this will lead to better estimates of the total carrying capacity (or equilibrium value) of an area such as Pilanesberg.

M. Borthwick .

N E W B L A C K R H I N O S

Four more black rhino were released in Pilanesberg Game Reserve on 16th May. They comprised two adult males, one adult female and one young adult female. The young female and one of the males were caught close together and had been known by Peter Hitchins to have had an association for some time. They bring the total of black rhinos in the reserve up to 12. Eleven have been released, but one of the females released in September last year had a calf around the end of January.

The rhinos were caught from Umfolozi Game Reserve on the 15th, transported overnight and released near the lower Mankwe valley. They have all been moving considerably since then. The first evening, the two females were close to the Mankwe Dam and the two smaller dams to the east respectively; the males were north and east of Pilanesberg workshops; distances of minimum 4,6,10 and 12 kilometres respectively. Shortly afterwards the young female moved to the area north of Manyane Gate, and subsequently through to Bakubung Gate, then along the southern fence line and into valleys there,a minimum of 43km by the end of May. She had been named "Gijima" (Zulu for the runner) in reference to the distance she moved during darting. She appears to have been living up to that name. The other female, "Dongalina", since she had been stuck in a donga on capture, moved through into the Tlou Drive area,then probably through the Tshukudu Link region to near Bakubung Gate. She then moved back round to the lower Mankwe Valley by the beginning of June. One of the males, who had been north of Pilanesberg, "Nani Amepotea" (which means 'He who was lost' in Swahili, since it had taken us over an hour and a half to find him after he had been darted at Umfolozi), moved along the Tlou Drive Valley to near the fence, then back, and at the beginning of June was along the fence line south of the lower Mankwe Valley, roughly 30 km. The other male "Madlozi" (from the area where he was caught in Umfolozi) moved from east of Pilanesberg, down near Bakubung Gate and then through to the Mankwe Valley, a minimum of 28 km. At the beginning of June three of them were thus within 5 km of where they were released, but had been a long way to get there and may still be moving. They do not however appear to have had any major problems and will probably soon settle. Water, food and cover have not been limiting factors which could have prompted so much movement. The young female has twice been observed disturbed, but the others have usually been eating, sleeping or once travelling, when seen recently.



K. Hillman.