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Utilization of woody browse and habitat by the black rhino (*Diceros bicornis*) in western Itala Game Reserve

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Abstract

Black rhinoceros browse utilization was assessed at the woody plant species and community levels in western Itala Game Reserve, South Africa, using a semi-quantitative, plant-based method. Theis knowledge was used to hypothesize the possible effects of vegetation change on the black rhinoceros (*Diceros bicornis*). *Acacia nilotica, Acacia karroo*, and *Dichrostachys cinerea* contributed most to the diet, and *Cassine transvaalensis, Rhus guenzii*, and *Acacia gerrardii* were the most preferred species. Eighty-six percent of the recorded browse was from plants <2.5 m, suggesting that a change from open woodland, with many trees, to a closed woodland, with a few small trees, would disadvantage black rhino. Plant communities ranged from highly utilized (bottomland scrub forest) to unutilized (*Combretum apiculatum* sparse woodland). The extremely patchy distribution of browse utilization within communities suggests that there are other important factors affecting browse utilization besides plant species composition. It appears that tall grass detracts from browse value, while factors that improve access, such as gentle slopes and paths, enhance habitat suitability. It is hypothesized that forest verges provide important black rhino feeding areas.

Introduction

A comparison of 1947 aerial photographs with those from 1980 shows that a considerable increase in the woody plant cover has occurred in western Itala Game Reserve. The Natal Parks Board is responsible for the management of the reserve and gives black rhinoceroses (*Diceros bicornis*, referred to as black rhinos) high priority (N.P. le Roux, pers. comm., Natal Parks Board, P.O. Box 662, Pietermaritzburg, 3200 Republic of South Africa). In order to predict what the potential impact of bush clearing treatments would be on the black rhinos, some knowledge of the use of the existing vegetation is required. Therefore, a project was undertaken to identify, describe, and map the different woody vegetation types in part of the reserve and assess their relative importance to the black rhinos.

Such an assessment, using an established technique, would be extremely time-consuming and consequently a more rapid technique was required. The chosen technique was one recently developed by Emslie & Adcock (1990).

The objectives in this article are to (1) describe the method for determining utilization of browse by black rhino; (2) present the results of the browse selection assessment, based on individual woody plant species and height classes; and (3) suggest possible implications for management.

Procedure

Study area

This concentrated on a 3 500 ha portion in the southwest of Itala Game Reserve (27°30′S; 31°15′E), which is situated in northern Natal, South Africa. The altitude ranges from 580 m to 1 060 m and the rainfall from 600 mm a^{-1} at the lower altitudes to 1 000 mm a^{-1} at higher altitudes. The study area comprised two veld types, Lowveld and Northern Tall Grassveld (Acocks 1975) and was subjected to extended periods of heavy grazing and browsing by cattle and goats before its proclamation as a conservation area in 1972 and 1974.

The study area contained 13 principal woody vegetation types (Kotze unpubl.) consisting of three main groupings: woodland, forest, and woodland/forest mosaic. Forest refers to a presominantly closed canopy which is short and shrubby (<5 m) with a sparse grasslayer not able to support fire. In contrast, woodland types are generally dominated by savanna species and have a grass layer capable of supporting fire. The only exception was the *Acacia nilotica* transitional woodland which is intermediate between woodland and forest (Kotze 1990).

The diet composition assessment technique

Three main groups of methods by which diet composition of browsers can be estimated were evaluated for their suitability for this study. These were (1) analysis of ingesta or faeces of animals; (2) direct observation of feeding; and (3) the measurement of previously browsed vegetation (plant-based methods) (Barnes 1976).

The analysis of ingesta was not possible as this requires large-scale capturing, or killing, of animals for representative data, whilst the analysis of herbivore faeces is subject to various limitations (Goddard 1968; Monro

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1982). Direct observation of feeding black rhinos was successful in northern Tanzania (Goddard 1968) and Kenya (Goddard 1970). However, as a large proportion of this study area is densely vegetated, it was decided that a direct observation technique was unsuitable and a plant-based method was chosen.

A plant-based method is considered to have a number of advantages over direct observation techniques. These include:

1. Black rhinos may be difficult to find.
2. Observers may cause a change in animal behaviour.
3. Black rhinos spend a considerable time browsing during the night (Owen-Smith 1988; R. Emslie & K. Adcock, pers. comm., Pilanesberg National Park, P.O. Box 707, Rustenburg, 0300 Republic of South Africa) and this is not accounted for by direct observation.
4. Vegetation may obscure feeding animals.

The method relied on the characteristic way in which black rhinos browse, biting off mainly large twigs in a pruning-shear manner (Joubert & Eloff 1971; Emslie & Adcock, pers. comm.). Browse was measured in standardized browse volumes (SBVs), called browse-bottles by Emslie & Adcock (pers. comm.) using photographic standards. Browse offtake (in SBVs) is estimated by comparing the diameter of browsed twigs with unbrowsed branches on the same tree (or a neighbouring tree of the same species and similar size) and then estimating the amount of browse on an equivalent unbrowsed twig.

Pilot study

Due to the patchy nature of the vegetation and the spatially uneven manner in which black rhinos browse, it was necessary to check the adequacy of the browse assessment sample size in a pilot study. All borwsed twigs encountered in 80 randomly placed 90 m × 5 m quadrats was recorded and expressed as SBVs ha^{-1}. The results of this study showed that within-vegetation type variation in average utilization (SBVs ha^{-1}) was exceptionally high (CV > 100%). Because of this low precision, the number of quadrats required for adequate assessment of browse would be prihibitive and a more rapid method was developed. This consisted of 2.5 m wide belt transects, of variable length, semi-randomly located in each vegetation type and orientated perpendicularly to drainage lines. The lengths of the transects depended on the dimensions of the vegetation type at each sampling location.

Determining principal and preferred food species

A preferred food species is proportionally more frequent in the diet than it is available and a principal food is simply that which is consumed in the greatest quantities irrespective of its availability or proportional abundance (Petrides 1975).

To determine the principal and preferred woody plant species and size classes, all browse utilization was recorded in terms of species and size class. Sampling occurred in January and July to account for both seasons, but sample size and the difficulty of determining age of the browsed material did not allow for inter-seasonal comparisons.

In attaching preference values to the different species, a preference index was calculated as the ratio of the total number of SBVs recorded, to the amount of browse on offer, which was in the form of a crude semi-quantitative percentage frequency measure. This was calculated by dividing the 2.5 m wide belt transects into 2.5 m × 10.0 m sub-transects and assigning each species a semi-quantitative abundance value based on its frequency in the sub-transects.

Determining the principal foods simply involved calculating the sum of all recorded SBVs for each species. Although recorded in the field, browse utilization of rare species (relative frequency <3%) was excluded from the assessment as their sample size was considered to be too small to place reasonable confidence in total SBV estimates.

Assessing habitat preference

The relative degree of utilization of the different vegetation types was determined by dividing the total number of browsed units (SBVs) encountered in a given vegetation type by the total area sampled for that vegetation. The results from all belt transects in a given vegetation type were pooled to give the mean utilization level for that vegetation type. Because the sampling units are of variable size, influencing the probability of encountering browse within a given quadrat, they were not subjected to any formal statistical analysis but are presented as averages (Table 2).

Assessing preference variability within woody plant communities

The extremely patchy nature of browse utilization within vegetation types suggests that there are other important factors which affect the utilization of browse by the black rhino.

Browse assessment in *A. karroo—A. nilotica* woodland, which exists predominantly on old croplands, was carried out separately in those transect portions with a tall dense grass cover (dominated by *Hyparrhenia* spp.) and in the area with a relatively short grass cover (maintained by grazers or associated with old kraal sites). Browse assessment in bottomland/scree slope forest was also carried out separately in those transects occurring in steeply incised valleys and steep scree slopes (average slope 32%) and in less incised river valleys (average slope 9%).

Results and discussion

As is the case with the animal-based technique of Goddard (1968), one does not expect the present plant-based technique to give a precise measure of the bulk or volume of plant material consumed. However, because the amounts taken from individual plants are assessed, it is an improvement on simply recording whether individual plants have been browsed or not.

Although the present plant-based technique appears to have several advantages over direct observation techniques, it is important that some of the limitations of this technique are recognized.

1. Certain plant species, particularly the succulent genera such as *Euphorbia* and *Aloe*, as well as those with fine stems (e.g. *Lippia javanica*), could not be considered because they are not browsed in the characteristic way.
2. Black rhinos may browse non-thorny species by running their lips over the twigs (Joubert & Eloff 1971; Owen-Smith 1988) in a manner similar to kudu and giraffe. Consequently, browse offtake from species browsed in this manner would be underestimated.
3. Forbs, which may constitute an important part of the black rhinos' diet, cannot be considered as they are not browsed in the recognizable way owing to their herbaceous nature.
4. It is impossible to tell by looking at a utilized plant exactly when that utilization occurred. In this study, utilization that occurred long before the assessment (indicated by partial decomposition of the end of browsed branches or by bud growth as a response to browsing) was not recorded.

Preferred and principal woody plant species

The contribution of the individual woody plant species is such that the ten most frequent species made up 80% of the measured diet (i.e. excluding herbaceous and unconsidered woody plants) (Table 1). Most of the principal species, such as *A. nilotica*, which contributed the most (18%), had intermediate preference ratings.

Food preference varied considerably, ranging from highly preferred species such as *Ehretia rigida* to non-preferred species such as *Rhus lucida* (Table 1). An investigation of size class preference showed that 86% of the browse was taken from small plants (<2.5 m). This is consistent with the findings that black rhinos' preferred browsing level is between 0.5 and 1.2 m (Owen-Smith 1988) and that small plants are preferred (Emslie & Adcock 1990). The diet composition results are similar to those obtained by Emslie & Adcock (1990) who found that some less common species such as *Acacia gerrardii* were the most preferred and the more widespread species such as *Dichrostachys cinerea* were the principal diet species. While this assessment of the black rhinos' diet may be an over-simplification, it does provide an approximation on which to base management decisions.

Table 1 Contribution of individual woody species, listed in order of decreasing preference, to the diet of the black rhino (*Diceros bicornis*)

Species	Total percentage contribution
Ehretia rigida	7.6
Cassine transvaalensis	1.5
Rhus guenzii	2.5
Acacia gerrardii	5.9
Berchemia zeyheri	4.6
Scolopia zeyheri	4.9
Maytenus nemorosa	7.0
Acacia nilotica	18.4
Dalbergia armata	1.1
Coddia rudis	7.3
Dichrostachys cinerea	11.2
Acacia karroo	10.5
Ziziphus mucronata	0.8
Grewia occidentalis	1.7
Acacia caffra	2.7
Ormocarpum trichocarpum	1.8
Dombeya rotundifolia	1.8
Euclea schimperi	2.4
Rhus lucida	0.8
Other species	5.5

Habitat preference

The degree of utilization of the different vegetation types by black rhinos varied from zero in *Combretum apiculatum* sparse woodland to high in bottomland/scree slope forest, moist forest, and *A. nilotica* transitional woodland (Table 2). A tentative conclusion, based on this, would be that management action taken to encourage an increae in the woody plant component and the development of open acacia-dominated woodland into forest, would favour the black rhino. However, if this could be achieved it would not necessarily be to the advantage of black rhinos because the value of a given area for providing black rhinos with browse is no solely dependent on the relative proportions of the different vegetation types occurring in that area. Instead, the distribution pattern of these different vegetation types may also be important.

In the moist forest-*A. karroo*-*A. nilotica* open-sparse woodland mosaic, for example, black rhinos obtain more browse from the forest component of the mosaic than from the open/sparse woodland component. This suggests that an increase in the forest:woodland ratio would increase the carrying capacity for black rhinos. Although not quantified, it was observed during the browse assessment that a large porportion of black rhinos' browsing occurs at forest verges. Thus, if the forest:woodland ratio were to increase, resulting in the amalgamation of forest patches and a decrease in the amount of forest verge, the predicted increase in value for black rhinos would be less than that predicted using the results of this study. It would appear that a similar situation exists with regard to the bottomland/scree slope forest. The present distribution pattern of this vegetation type is long, narrow strips which, if they were to expand, would not increase the amount of forest verge. Thus, a higher resolution study is required to accurately predict the consequences of forest expansion for the black rhinos.

In contrast to the other forest communities, the *Olea europaea* forest and *Olea europaea* forest–sparse woodland mosaic appear to have inherently low value browse sources for black rhinos. It seems that this is due to the dominance of plant species with low and intermediate browse preferences (such as *Olea europaea* subsp. *africana*) in the forest component, and the very low abundance of browse in the sparsewoodland component. *Acacia caffra* sparse woodland and *C. apiculatum* sparse woodland both have the lowest value with regard to the provision of browse for black rhinos. It is likely that this is simply due to the low abundance of browse in these vegetation types. The extremely shallow nature of the soils in these vegetation type areas suggests that the potential for these areas to support woody vegetation is lower than that for most of the other vegetation types within the reserve.

Although no significant differences were shown (owing to the extremely high within-vegetation type variation) the browse value of open *A. nilotica* woodland appears to be greater than that of closed *A. nilotica* woodland, which has a greater ratio of large to small woody plants. The results of the browse assessment, as well as the browse preference results from Hluhluwe (Emslie 1989; Emslie & Adcock 1990), show clearly that black rhinos obtain the majority of their food from smaller plants (<2.5 m). Any management action taken to prevent the development of *A. nilotica* open woodland to closed woodland should therefore be to the advantage of (or at least not be detrimental to) black rhinos.

Disturbed areas surrounding old kraal sites are dominated by acacia thickets of the *A. karroo–A. nilotica* sparse/open woodland. These generally have a low value in terms of provision of blsck rhinos' browse because of tree size (>2.5 m). If some of these areas were cleared or thinned, the recruitment of young acacias should occur, and so increase the amount of available browse.

Browsing variability within habitats

In the *Acacia karroo–Acacia nilotica* sparse/open woodland, utilization (SBVs ha^{-1}) was shown to be substantially lower than in the areas with a tall grass cover compared with areas with short grass cover (Table 2). This is despite the fact that the species composition and physiognomy of the woody plants is fairly uniform throughout the vegetation type. Thus, it appears that, as shown by Emslie (1989), tall grass decreases browse utilization by interfering with browsing behaviour. Consequently, any management action taken to try and encourage the development of patches of shorter grass within the tall grass is likely to favour the black rhinos.

Table 2 The vegetation communities of the western Itala Game Reserve based on the classification of proportional species composition and the degree of utilization (SBVs ha^{-1}) and inferred browse value for black rhino (*Diceros bicornis*)

Vegetation types	Utilization (SBVs ha^{-1})	Browse value
Acacia karroo–A. nilotica		
sparse/open woodland	60*	moderate
(with long grass)	38	
(with short grass)	130	
A. nilotica open woodland	60	moderate
A. nilotica closed woodland	40	moderate
A. nilotica–Dombeya rotundifolia		
open woodland	55	moderate
A. caffra sparse woodland	5	very poor
Combretum apiculatum sparse woodland	0	very poor
A. nilotica transitional woodland	110	good
Moist forest–*A. karroo–A. nilotica*		
open/sparse woodland mosaic	125	good
Bottomland/scree slope forest	130*	good
(with gentle slopes)	223	
(with steep slopes)	59	
Olea europaea forest	20	poor
Olea europaea forest–sparse woodland mosaic	10	poor
Olea europaea forest–moist forest–		
A. nilotica transitional woodland mosaic	40	moderate

*Figures are weighted averages based on proportional area of habitat

The results from the bottomland/scree slope forest show that utilization appears to be substantially lower in the steeply sloped transects (Table 2). Again, woody plant species composition and physiognomy are relatively similar in the two subdivisions. This suggests that factors such as slope and abundance of paths, which affect the accessibility of a given area, may have an important influence on the degree to which certain parts of the reserve area are utilized by black rhinos.

Conclusions

Although it seems that this study has provided a reasonable approximation of the black rhinos' woody plant preferences in the study area, the following important potential sources of bias should be considered.

1. Herbaceous and succulent plants were not considered.
2. Browse utilization by black rhinos may very considerably with time (i.e. the rank order of the vegetation types may change if the assessment were to be carried out in another year).

3. Browse utilization by black rhinos is spatially very uneven in space requiring a high sampling intensity.

While it cannot be stated conclusively what the general effects of the increase in the woody plant component will be, two hypotheses, requiring formal testing, are offered:

1. Where an increase in the woody plant component results in the development of an open *Acacia*-dominated woodland into a closed *Acacia*-dominated woodland, then this will detrimentally affect the black rhino because density of small acacias (<2.5 m) decreases as the open woodland becomes closed.

2. Where the increase in the woody plant component results in the development of an open *Acacia*-dominated woodland into a moist forest or a bottomland/scree slope forest, then the increased value to the black rhino would not be as great as this study might suggest. This is because the importance of such factors as the amount of forest verge was not considered.

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