Selected papers

Proposed conservation plan for the black rhinoceros *Diceros bicornis* in South Africa, the TBVC[1] states and Namibia

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The conservation plan for the black rhinoceros presents specific aims and management guidelines for the conservation of the African black rhinoceros *Diceros bicornis* in the Republic of South Africa, the TBVC states and Namibia. The adoption of this plan, and the application of the strategies described therein (managing existing populations, establishing new populations and aspects of captive breeding) by the relevant conservation authorities should enhance the survival prospects of this species, both in the region and globally.

Key words: Black rhinoceros, *Diceros bicornis*, management, South Africa, Namibia, conservation plan, strategy.

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Introduction

The black rhinoceros *Diceros bicornis* (Linnaeus, 1758) is restricted to the African continent where it was widely distributed in the sub-Saharan region. Although early records lack detail, it is clear that the black rhinoceros has suffered a very severe decline in numbers and in the extent of its range since the turn of the century. It is currently listed as 'vulnerable' both globally and in South Africa (IUCN and South African Red Data Books).

The recent trend has been dramatic, with numbers dropping from an estimated 65 000 in 1970, to 15 000 in 1982, 9 500 in 1984 (distributed between 18 countries), down to 6 000 in 1985 and about 3 800 in 1987. This represents a decline of over 90 percent in the last 17 years. In 1970 the Selous National Park in Tanzania held more black rhinoceros than currently survive on the whole of the continent today. In recent years the black rhinoceros has either disappeared from, or is on the verge of extinction in 12 African countries (Cumming 1987). It is now only found in reasonable numbers (i.e. more than 100) in Zimbabwe, South Africa, Namibia, Tanzania, Kenya and Zambia.

[1] Republics of Transkei, Bophuthatswana, Venda, and Ciskei.

Poaching for horn is very largely responsible for this massive decline; and the southern sub-continent, where more than two thirds of the remaining black rhinoceros are conserved, is coming under increasing pressure with the first substantial poaching of rhinoceros taking place in the Zambezi Valley, Zimbabwe, in 1985.

The black rhinoceros was formerly widespread throughout most of South Africa, but by the 1930s it had been reduced to two relict populations comprising 100 to 150 rhinoceros of the southern-central subspecies *Diceros bicornis minor* (Drummond, 1876) in Hluhluwe-Umfolozi and Mkuzi game reserves in Zululand. Numbers increased under protection, so that by 1962 the Natal Parks Board was able to translocate animals to form new populations in reserves within their former range. By the end of 1987, a total of 150 black rhinoceros had been moved to reserves within Natal, as well as to re-establish the subspecies in the Pilanesberg and Kruger national parks (Hitchins 1984), and the Andries Vosloo Kudu Reserve in the Cape Province. A further seven have been supplied for captive breeding programmes in the United States of America. The re-establishment history of *Diceros bicornis minor* in the region is presented in detail in Appendix 1.

In Namibia a significant population of the arid zone *Diceros bicornis bicornis* (Linnaeus, 1758) survived in the Etosha National Park and relict populations elsewhere in Kaokoland/Damaraland. In 1985, the Directorate of Nature Conservation and Recreation Resorts in Namibia agreed to relocate 12 rhinoceros from Etosha to two reserves in the arid northwestern Cape region, namely the Augrabies Falls National Park and the Vaalbos National Park (Hall-Martin 1985, 1986).

There are currently about 990 black rhinoceros in the wild in South Africa, the TBVC states and Namibia (hereafter termed "the region"). These comprise just over 580 *Diceros bicornis minor* distributed between nine reserves, about 390 *Diceros bicornis bicornis* occurring in four reserves or areas, and a small but expanding population of *Diceros bicornis michaeli* Zukowsky, 1964 in the Addo Elephant National Park (see Table 1 for details).

In international terms, these populations are becoming increasingly important, not only because they represent more than 25 percent of the surviving world population, but also because they are the only ones to have expanded both in numbers and distribution in recent years.

Table 1
Current (1988) population sizes of black rhinoceros in the region (Key: 1-6 denotes the controlling bodies which are given in the text)

Subspecies	Location	Population size
D. b. minor	[1] Hluhluwe-Umfolozi Game Reserve	220
	[2] Kruger National Park	160
	[1] Mkuzi Game Reserve	70
	[4] Ndumu Game Reserve	42
	[1] Itala Game Reserve	35
	[5] Pilanesberg National Park	27

	[1] Eastern Shores Nature Reserve	15
	[1] Weenen Nature Reserve	7
	[5] Andries Vosloo Kudu Reserve	4
	(Private land — Eastern Transvaal)	1
		Total: 581
D. b. bicornis	[3] Etosha National Park	300
	[3] Kaokoland/Damaraland	80
	[2] Augrabies Falls National Park	6
	[2] Vaalbos National Park	6
		Total: 392
D. b. michaeli	[2]Addo Elephant National Park	18
		Total: 18

In recent years it was generally accepted that the surviving rhinoceros in Africa represented four subspecies, namely *Diceros bicornis minor* (southern Africa), *Diceros bicornis bicornis* (Namibia), *Diceros bicornis michaeli* (East Africa) and *Diceros bicornis longipes* Zukowsky, 1949 (West Africa). This has recently been challenged and a taxonomic review is under way. However, it was agreed at the African Rhino Workshop (Cincinnati, October 1986) that, for practical management purposes, four basic ecological groupings should be recognised. These were the south-western (Namibia), southern-central (South Africa though Zimbabwe and Zambia to southern Tanzania), north-eastern (Kenya and northern Tanzania) and north-western (Cameroun, Central African Republic) groups, which accord closely with the subspecies breakdown given above. The workshop recommended that both *in situ* and captive management programmes should attempt to maintain the integrity of these ecotypes, i.e. they should not be allowed to interbreed, unless future genetic and other studies indicate that this separation is unjustified.

At its meeting in Zimbabwe in September 1985, the African Elephant and Rhino Specialist Group (AERSG) of the IUCN agreed that all countries should draft national conservation plans for the black rhinoceros. These would identify the key concerns requiring action, afford the countries concerned the opportunity critically to evaluate them and provide guidelines for future management action. The southern African representative for the AERSG, Dr. P.M. Brooks, was therefore tasked with developing the plan. This was undertaken with the assistance of other South African members of AERSG, namely Dr. J.L. Anderson (KaNgwane), Dr. A.J. Hall-Martin (National Parks Board) and Mr. P.M. Hitchins (KaNgwane), and other conservationists, in particular Dr. E. Joubert (Namibia), Mr. R.F. Collinson (Bophuthatswana), Mr. P.S. Goodman (Natal Parks Board) and the Hon. Richard Emslie (consultant ecologist).

The "Conservation plan for the black rhinoceros *Diceros bicornis* in South Africa, the TBVC states and Namibia" provides detailed information on the current rhinoceros populations and their management history, and presents

clear conservation aims for each of the three subspecies represented. The adoption of common policy and management guidelines by the relevant conservation authorities, in conjunction with the specialist advice and co-ordination provided by the Rhino Management Group (RMG), should enhance the survival and growth prospects of these populations in the region. This is considered necessary, as the current rhinoceros populations are controlled by no fewer than six conservation bodies: the Natal Parks Board[1], the National Parks Board[2], the Department of Agriculture and Nature Conservation of Namibia[3], the KwaZulu Bureau of Natural Resources[4], the Cape Department of Nature and Environmental Conservation[5] and Bophuthatswana National Parks Board[6].

Participation in the black rhinoceros conservation programme (such as eligibility to receive surplus animals) by any conservation body would depend on its adoption of the conservation plan and observance of the CITES regulations pertaining to the trade in rhinoceros products.

While the conservation plan is restricted to South Africa, the TBVC states and Namibia, it is hoped that this co-operative approach will extend to the whole of the southern African region, including Botswana, Malawi, Mozambique, Zimbabwe and Swaziland. The adoption of national plans by these countries would form the basis for discussions on closer liaison regarding black rhinoceros conservation.

Aims

It is important that the conservation management programme for black rhinoceros in the region has clear aims which are accepted by all the relevant conservation bodies, and that it is undertaken co-operatively.

Internationally, it has been agreed that the medium-term aim is the maintenance of a large population of at least 2 000 rhinoceros of each of the four recognised ecological types, this being required to ensure long-term genetic viability. Smaller populations will lose genetic diversity in time, although this loss will be minimised if population growth is rapid.

Most of the rhinoceros in South Africa belong to the southern-central ecotype, currently recognised as *Diceros bicornis minor*, which also occurs in Zimbabwe, Zambia and southern Tanzania. Together they number just over 2 000 animals, of which about 580 occur in our region (see Table 1). However, there are two reasons why, while co-operating at all levels possible with our northern neighbours, we should take steps to ensure that a viable population is maintained within South Africa itself, and not depend on the populations to the north for long-term viability. The reasons are, firstly, that the Zambian and Tanzanian rhinoceros have already been depressed to critically low numbers and the large Zimbabwean population (*ca.* 1 600) has recently been experiencing heavy poaching pressure; and secondly, that political differences may prevent any interchange of animals across the Limpopo.

The south-western ecotype *Diceros bicornis bicornis* only occurs in Namibia and the south-western Cape, so clearly the responsibility for maintaining a viable population rests solely with the conservation bodies in the region.

The primary aims for the conservation of black rhinoceros in the region are:

- To develop, as rapidly as possible, and conserve in the long term, a genetically-viable population of at least 2 000 black rhinoceros of the southern-central ecotype *Diceros bicornis minor* in its natural habitat in the region.
- To develop, as rapidly as possible, and conserve in the long term, a genetically-viable population of at least 2 000 black rhinoceros of the south-western ecotype *Diceros bicornis bicornis* in its natural habitat in the region.
- To develop, as rapidly as possible, and conserve a population of at least 100 of the north-eastern ecotype of black rhinoceros *Diceros bicornis michaeli* in the wild in the region.
- To support captive breeding programmes for all three subspecies, both within and outside the region and the African continent, providing they can play a significant and sustained role in maintaining or improving the conservation status of the species.

Role of the Rhino Management Group

The conservation management programme and other related programmes described in this conservation plan will be co-ordinated by the Rhino Management Group. The group, which will comprise one representative from each organisation actively involved in black rhinoceros conservation management (currently the six bodies with black rhinoceros populations specified in the Introduction) and selected rhinoceros specialists, will act in an advisory capacity for the various nature conservation authorities by:

— updating the conservation plan as new strategies and procedures are developed;
— evaluating the effectiveness of management programmes being applied and providing advice for their improvement;
— assessing the relative importance of potential new areas for black rhinoceros establishment;
— recommending rhinoceros offtakes and relocation areas in accordance with policy laid down in the conservation plan; and
— developing and co-ordinating an integrated research programme to meet the conservation needs of the species.

Each conservation body will be required to provide an annual report on the black rhinoceros populations under its control to the Rhino Management Group. This should be submitted by 1 March for the preceding calendar year, and will include information on the latest population estimates (including details of methods and dates), population structures, the marking of rhinoceros, personal history records, births, re-establishment exercises, mortalities, poaching and any cases of the illegal trade in rhinoceros products.

The group will meet at least once each year to discuss these annual reports and other priority issues, and recommendations will be forwarded to the relevant conservation bodies for their consideration.

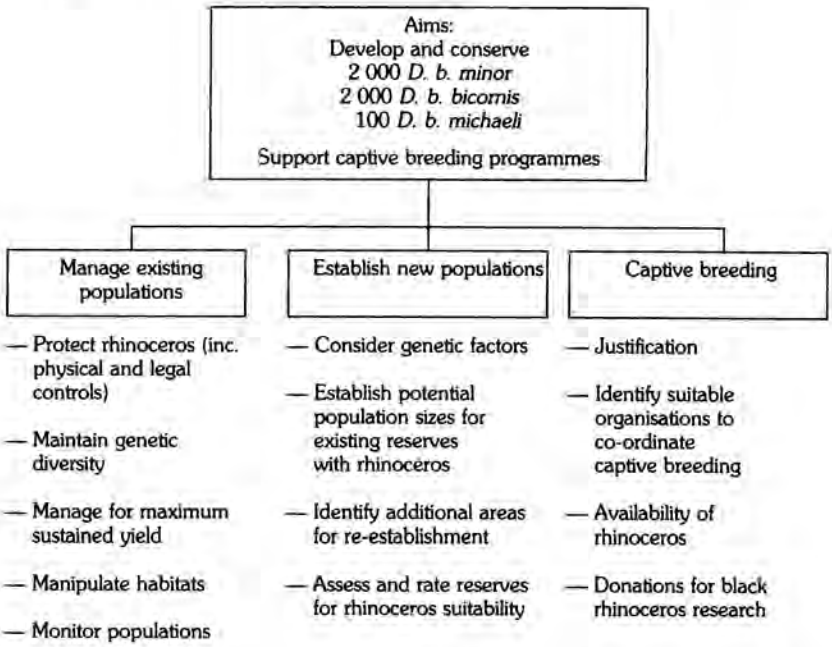
Conservation Management Programme

The philosophy underlying the conservation aims for the black rhinoceros is based on the perceived need to prevent extinction due to man-induced changes and to maintain the evolutionary potential of the species.

The actions most essential for achieving these conservation aims are the management of existing populations, the re-establishment of new

populations and the support of captive breeding programmes. The rhinoceros need to be protected, their habitats conserved and the species managed to maximise the rate of population increase and to maintain genetic diversity.

These, and other related actions and needs, are summarised below and are elaborated on later in this paper.



1. *Management of existing populations*

The survival of black rhinoceros in their natural habitats is the key aim of both this "Conservation Plan" and the "Continental Strategy for the Conservation of Black Rhino" (AERSG draft, July 1986).

The black rhinoceros populations and their habitats need to be managed to protect the current resources, to maximise recruitment and survival so as to provide animals for re-establishment elsewhere, and to maintain genetic diversity. At the very least, recruitment into the adult population from breeding must balance the animals lost.

(i) Protection of rhinoceros populations

The major threat to the rhinoceros populations in the region, as elsewhere in Africa, is illegal hunting for the horn. Their survival therefore depends largely on the ability of the relevant conservation bodies to control poaching through direct law enforcement supported by intelligence work and adequate legislation, and through national and international trade bans and propaganda campaigns.

(ii) Legal status

The legal status of the black rhinoceros and the penalties for illegally

killing, or trading in rhinoceros products, varies throughout the region. The species is classified as Protected Game in the Transvaal, Specially Protected Game in Natal, Bophuthatswana, Namibia and KwaZulu, and as an Endangered Species in the Cape. The penalties for a first offence vary from maxima of R200 or 200 days imprisonment (KwaZulu) to R100 000 or 10 years (Bophuthatswana). Apart from Bophuthatswana, the next highest penalties are found in Natal (R2 000 or 2 years) and in the Transvaal (R3 000 or 1 year).

There is a clear need to standardise the legal status, and in particular to increase the penalties for illegal activities throughout most of the region. This is supported by the recommendation from the CITES meeting held in Canada, July 1987, namely that "... an increase in penalties for individuals/companies convicted of relevant (rhino) offences ... is one of the measures necessary to halt the catastrophic decline in numbers throughout Africa".

The Natal Parks Board has motivated for such an increase, to bring legislation in line with that operating currently in Zimbabwe (min. Z$15 000 or 5 years) and Bophuthatswana (maximum R100 000 or 10 years), and the National Parks Board is taking similar action. The other conservation bodies are urged to do likewise to ensure that the penalties operate as a significant deterrent.

(iii) Control of trade

While South Africa is the only signatory to the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) in the region, the TBVC States and Namibia also abide by the CITES regulations. The black rhinoceros is listed under Appendix 1 of the agreement, which effectively means that any trade in rhinoceros products is banned. Hunting trophies may, however, be exported under a CITES permit issued by a relevant conservation body, although hunting of the black rhinoceros is currently not allowed in any country in Africa.

(iv) Anti-poaching

The poaching of rhinoceros for its horn is sporadic and of low intensity in the region, and is not associated with well-organised, armed gangs as in the rest of Africa. However, there are no grounds for complacency, and conservation authorities need to be constantly on the alert.

Efficient and intensive ground surveillance is clearly essential to detect illegal activities within reserves, but because the levels of poaching can be difficult to determine, this cannot work independently of intelligence work in the surrounding areas and information on the rhinoceros populations themselves.

Procedures are particularly required to ensure that the causes of death of rhinoceros in the field are adequately investigated and, once the horns have been collected, that the carcasses cannot be mistaken at a later date (see Rhinoceros mortalities). The security of the horns is also important, and the effectiveness of safes or strongrooms used for storage needs to be evaluated accordingly.

Close monitoring of rhinoceros numbers also provides invaluable information. Census techniques should be precise enough to detect clear trends, and any unusual declines investigated (see Monitoring black rhinoceros populations).

Intelligence work comprises obtaining inside information, investigating any possible illegal activities (including trade) and co-ordinating the activities of, or co-operating with, a variety of law enforcement and conservation agencies. The adequacy of such operations needs to be constantly re-evaluated.

(v) Maintenance of genetic diversity

It is important that the potential genetic concerns for the black rhinoceros be kept in perspective with the other factors affecting the conservation of the species, such as the need for physical protection. Genetic management should therefore be viewed as a long-term insurance policy should the protective and other conservation measures succeed. However, as genetic considerations give direction to, while not dictating, the management programmes described in this plan, a brief overview of these considerations is warranted.

The major genetic concern relates to the size of the black rhinoceros populations in the region, with only three of the 14 populations numbering more than 100 individuals (see Table 1). The loss of genetic variability in such small populations is a potential threat to their survival, and so, in the absence of specific information on the genetic characteristics of our black rhinoceros populations, an attempt has been made to draw up sound conservation management guidelines based on genetic principles. This was undertaken at a CSIR workshop entitled "Population genetics for conservation management", which was held in Pietermaritzburg on 7-9 July 1987. The following (abridged) guidelines for the genetic management of existing populations were forthcoming:

- The management goals of 2 000 *Diceros bicornis minor* and *Diceros bicornis bicornis* should be achieved as rapidly as possible, as this would provide the best insurance against significant loss of genetic diversity. Similarly the rapid expansion of the population of *Diceros bicornis michaeli*, albeit to a lower target level, would also minimise genetic losses.
- Until the population targets are reached for the various subspecies, each population should be managed at a level below ecological carrying capacity to maximise rates of increase.
- An alternative short-term (+ 200 years) strategy would be to interchange animals between sub-populations at the rate of one per generation, as this would maintain a large proportion of genetic diversity. However, this approach is not currently recommended as the same results can be achieved through the first option given above, with less disturbance and without the risks inherent in relocating animals into high density situations.
- An effective population size (Ne) of 50 represents a critical threshold. Below this, the rate of loss of genetic diversity exceeds 1 percent per generation, which is highly undesirable.
- Random gene flow is undesirable, and the exchange of individuals of different subspecies or ecotypes should not be undertaken under any circumstances, including the impending total collapse of any of the ecotypes.
- The selective removal of individuals is useful for maintaining heterozygosity in very small populations for which pedigrees are available. This requires personal history records to be kept for, and possibly nuclear DNA fingerprinting to be undertaken on all rhinoceros in small populations.

The genetic considerations applying to the establishment of new populations are presented separately (see below).

(vi) Managing populations for maximum sustained yield

Four reserves in the region, namely Hluhluwe-Umfolozi, Mkuzi, Ndumu (Hitchins 1984) and Etosha have provided black rhinoceros for re-establishment into other reserves. These removals have been conservative, with the only capital reduction taking place in Hluhluwe-Umfolozi in an attempt to drop the population below ecological carrying capacity and hence to stimulate breeding and survival (Brooks, Whateley & Anderson 1980). In Ndumu, which has a rate of population increase of 8-9 percent per annum (Conway & Goodman, *in review*), removals of 5 percent are implemented each year; while in Mkuzi, such removals average 3 percent each year, although in this case the addition of more land has enabled the population to expand in both size and range. Translocations from Etosha have, so far, been limited to the 12 animals supplied to the National Parks Board since 1985.

To achieve the primary conservation objectives for the species, it is essential to manage all the black rhinoceros populations for maximum sustained yield. Such management would ensure that both the rates of population increase and the numbers of rhinoceros available for relocation would be maximised. However, we currently lack the information on the response of black rhinoceros populations to different levels of harvesting under changing environmental conditions required to design such a programme.

The Rhino Management Group will consider the options available for maximising the production of rhinoceros for translocation, and will forward recommendations to the relevant conservation authorities for their consideration.

These options are:

(a) An adaptive management approach. Three or more levels of removal intensity are applied to different populations for at least two generations to determine equilibrium offtake. This would test the partial compensation model that Caughley (1985) suspects will be appropriate for most large herbivores in fairly stable environments. Such experimentation should ultimately provide the best basis for sound management.

(b) Fixed stocking rate strategy. This could be applied to the rhinoceros population in each reserve at a level below the ecological carrying capacity, i.e. below the threshold equilibrium level at which negative feedback from the food resources, social interactions and other environmental factors significantly reduces the rate of population increase, but at a sufficient density to ensure that all available females are mated. The optimum stocking rate could be fixed at about 75 percent of the estimated ecological carrying capacity, with numbers being permitted to build up by 5-10 animals, depending on overall population size, before removals take place. These periodic removals which, for the smaller populations, would take place at 3-4 year intervals (assuming a 4 percent annual rate of increase), would optimise the efficiency and cost-effectiveness of the removal programmes, would minimise the disturbance to the animals and would allow time for annually-repeated surveys to provide reliable

population estimates or trends. Such management would have to be based on accurate population estimates, particularly where the black rhinoceros populations are small (see Monitoring black rhinoceros populations). The implementation of this strategy would, assuming a 4 percent rate of increase, provide about 150 black rhinoceros for translocation in the first ten years from Hluhluwe-Umfolozi, Mkuzi, Ndumu and Itala Game Reserves (see Appendix 2).

(c) Recruitment rate. Age structure is a good performance indicator, both within and between populations (see Monitoring black rhinoceros populations). Such information can assist decision-making either by itself, as in Brooks *et al.* (1980), or in conjunction with other strategies, such as (a) and (b) above. For example, removals or increased removals might be indicated should certain threshold levels of calves or immatures not be reached over a period of years.

(vii) Habitat manipulation

The aim of habitat manipulation would mainly be to counter any adverse effects that vegetation change within a reserve might have on its ability to support black rhinoceros. Any persistent deterioration would not only threaten the survival of the rhinoceros in the reserve, but would also adversely affect the regional programme through a reduced rate of increase and fewer becoming available for translocation.

Management must be able to detect any significant declines in ecological carrying capacity for black rhinoceros and, if this is considered to threaten the achievement of the conservation goal for the species, it must be prepared to take appropriate action. This might comprise an immediate capital reduction to stimulate breeding and increase survival rates, possibly followed by habitat manipulation. The possibility of setting aside special rhinoceros reserves and managing the habitat specifically for the species could also be considered. Clear guidelines on how to improve habitat suitability for black rhinoceros are not currently available, but a study being undertaken in Zululand (Emslie 1987) should provide direction.

(viii) Monitoring black rhinoceros populations

To achieve the stated aims for the black rhinoceros, as presented in Aims (see above), information is required on the size and dynamics of each population, the causes, and extent, of mortality and long-term genetic fitness.

The details of each programme will vary according to the characteristics of the area, its rhinoceros populations and financial or manpower constraints, but certain minimum requirements need to be met, namely:

(a) An absolute estimate of population size, or a precise index of abundance, with performance indicators at least every 3 years, but preferably annually.
(b) Detailed rhinoceros-death records indicating numbers, location and causes of death.

All monitoring programmes need to be strictly controlled, and appropriate techniques applied, if they are to be effective in supplying the information required by management. Monitoring guidelines are given below along

with recommended procedures developed specifically for the black rhinoceros programme.

(ix) Population estimates

The accuracy, or precision, of estimates and their frequency will determine their use to management. The requirement is for accurate estimates (or at least precise indices of abundance) that allow the sizes, or trends, of the rhinoceros populations to be assessed at intervals of 1-3 years, but preferably annually.

Various census techniques are suitable for counting black rhinoceros, their selection depending mainly on the number and density of animals present.

(a) Known animals: highly suitable for small populations (less than 100) where every individual is recognisable through ear notching (see Marking rhinoceros for individual identification) or natural characteristics, e.g. sex, age, horn, scars, sores, ear tears or damaged tails. Estimate is accurate, and allows precise management through personal history records kept on all individuals (see Personal history records).

(b) Mark-recapture: estimates based on pattern of resightings of individually-recognisable rhinoceros seen on successive surveys. Most suitable for small to medium-sized populations (50-150) at moderate densities. Estimate has confidence limits, with accuracy depending on sampling design.

(c) Line transect sampling (Burnham, Anderson & Laake 1980). Suitable for large populations (100 +) that are evenly distributed. Estimate is precise (potentially biased) with confidence limits, thereby giving reliable trends.

Aerial techniques, except when used in (a) or (b) above, are not sufficiently accurate or repeatable (precise) for use on black rhinoceros populations in heavily-wooded areas (Knott & Brooks 1986).

(x) Recruitment rate

A variety of limiting factors may operate to reduce the rate of population increase in growing populations and to determine the level at which ecological carrying capacity is reached. These factors do not necessarily need to be identified nor the rate of increase determined because, providing adult mortality is not abnormally high (e.g. significant poaching), the rate at which young rhinoceros are recruited into the population can provide a good measure of the population's performance. This is because population regulation normally operates through reduced breeding and increased mortality amongst calves and immatures.

The age structure of each population should be monitored annually, either by ground or aerial sampling, or through the maintenance of personal history records.

The field criteria for ageing immature black rhinoceros are described by Hitchins (1970), and are presented in pictorial form on the reverse side of the form presented in Appendix 6. These should be strictly followed when undertaking surveys. The minimum requirement is to differentiate three age classes, namely 0-1 year (size classes A and B), 1-2 y (C) and 2 y +

(D, E and fully grown); while specific studies should attempt to identify all five calf and immature classes (A — E) and fully-grown adults (F).

Information collected at either level allows not only the performance trend of a population to be followed as rhinoceros densities and habitat conditions change, but also provides comparative information between populations on which management decisions can be based.

(xi) Personal history records

Detailed records of individual rhinoceros can provide a wealth of information useful to management. The regular sighting of known individuals provides data on reproduction (age of first parturition, calving intervals, mating, lineage), movements (home range size, dispersion), territorial behaviour (indicating reproductive dominance), numbers, density (high and low density zones to guide removals and re-establishments respectively), body condition (after Keep 1971), and survival and mortality (vulnerable ages, problem regions which can give early warning of poaching, and seasonal or cyclical peaks).

For such personal history records to be effective, individual rhinoceros must be clearly identifiable to a number of observers. The best way to achieve this is to mark the animals, and the recommended method is ear-notching (see below).

Once an individual becomes recognisable, a personal history record sheet is drawn up (see Appendix 3). This records the characteristics of the animal, its origin, each resighting and a variety of behavioural observations. These records may then be entered into the Natal Parks Board mainframe computer in Pietermaritzburg, and analysed on an annual basis.

(xii) Marking rhinoceros for individual identification

(a) External characteristics

It is recommended that all rhinoceros immobilised for research purposes, treatment or translocation be individually ear-notched according to the system described below. Ear-notching of additional animals specifically for monitoring purposes is also highly desirable. The presence of marked animals not only facilitates censusing, but also allows individual records to be kept of the individual's behaviour, reproductive performance and lineage which can assist management.

The marking system utilises V notches (2,0 cm — 2,5 cm deep) and occasional "triangular" notches cut from the perimeter of the ears, and also single holes (diameter 1,0 — 1,5 cm) through one or both ears. Treating males and females separately, this system allows for the individual marking of 764 rhinoceros of each sex (1 528 rhinoceros in all) without duplication. A detailed description of the marking system is given in Appendix 4.

Numbers are allocated to each reserve with a black rhinoceros population to avoid duplication either within or between reserves as shown in Appendix 5. A previously unmarked rhinoceros being relocated to another reserve would be marked using a number allocated to the donor reserve.

(b) Cryptic labelling

Techniques are being investigated for the cryptic labelling of both black rhinoceros horns (on live animals) and the rhinoceros itself, as follows:

(aa) Chemical labelling of horn by impregnation, or metabolic deposition, to render the horns permanently identifiable (either on an individual reserve, or combined reserves, basis) to conservation authorities, but not to illegal traders lacking the required sophisticated equipment or technology. This concept, the details of which should remain confidential for obvious reasons, would involve immobilising the rhinoceros and giving the required treatment, so that should the horn subsequently enter the illegal trade and be seized, the origin of the horn could be determined. This would hold obvious benefits for securing convictions.

(bb) Electronic labelling of the body of the rhinoceros, and possibly also of the horn, using a strategically placed transponder, pre-programmed with a unique and unalterable code. This would allow one to establish the identity of a carcass even if the ears and other identifying external features had been mutilated.

(xiii) Rhinoceros mortalities

The detection, examination and disposal of rhinoceros carcasses, as well as the maintenance of meticulous records, is a critical part of the black rhinoceros conservation programme. If handled correctly, this operation will provide management with early warning of a variety of potentially serious problems, such as nutritional deficiency, disease and, in the current climate, especially poaching; mismanaged, it will provide a cover, and even provide additional opportunities, for rhinoceros poaching that will result in an increased availability of rhinoceros products on the black market.

Serious considerations should be given to the routine implantation of transmitters which are only activated on death of the individual rhinoceros. This could enhance the timeous location of carcasses and the early detection of poaching.

The programme has a number of important components:

(a) Initial inspection on discovery
    Presence/collection of horns
    Distinguishing natural characteristics/ear notches
    External examination for cause of death.

(b) Post-mortem
    Veterinary surgeon
    Geiger counter
    Activation of transponder.

(c) Collection or destruction of skull/carcass.

(d) Marking, measuring and weighing horns, and handling to maintain security.

(e) Marking and storage of skulls, for later ageing and taking of morphometric measurements.

(f) Completion and distribution of a standard rhinoceros mortality form (see Appendix 6), including date, location, age, sex, horn measurements and disposal, skull details, cause of death (copy of post-

mortem report to be attached), names of individuals finding the carcass and completing the form.

(g) Checking of game death forms for completeness and accuracy, analysis for trend in numbers, distribution throughout reserve, and detection rates by different grades of personnel.

2. *Establishment of new populations*

The translocation of black rhinoceros from well established populations, either to create new populations or to bolster small, existing populations, is a major component of this conservation plan.

Decisions on which reserves should receive rhinoceros preferentially have to be based on a wide variety of considerations. Strategically, a large number of small populations, possibly in small reserves, provide protection against disease outbreak and localised, extreme climatic changes, and are arguably easier to police than larger areas. Conversely, large areas provide increased possibilities for natural population expansion and, in the long-term, will maintain higher levels of genetic diversity without management intervention. A balance needs to be struck between these strategic and genetic considerations, in conjunction with biological suitability, and decisions taken according to perceptions at the time.

(i) Genetic considerations

Some genetic considerations (in addition to those mentioned earlier under Maintenance of genetic diversity) of direct relevance to the re-establishment programme were identified at the Pietermaritzburg workshop, and these should be borne in mind when making decisions. These are:

- Preference should be given to the rapid achievement of the minimum founder number in any given area, rather than dispersing effort between areas.
- Priority should go to areas with the highest potential population sizes.
- There are no compelling genetic reasons for adding more founders to Kruger National Park, as the 70 re-established are adequate in numbers and diversity of origin (Hluhluwe-Umfolozi, Mkuzi and Zambezi Valley).
- The ideal situation would be at least one large population and several others over 200.
- The primary reservoir of genetic diversity should be the largest population. When filled to capacity, it should become the primary source for the repopulation of new areas.

(ii) Potential sizes of existing black rhinoceros populations

The estimated ecological carrying capacities of these reserves for black rhinoceros are presented in Table 2. These are, however, often based on fairly superficial information, and more accurate assessments are required, particularly for the smaller reserves. This is necessary if the reserves are to be effectively screened for suitability and rated for genetic potential (see Rating procedure for reserves).

Table 2

Potential sizes of existing black rhinoceros populations in the region

Subspecies	Location	
D. b. minor	Kruger National Park	3 500
	Hluhluwe-Umfolozi Game Reserve	300
	Pilanesberg National Park	120
	Eastern Shores Nature Reserve — Sodwana State Forest	100

	Mkuzi Game Reserve	70
	Itala Game Reserve	60
	Andries Vosloo Kudu Reserve	50
	Ndumu Game Reserve	40
	Weenen Nature Reserve	10
		Total: 4 250
D. b. bicornis	Etosha National Park	500
	Kaokoland/Damaraland	120
	Vaalbos National Park	40
	Augrabies Falls National Park	30
		Total: 690
D. b. michaeli	Addo Elephant National Park	30
		Total: 30

Detailed information on these populations, such as numbers, trends and population structures, as well as brief descriptions of the habitats, will be included in the conservation plan in the forseeable future.

The size of the *Diceros bicornis minor* population in the region is not currently limited by lack of available conserved habitat. The reserves holding this ecotype amount to about 2,2 million hectares, and have an estimated ecological carrying capacity of over 4 000 animals (see Table 2), or about double the target figure of 2 000. Kruger National Park could hold by far the largest population of about 3 500, followed by Hluhluwe-Umfolozi (300), and Pilanesberg (120) and the Eastern Shores-Sodwana Complex (100); the remainder all having carrying capacities of less than 100. It would, nevertheless, from a strategic viewpoint, be preferable to have the population more widely spread.

In the cases of *Diceros bicornis bicornis* and *Diceros bicornis michaeli*, there is currently insufficient space in reserves for either to achieve their minimum target figures of 2 000 and 100 respectively, although there are up to about 4 million hectares of rhinoceros habitat suitable for *Diceros bicornis bicornis* in Kaokoland/Damaraland. Additional reserves, or significant extensions to current reserves, will definitely be required.

(iii) Additional areas for re-establishment
A number of reserves have been proposed as being possibly suitable for black rhinoceros, and these will be assessed by the Rhino Management Group in due course. A standard procedure will be adopted, which may necessitate a new assessment being done for reserves evaluated in the past so as to get a good indication of relative suitability.

Some potential new areas are listed below:

D. b. minor	Pongola Nature Reserve	Transvaal
	Loskop Dam Nature Reserve	
	Langjan Nature Reserve	
	Messina Nature Reserve	

	Timbavati Private Nature Reserve	}
	Hans Merensky Nature Reserve	}
	Borakalalo National Park	Bophuthatswana
	Songimvelo Game Reserve	KaNgwane
D. b. bicornis	Karoo Nature Reserve	}
	Karoo National Park	} Cape Province
	Richtersveld National Park (Proposed)	}
D. b. michaeli	Zuurberg National Park	Cape Province

(iv) Assessing the suitability of reserves

The success of the re-establishment programme, measured in terms of the achievement of the stated conservation goals (see Conservation aims), depends largely on the identification of those areas most suitable for rhinoceros population growth and survival.

The selection of areas will be based on a field assessment of all areas potentially suitable for black rhinoceros. This assessment will provide the information required for an initial screening of reserves and the subsequent rating of suitable reserves for their biological, genetic and security potential. This exercise will be undertaken by the Rhino Management Group, and recommendations forwarded to the appropriate conservation authorities for consideration.

(v) Initial screening of reserves

The initial sorting of reserves and areas into those potentially suitable and those unsuitable for the re-establishment of black rhinoceros is based on a set of minimum standards. If any of these standards, which are given below, are not met, then the area is disqualified from further consideration.

- The habitat must be suitable.
- Areas of less than 10 000 ha must have physical boundaries preventing dispersion.
- Poaching threat should not be severe, or if it is, effective control must be demonstrated.
- No threat of deproclamation must be apparent.
- Current or proposed land-use must be compatible with conserving the species.
- Potential rate of increase of rhinoceros population in recipient area must be greater than in donor areas.
- Potential effective founder population must be at least 10 rhinoceros.
- Number of founders must not exceed 50 percent of ecological carrying capacity.
- Current population size must not exceed 60 percent of ecological carrying capacity.
- Ecological carrying capacity must be at least 20 rhinoceros.
- If previous re-establishment was unsuccessful, causes must have been rectified.
- Re-establishment must not adversely affect another Red Data Book species with a more critical conservation status.
- Veterinary clearance must be granted.

Those reserves that meet the minimum standards are then rated for relative suitability according to the ecotype or subspecies *(D.b. minor, D.b. bicornis* or *D.b.michaeli)* allocated to them.

(vi) Rating procedure for reserves

The rating system, which identifies three major areas of concern (biological, genetic and security), provides for flexibility as the decision-making climate changes. Improved biological or genetic knowledge can be integrated and changes in the security situation can be taken into account without a complete re-assessment being necessary.

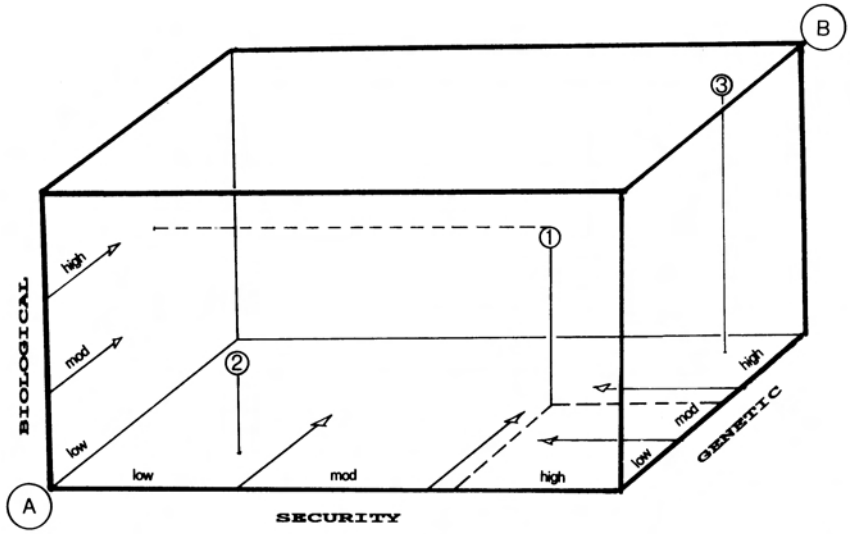


Fig. 1. Scores for biological, genetic and security concerns presented three-dimensionally for rating procedure for each reserve.

A variety of factors falling under the three areas of concern are scored for each reserve as shown below.

(a) Biological concerns

Habitat suitability: 1 — 10

This is based on a wide variety of observations, such as base level of soils, availability of palatable browse, condition and performance of browsers. Ideal habitat scores 10.

Predation threat : 1 — 3

Assuming that large predators, e.g. lions, spotted hyaenas, inflict some mortality, scoring varies from a high density of such predators (1) to there being no significant predators (3).

Disease threat: 1 — 3

This may vary from a known risk affecting the rate of increase of the re-established or resident population (1) to no known risk (3).

(b) Genetic concerns

Potential population size: 1 — 10

Long-term genetic viability increases and the need for interchange management decreases with increasing population size. Scoring:

(1) 20 — 29 rhinoceros	(6) 100 — 149
(2) 30 — 39	(7) 150 — 249
(3) 40 — 49	(8) 250 — 349
(4) 50 — 74	(9) 350 — 499
(5) 75 — 99	(10) 500+

Number of founders present: 1 — 3

The genetic risk decreases as the number of founders increases. The allocation of additional animals where founder numbers are low is therefore encouraged.

Scoring : (1) 50 + founders
(2) 20 — 49 founders
(3) 10 — 19 founders

(c) Security concerns

Poaching threat: 1 — 10

Aspects considered include distance to political (national) boundary, extent of organised crime, security status of region, previous incidents of poaching. Scores increase as the threat decreases.

Management control: 1 — 10

This is a measure of the intensity and effectiveness of law enforcement in the reserve and in surrounding areas, the effectiveness of the boundary fence (especially in smaller reserves) and the security of land tenure. Excellent control rates 10.

The scores for the biological, genetic and security concerns are then presented three-dimensionally for each reserve as shown below. The three reserves shown have the following characteristics:

Reserve	Biological suitability	Genetic viability	Security status
(1)	High	Moderate	High
(2)	Moderate	Low	Low
(3)	High	High	High

This presentation results in reserves with similar characteristics being clumped together, with the least suitable tending towards (A) and the most suitable towards (B). Also those that rate highly for any particular concern can be easily identified (Fig. 1).

3. *Captive breeding*

While accepting that *in situ* protection and conservation of black rhinoceros populations in Africa is the highest priority, it is recognised that these efforts may be unsuccessful for one or more of the four recognised ecotypes. The alternative is captive propagation.

The African Rhino Workshop (Cincinnati, October 1986) strongly recommended that viable foundation populations should be established immediately for those ecotypes not presently well represented in zoological gardens. Genetic analysis suggest that a viable captive population should be based on at least 20 founder individuals that will reproduce. Of the four ecotypes, only the East African *Diceros bicornis michaeli* is well represented in captivity.

Captive breeding can serve two purposes, namely:

(i) to produce surplus rhinoceros for the on-going exercise of re-establishment in reserves; however such a breeding programme, which could be based in Africa, can only be justified if rhinoceros husbandry is developed to the stage where the population growth rate in captivity exceeds that in natural habitats; or

(ii) to insure against the worst-case scenario, that of economic or political collapse within the region resulting in the loss of all rhinoceros; in which case the breeding programme must be based outside Africa and lower population growth rates would be acceptable. The purpose would be to maintain genetically diverse populations for re-establishment in natural habitats within Africa should conditions return to normal. The implication is that this is a very long-term programme, with no return expected in less than 10-50 years.

(a) The American Association of Zoological Parks and Aquaria Programme

Captive breeding programmes are extremely expensive, and require sophisticated management to be effective. The only organisation considered capable of supporting and co-ordinating such an exercise at present is the American Association of Zoological Parks and Aquaria (AAZPA) under the auspices of the Species Survival Programme (SSP) of the IUCN. This breeding programme falls into the strategic planning scenario (ii) above. New founder animals becoming available from the wild would be assured, through AAZPA, of placement in facilities with proven records in black rhinoceros reproduction and survival.

The two black rhinoceros ecotypes native to the region, the southern-central *Diceros bicornis minor* and south-western *Diceros bicornis bicornis*, are very poorly represented in captivity in North America and Europe, with only 4 founders from the southern-central type currently available.

(b) Availability of rhinoceros

Limited numbers of *Diceros bicornis minor* are currently available each year for relocation from Natal's reserves, and consideration needs to be given as to whether some might be made available for the AAZPA SSP programme. There also exists the possibility of supplying some *Diceros bicornis bicornis* from Namibia to form a breeding nucleus.

Rhinoceros do occasionally become available that are not suitable for translocation into the wild. These would include orphaned calves that need to be hand-reared or which are not old enough to risk introducing into occupied areas in the wild, or adults that have recovered (in captivity) from injury but which are to some extent handicapped and which would therefore be disadvantaged in the wild. Provided these animals are potentially suitable for captive breeding, they should be offered to the AAZPA SSP programme.

(c) Donations for black rhinoceros research

It is recommended that black rhinoceros should not be sold at the full market rate to captive breeding institutions, as this might (a) upset the economic viability of the breeding programme, which is anyway planned mainly for Africa's benefit, and (b) result in the highest bidder, possibly not offering the best conservation breeding programme, gaining the rhinoceros.

Instead, it is suggested that a voluntary donation be solicited to support research and monitoring programmes for black rhinoceros. It is envisaged that this could be in the region of 10-50 percent of the current export

value, but that it should not in any way prejudice the selection of the breeding institution.

Acknowledgements

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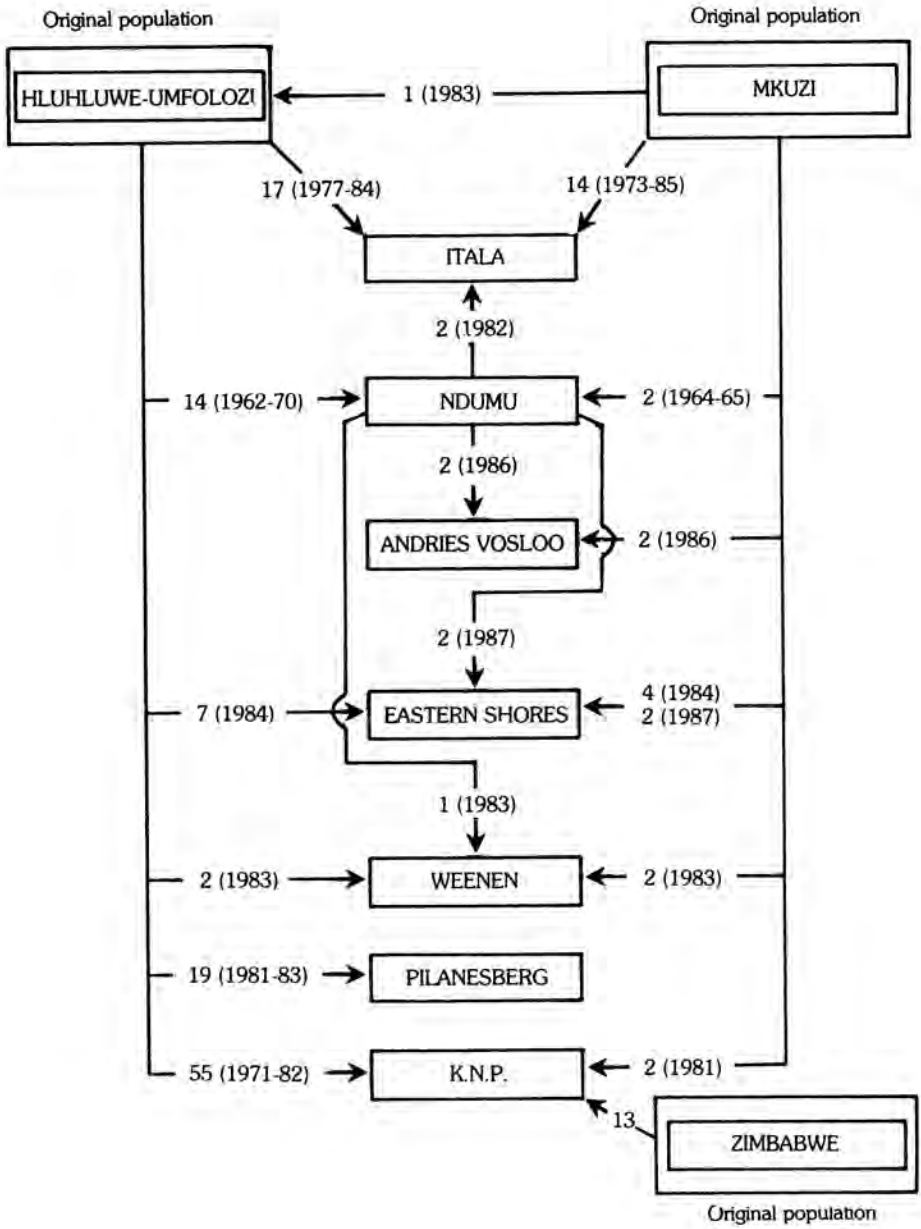
Appendix 1

Re-establishment history of *D. b. minor* in the region (September 1962 — December 1987).



Appendix 2

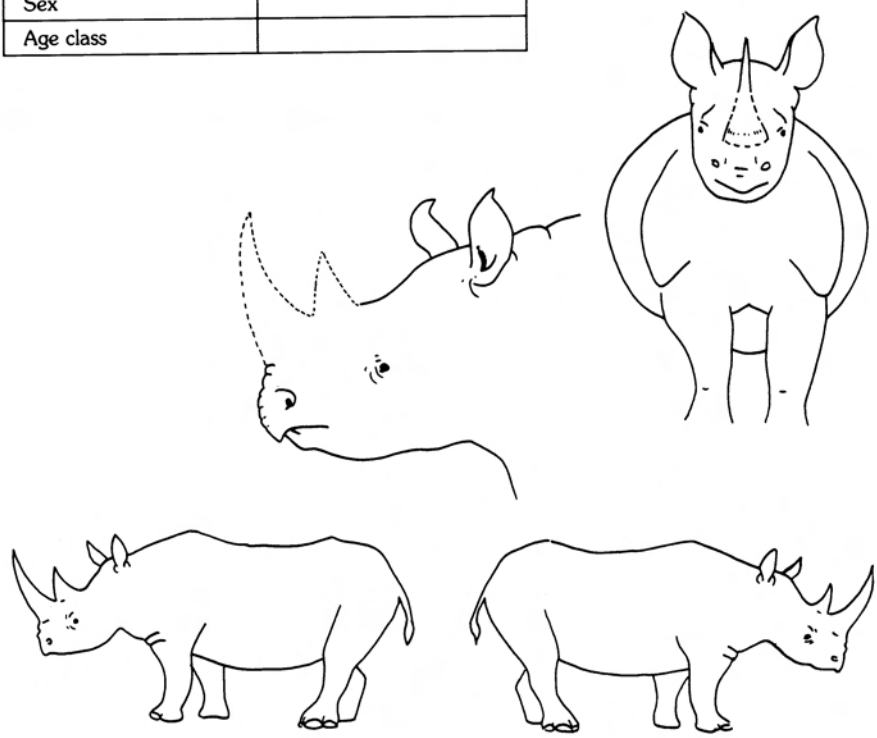
Availability of black rhinoceros for translocation over a 10 year period if populations managed at 75% of ecological carrying capacity.

Reserve	Current population size	75% ECC	Removals									
			Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
HGR-UGR	220	225	—	13	9	9	9	9	9	9	9	9
Mkuzi	70	53	17	—	—	7	—	—	7	—	—	7
Ndumu	42	32	10	—	—	—	5	—	—	—	5	—
Itala	35	45	—	—	—	—	—	—	—	—	5	—
		TOTALS	27	13	9	16	14	9	16	9	19	16

Appendix 3

Black rhinoceros personal history record.

Reserve	
Rhino code no.	
Ear-notch no.	
Date identified	
Sex	
Age class	



Identification	Ears			
	Horn			
	Sores/scar			
	Tail			
	Other			
Origin	Mother		Date	
	Donor reserve			
Death or Removal	Date			
	Cause/reason			
	Skull no.			
	Housed			

(Appendix 3 *Continued*)

SIGHTINGS

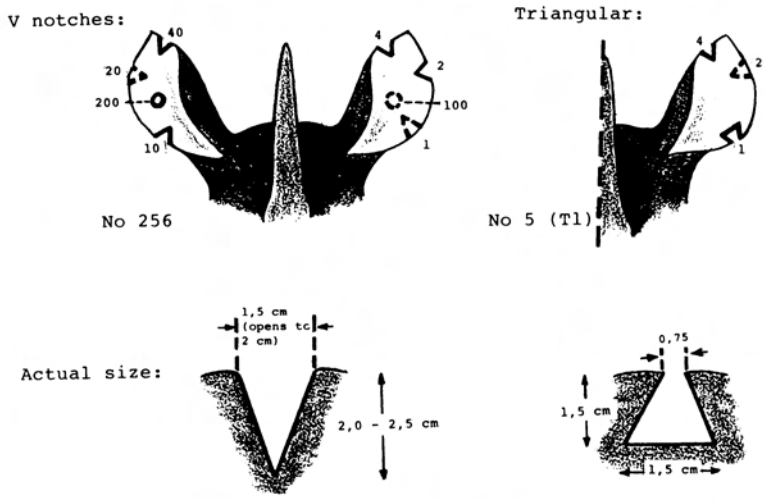
Sighting no.	Grid ref	Date	Body condition	Observations (e.g. with calf (age, sex), mating, fighting, spray urinating, immobilisation, treatment, etc.)

Calves	Date born	Sex	Rhino code no.	Ear-notch no.	Remarks (inc. death(date), translocation, destination, etc.)

Appendix 4

Ear-notch marking system for black rhinoceros *Diceros bicornis* in the region.

The ear-notching system is based on V and inverted triangular (T) notches cut from the perimeter of the ears and holes punched through the ear pinnae as shown below.



Each black rhinoceros will receive an individual number code, derived from the number of notches or holes cut in the ears, and whether or not a triangular notch is present. The types of marking are:

(i) V notches only. This allows 63 individuals (1 — 7, 10 — 17, etc). of each sex to be marked without duplication.

(ii) One triangular notch (at positions 1, 4, 10 or 40) plus V notches. Gives 128 combinations for each sex, with numbers allocated to individual rhinoceros being post-fixed by T1, T4, T10 or T40 depending on the triangular notch used to avoid confusion with (i) above. Errors due to failure to detect the triangular shape of the notches are avoided due to similar codes, e.g. 15, 15(T1), 15(T4) and 15 (T10) being allocated to different reserves.

(iii) Holes in one or both ears, i.e. 100, 200 or 300. Used in combination with the V notch and triangular notch systems, the holes add 189 and 384 combinations respectively for each sex.

Use of the above system allows for the individual marking of 764 rhinoceros of each sex. Each reserve is allocated certain numbers as shown in Appendix 5, these having been carefully selected to avoid recording errors.

When marking animals, numbers in the table in Appendix 5 should be preferentially selected from left to right. This is because:

— If marking is restricted to numbers appearing in columns 1-10 (i.e. restricted to simple V and triangular notch systems) then individuals can be identified without sexing or, in fact, distinguishing between V and triangular notches.

— When marking is extended to columns 11-16 (i.e. V notch and holes) the same conditions apply as above. However, if there is difficulty in detecting the holes (denoting hundreds), then animals must be sexed to avoid confusion with those marked earlier. For example, if No 150 (male) is read as 50, reference to the table in Appendix 5 reveals the error, as No 50 is a female.

— When marking is extended beyond column 16, the need to detect triangular notches and holes and to record sexes increases if errors are to be avoided.

Appendix 5

Allocation of ear-notch numbers to black rhinoceros *D. b. minor* in the region.
(Excludes rhinoceros marked before 1 January 1988, *combinations of ⏢ (T) notch and V notches and hole(s) not shown or allocated).

Reserve	V notches only		⏢ (T) notch plus V notches			
			T1 notch		T4 notch	
	Male	Female	Male	Female	Male	Female
Hluhluwe-Umfolozi GR	7,20-27	6,47,50-57	61,63,65,67	11,13,15,17	74,75,76,77	34,35,36,37
Mkuzi GR	44,46,47,50-57	45	21,23,25,27	31,33,35,37	14,15,16,17	—
Itala GR	30-37	—	51,53,55,57	1,3,5,7	24,25,26,27	14,15,16,17
Weenen NR	—	1	11,13,15,17	—	64,65,66,67	44,45,46,47
Eastern Shores NR	10-17	60-67	71,73,75,77	21,23,25,27	34,35,36,37	—
Ndumu GR	3	20-27	31,33,35,37	71,73,75,77	44,45,46,47	4,5,6,7
Kruger NP	60-67	—	—	51,53,55,57	4,5,6,7	74,75,76,77
Pilanesberg NP	70-77	10-17	1,3,5,7	41,43,45,47	54,55,56,57	64,65,66,67
Andries Vosloo NR	—	30-37,70-77	—	—	—	24,25,26,27
New reserves 1	—	—	—	—	—	—
2	—	—	41,43,45,47	—	—	54,55,56,57
3	—	—	—	61,63,65,67	—	—
Remainder	—	—	—	—	—	—

T10		T40		V notches plus hole(s)						*	Number of ear-notch combinations allocated	
				Hole 100		Hole 200		Hole 300				
Male	Female	Male	Female	Male	Female	Male	Female	Male	Female		Male	Female
—	—	—	—	150-157	120-127	210-217	260-267	330-337	370-377		41	42
—	70-77	60-67	—	130-137	150-157	270-277	220-227	—	310-317		43	37
—	—	70-77	60-67	101-107	140-147	260-267	230-237	310-317	320-327		47	40
—	—	50-57	70-77	No more allocated							16	13
—	—	—	50-57	160-167	130-137	220-227	201-207	—	—		32	35
10-17	50-57	—	—	120-127	110-117	—	240-247	No more allocated			25	40
30-37	10-17	—	40-47	140-147	101-107	250-257	—	320-327	330-337		44	39
—	30-37	—	—	110-117	170-177	230-237	250-257	No more allocated			32	40
50-57	—	40-47	—	—	160-167	201-207	—	—	—		23	28
—	70-77	—	—	—	—	—	—	340-347	350-357		16	8
—	—	—	—	170-177	—	—	210-217	301-307	—		19	12
—	—	—	—	—	—	240-247	270-277	350-357	301-307		16	19
—	—	—	—	—	—	—	—	360-367	340-347		16	16
								370-377	360-367			
									TOTAL		370	369

Appendix 6

Black rhinoceros mortality record

Reserve: _____

Month: _____ Year: _____

Code Numbers		Date	Location		Age Class (A-F)	Sex (M,F)
Rhino death	"Known" death		Area	Grid ref		

Horns

Present	Collected	Marked	Measurements (nearest mm or g)						Disposal	
			Front			Rear			Destination	Date
			Length	Circum	Mass	Length	Circum	Mass		

Skull

Collected	Destroyed	Marked	Aged	Measurements				

Post-mortem

Undertaken	Vet's Name	Report Attached	Cause of death		If predation, then:	
			Code		Predator	
			Details		Evidence (A-E)	
					Details	

Individual reporting death _____

Officer completing form _____

(Appendix 6 *Continued*)

All horns and skulls to be marked immediately with the game death code number, initially using permanent marker pen and later permanent labels.

Age classes:

Size Class Description	A	B	C	D	E
Size in relation to adult	Level with inguinal region of adult female	Top of shoulder level with ventral part of vulva	Shoulder level with base of tail	Shoulder height at a level between base of tail and sacral region	Slightly smaller than adult
Skin lesions	Absent	Absent	Start appearing on chest. Absent on sides.	Present on chest. Absent on sides.	Present on chest, start developing on sides, but generally not in the usual position of behind the shoulder
Horns	Absent	Anterior horn small and 'knob' like (approx. 3 inches in length). Posterior horn not noticeable	Anterior horn approx. 6 inches in length. Posterior horn noticebale	Anterior horn approx. 6-12 inches in length. Posterior horn approx. 2-4 inches.	Anterior horn approx. 10-12 inches in length. Posterior horn approx. 2-4 inches

Black rhino age classes

0-1 year

1-2 years

2 years

(Appendix 6 *Continued*)

Horn measurement:

These are taken in accordance with Rowland Ward and Safari Club International specifications.

Length:	Measure length of the horns on the front surface along the curve from the lowest point in front to the tip.	
Circumference:	Measure along the edge of the base as close to the head as possible. This does not have to be at right angles to the axis of the horn.	
Cause of death codes:	P — poacher C — carnivore F — fighting injury I — other injury	B — capture D — destroyed U — unknown
Evidence of predation:	A — observed killing B — heard killing C — seen at carcass	D — spoor at carcass E — signs of struggle