KENYA BLACK RHINOCEROS

METAPOPULATION ANALYSIS WORKSHOP

BRIEFING BOOK

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KENYA BLACK RHINOCEROS METAPOPULATION WORKSHOP BRIEFING BOOK

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KENYA BLACK RHINOCEROS
Diceros bicornis michaeli

METAPOPULATION AND HABITAT VIABILITY ASSESSMENT AND CONSERVATION ACTION PLAN WORKSHOP

Problem Statement

The numbers of black rhino in Africa have declined 90% in the last 20 years. Only 3800 are estimated to survive on the entire continent. The major cause of the decline is poaching for the horn.

The decline of this species has been particularly severe in Eastern Africa which is inhabited by populations described as the *Diceros bicornis michaeli* subspecies or ecotype. Fewer than 100 *D.b. michaeli* are believed to survive outside Kenya; 370-400 are estimated inside Kenya.

The majority of the Kenya rhino (285) are located in 11 intensely protected areas designated "sanctuaries". Of these sanctuaries: 6 are entirely enclosed by fence; 3 are partially enclosed; and two are open. The range of population sizes in these sanctuaries is from 4 to 60. For the most part, these populations have been established with founders translocated from areas outside the sanctuaries. The range of estimated carrying capacities of these sanctuaries is 15 to 100. The total estimated ecological carrying capacity of the 11 sanctuaries is 680. The sanctuaries thus constitute a metapopulation of 11 small and fragmented subpopulations. As such, they are subject to risks of extinction from demographic, environmental, and genetic stochasticity.

The remainder of the Kenya rhino (85-100) occur outside the sanctuaries and most (50-70) are isolated and non-reproducing animals living in remote and largely unprotected areas. These animals are potential resources and candidates for translocation into the sanctuaries to reinforce the founder populations as needed and feasible.

There are about 150 *D.b. michaeli* in zoos worldwide. About 130 of these are in well organized captive propagation programs (SSP in North America; EEP in Europe; SSCJ in Japan).

The current conservation strategy and recovery plan for this species in Kenya is to expand the number of rhinos in the sanctuaries from an appropriate number and diversity of founders from the current 285 to 500 in 1995 and then to the sanctuary carrying capacity of 680 by 2000. The Kenya plan further aspires to manage the sanctuaries as a metapopulation by managed interchange of animals where feasible and desirable to maintain genetic diversity and demographic integrity and productivity. Thereafter, the plan is to use a sustainable harvest of surplus from the sanctuary populations to recolonize areas in the former range of the species in Kenya and perhaps neighboring Tanzania and Uganda. The ultimate goal of the Kenya plan is to restore a population of at least 2000 *D.b. michaeli* in Kenya and environs.

Goals

(1) Conduct a Population and Habitat Viability Analysis for the Kenya metapopulation(s) of black rhino.

(2) Assess the current Kenya rhino conservation plan using models (VORTEX, perhaps GAPPS and RAMAS) for quantitative evaluation of genetic, demographic, and environmental risks.

(3) Using the simulation models in conjunction with other information on the biology of the rhino and its environment, delineate a metapopulation strategy for black rhino in Kenya that will provide for maintenance of genetic diversity and demographic security over the short term (10-50 years) and recovery of evolutionary potential over the longer-term. This strategy will recommend:

- total metapopulation number
- number and sizes of subpopulations
- number and nature (sex, provenance, etc.) of founders for each subpopulation
- rate of migration (managed) among subpopulations

(4) Prepare a report of the analyses and results of the workshop with recommendations for achieving the above goals.

Objectives

(1) Consolidate existing information on black rhino distribution, numbers, and habitat. As far as possible, this information will be assembled using maps of the various areas involved.

(1) Operationally review life history information of the species as needed for simulation models.

(3) Explicitly, and as far as possible quantitatively, identify and assess specific risks, deterministic and stochastic, to the black rhino and its habitat in various sanctuaries under existing and projected conditions.

(4) Assemble information to:

(A) assess human population growth around each area;

(B) identify current and planned land use patterns and their impact on protected reserves and rhino habitat;

(C) explore full range of possible poaching scenarios over next 20 years.

(5) Delineate current, planned, and possible/desirable levels of protection and management of reserves.

(6) Project the potential expansion or decline of black rhino population numbers under various management regimes.

(7) Evaluate the need/benefit of retrieving additional outlier rhino as founders for the sanctuary populations.

(8) Employing simulation models, determine numbers of black rhino and subpopulations required for various probabilities of survival and preservation of genetic diversity for specified periods of time (i.e. 50, 100, 200 years) and for eventual recovery of evolutionary potential.

(9) Consider habitat and carrying capacity requirements needed to achieve objectives of establishing population sizes needed for a viable population.

(10) Explore metapopulation manipulations that could be used to establish or maintain viable populations: e.g. managed migration among subpopulations; pedigree management of sanctuary populations.

(11) Examine obstacles (e.g. behavioral, logistic, financial problems) to and consequences of this approach.

(12) Consider how possible interventions in the wild population and its habitat might increase its rate of growth, maximize retention of genetic diversity, and reduce risk of extinction.

(13) Evaluate possible role of captive propagation as a component of the metapopulation strategy. In particular, consider how captive propagation could: A) contribute to expansion of population; B) enhance preservation of genetic diversity; C) protect population gene pool against fluctuations due to environmental vicissitudes in wild and D) provide animals for reinforcement of wild populations or establishment of new wild populations.

(14) Consider other ways the global zoo community can strategically but realistically assist the conservation of black rhino in Kenya.

(15) Formulate and/or evaluate criteria developed for establishment of new black rhino populations.

(16) Develop quantitative scenarios for harvest of animals from sanctuary populations for translocation to new areas.

(17) Identify problems and issues that need continuing research and analysis.

(18) Consider how social and rural development realities as well as educational and informational efforts can be effectively incorporated into action plans.

(19) Consider Kenya strategy in context of (A) plans for species elsewhere in Africa and (B) of subspecies issue.

(20) Produce a Conservation Strategy and Action Plan Document presenting the results and recommendations from the Workshop for various scenarios and courses of conservation action.

KENYA BLACK RHINO PHVA/CAP WORKSHOP OVERVIEW

A Metapopulation Conservation Strategy Document will be prepared in draft form during the workshop. It is a goal of the workshop that this document be reviewed and revised by all participants during the workshop to achieve agreement on its content before departure. This document will include specific recommendations and priorities for management and research of both captive and wild populations. The Conservation Strategy will be developed by detailed examination of the natural history, biogeography, life history characteristics, status in the wild and captivity and threats to the species continued existence.

Participants

The workshop will be conducted as a joint endeavor of the Kenya Wildlife Service and the Captive Breeding Specialist Group (CBSG). The list of invited participants includes the Chairman of the SSC African Rhino and Reintroduction Specialist Groups. Representatives of the African Rhino Specialist Group from several other African nations (Tanzania and Zimbabwe) have also been invited.

Briefing Book

A briefing book will be distributed to all participants at the workshop. The book will contain summary information on: population biology concepts as they relate to developing conservation strategies (species survival plan, recovery plan); selected papers on the Kenya black rhino situation and recovery plan; natural and life-history of the black rhino; status of the wild and captive populations; and preliminary results of computer models evaluating the extinction vulnerability of rhino species (to be revised and refined during the workshop).

Workshop Format

The duration of the workshop will be 3 full working days and then an additional day for a smaller group to complete preparation of the report. The workshop will be organized in an effort to combine available information on the biology and status of the species with analytical techniques that evaluate their conservation implications. Once the basic data are presented, analytical models will be prepared to simulate future population trends. These models will focus on estimating the probability of the species going extinct given various conditions and scenarios (Population Viability Analysis PVA). Conservation strategies for both captive and wild populations based on information obtained will be developed.

KENYA BLACK RHINO METAPOPULATION WORKSHOP
DRAFT AGENDA

DAY 1:

MORNING

Introductions, opening remarks and arrangements. (Brett, Leakey)

Identify Goals, Problems, and Assignments for Workshop. (Brett, Seal)

Basic Overview of Small Population Biology and Management (Seal, Foose, Lacy, Mace).

- Demographic, environmental, and catastrophic effects on persistence of small populations.
- Genetics and persistence of small populations.
- Species survival planning and collaborative management approaches for small populations.
- VORTEX and other models available for PHVA.

Overview of the Kenya Black rhino situation and current plan. (Brett, Wanjohi)

AFTERNOON

Taxonomy, genetic analyses, population substructure (Ryder, Aman)

Discussion of Kenya populations and plans in relation other national strategies and continental action plan by AERSG. (Brett, Brooks, DuToit)

Review and assembly of population biology, life history and basic black rhino biology parameters for models. (Brett et al.)

Organize working groups.

EVENING

Initiate working groups and simulation runs for black rhino.

DAY 2:

MORNING

Distribution and review of draft minutes from Day 1.

Present results from initial model simulations.

Discussion of behavioral, logistic, financial, other impediments to metapopulation management. (Brett, DuToit)

Consider possible pedigree management of sanctuary populations. (Lacy, Mace)

Consideration of reintroduction protocols and criteria (Price)

Consideration of role of possible role of captive propagation and other actions by global zoo community in recovery plan. (Seal, Foose)

AFTERNOON

Continue working sessions and model runs.

EVENING

Working groups work on documents.

DAY 3:

MORNING

Distribution and review of draft minutes and reports from Day 2.

Presentation of results from model simulations. Discussion of full range of scenarios, problems and potential solutions. Identification of conservation priorities.

Assemble first draft of final workshop document.

AFTERNOON

Presentation and review of final documents.

Identify items that are dependent upon further data and analysis to be completed after the Workshop. Organize mechanism to continue process developed at Workshop.

Achieve consensus on the Summary and Recommendations of the Conservation Strategy Document.

EVENING

Working groups continue to refine and finalize documents.

DAY 4 (?):

MORNING

Further modeling analysis, if required.

AFTERNOON

?

KENYA BLACK RHINO METAPOPULATION WORKSHOP

AGENDA AND TIMETABLE

DAY 1: SATURDAY 2ND NOVEMBER

MORNING

9:00 Introductions, opening remarks and arrangements (Leakey, Brett)

9:30 Identify goals, problems and assignments for workshop (Brett, Seal, Foose)

10:30 Break

11:00 Basic overview of small population biology and management (Foose, Lacy)

- Demographic, environmental and catastrophic effects on persistence of small populations
- Genetics and persistence of small populations
- Species survival planning and collaborative management approaches for small populations
- VORTEX, GAPPS and other models available for PHVA

12:00 Overview of the Kenya black rhino situation and current plan (Brett, Wanjohi)

13:00 Lunch

AFTERNOON

14:00 Taxonomy, genetic analyses, population substructure (Ryder, Aman)

15:00 Review and assembly of population biology, life history and basic black rhino biological parameters for models (Brett, Emslie, Hillman et al)

15:30 Break

16:00 Organise working groups:

EVENING Initiate working groups and simulation runs for black rhino

DAY 2: SUNDAY 3RD NOVEMBER

MORNING

9:00	Distribution and review of draft minutes from Day 1
	Present results from initial model simulations
9:30	Consideration of possible pedigree management of sanctuary populations (Lacy)
10:30	Break
11:00	Consideration of reintroduction protocols and criteria (Price)
12:00	Consideration of possible role of captive propagation and other actions by global zoo community in recovery plan (Foose)
13:00	Lunch

AFTERNOON

14:00	Continue working sessions and model runs

EVENING Working groups work on documents

DAY 3: MONDAY 4TH NOVEMBER

MORNING

9:00 Distribution and review of draft minutes and reports from Day 2

9:30 Discussion of Kenya populations and plans in relation to other national stragegies and continental action plan by ARSG (Brett, Du Toit, Emslie)

10:30 Break

11:00 Discussion of behavioural, logistic, financial and other impediments to metapopulation management (Brett, Du Toit)

12:00 Presentation of results from model simulations. Discussion of full range of scenarios, problems, and potential solutions. Identification of conservation priorities.

Assemble first draft of final workshop document

13:00 Lunch

AFTERNOON

14:00 Presentation and review of final documents.

Identify items that are dependent upon futher data and analysis to be completed after the workshop. Organise mechanism to continue process developed at workshop.

Achieve consensus on the Summary and Recommendations of the Conservation Strategy Document

EVENING Working groups continue to refine and finalise documents

DAY 4: TUESDAY 5TH NOVEMBER

MORNING

Further modelling analysis, if required

AFTERNOON

KENYA BLACK RHINO PHVA WORKSHOP

2nd-5th November 1991

LIST OF PARTICIPANTS

Kenya

Richard Leakey (to open 2/11)	KWS
Evelyn Wanjohi	KWS
Jim Else	KWS
Fred Waweru	KWS
Tim Oloo	KWS
Rob Brett	KWS
Sam Ngethe	KWS
John Kagwi	KWS
Pius Mulwa	KWS
Mark Stanley Price (from 3/11)	AWF
Chris Gakahu	WCI
Rashid Aman	NMK/IPR
Esmond Bradley Martin	WWF/ARSG
Holly Dublin	WWF
Rob Eley	IPR
Steve Mihok	ICIPE
Kuki Gallmann	APRLS

Outside Kenya

Ulie Seal	CBSG/PVA team
Tom Foose	CBSG/PVA team
Bob Lacy	CBSG/PVA team
Richard Kock	ZSL/KWS
Raoul Du Toit (from 4/11)	WWF/Zimbabwe National Parks
Ollie Ryder	San Diego Zoological Soc
Kes Hillman-Smith	Garamba NP/White rhinos
Richard Emslie	Natal Parks Board/RMG
Representative	Tanzania National Parks
Representative	Tanzania Wildlife Division

Apologies

David Western	WCI
Martin Brooks	Natal Parks Board/ARSG Chair
Nigel Leader-Williams	AWF/Tanzania Wildlife Division
Georgina Mace	ZSL/Institute of Zoology

KENYA BLACK RHINOCEROS

METAPOPULATION WORKSHOP

BRIEFING BOOK

SECTION 2
KENYA BLACK RHINO OVERVIEW

The Black Rhino Sanctuaries of Kenya

R.A. Brett

The purpose of this article is to show that the policy adopted by Kenya in 1984 of creating rhino sanctuaries has been a success over the last four years. This is qualified by the fact that the areas showing the largest increases in rhino numbers, Nairobi National Park and Solio Ranch Game Reserve, were stocked in the late 1960s and early 1970s long before the term 'rhino sanctuary' had been coined. As mentioned in a previous *Pachyderm*, the established rhino sanctuaries are now beginning to show the population growth which it was hoped they would promote, in addition to providing security from poaching either by fencing, alarms, armed patrols or a combination of these.[1]

Sanctuaries and Rhinos

The total number of black rhinos remaining in Kenya is between 370 and 400 animals. The majority of these animals are located in 11 well protected areas which come under the general heading of rhino sanctuaries. None of these areas has more than 60 rhinos and of the areas concerned, six are ring fenced, three are partly fenced and two are open. Data from these 11 major protected rhino populations are shown in Table I. Two sanctuaries are at an early stage of stocking and development; the completed 93 km^2 Ol Pejeta Ranch Game Reserve has received only 4 males so far and the Tsavo Ngulia sanctuary, being extended this year to 73 km^2, has been stocked with six females and one male. Each of these sanctuaries eventually should be stocked with at least 20 rhinos in more balanced sex ratios.

In addition to the total of 285 black rhino in sanctuaries, a WWF-funded census has produced an estimated number of 85-100 rhinos living outside these areas. There still exist significant breeding populations of 20 in the Ngeng Valley and 12 in the Loita Hills. Other animals are widely separated and include rhinos still remaining in areas which have been heavily poached, such as Tsavo National Park outside the Ngulia sanctuary. Many of these 'outlier' rhinos are isolated and non-breeding individuals living in remote and largely unprotected areas. Although several have been captured since 1984, in particular to stock the Lewa Downs and Tsavo Ngulia rhino sanctuaries, the remaining outliers, almost by definition, are very difficult to locate and capture and hence costly to translocate.

Management of Sanctuaries

Apart from protection, the aim of the sanctuaries is to build up the number of rhinos as quickly as possible. In the absence of an adaptive management system which would maintain a defined balance of age structure and sex ratio, a fixed stocking rate approach is appropriate, particularly in the relatively small ring-fenced sanctuaries which range in area from 40 to 142 km^2 with an average of 55 km^2.[2] Initial estimates of the carrying capacities of the rhino sanctuaries have been calculated and are shown in Table 2. For each of the ring-fenced sanctuaries and Nairobi National Park the Ecological Carrying Capacity (ECC) was estimated and three-quarters of this figure was taken as the

Table I
The Black Rhinoceros in Kenya: Population Statistics as at the End of 1988

SANCTUARY: TYPE and Name	Males				Females				Unknown sex				TOTAL
	Adults >6yr	Sub-adult 4-6yr	Calves <4yr	Sub-total ♂	Adults >6yr	Sub-adult 4-6yr	Calves <4yr	Sub-total ♀	Adults >6yr	Sub-adult 4-6yr	Calves <4yr	Sub-total ?	
RING-FENCED													
Nakuru NP	8	3	0	11	5	2	0	7	0	0	2	2	20
Ngulia RS	1	0	0	1	5	1	0	6	0	0	2	2	9
Solio GR*	16	2	8	26	19	5	6	30	0	0	2	2	58
Lewa Downs RS*	1	1	1	3	5	1	4	10	0	0	0	0	13
Ol Jogi GR*	1	3	1	5	3	1	0	4	0	0	1	1	10
Ol Pejeta GR*	2	2	0	4	0	0	0	0	0	0	0	0	4
	29	11	10	50	37	10	10	57	0	0	7	7	114
PART-FENCED													
Nairobi NP	15	9	3	27	18	6	5	29	0	0	1	1	57
Aberdare NP^S	7	1	2	10	9	3	31	5	?	?	?	12	37
Laikipia R*	19	3	1	23	10	4	1	15	3	0	2	5	43
	41	13	6	60	39	13	9	59	3	0	3	18	137
UNFENCED													
Masai Mara GR	5	1	3	9	11	1	2	14	1	0	1	2	25
Amboseli NP	4	1	0	5	2	1	0	3	0	0	1	1	9
	9	2	3	14	13	2	2	17	1	0	2	3	34
TOTALS	79	26	19	124	89	25	21	133	4	0	12	28	285

NP = National Park GR = Game Reserve RS = Rhino Sanctuary R = Ranch * = Private Land ^{S} = Aberdares National Park Salient

number of rhinos the area should normally support, i.e. a management level of 75% of ECC. Rhinos surplus to this number would have to be removed to maintain maximum breeding output and adequate food supply. Calculation of such management levels is at present inappropriate for the Aberdares Salient, Laikipia Ranch, Masai Mara Game Reserve and Amboseli National Park, where, in each case, rhinos exist in a small and relatively secure but open area contained within a much larger potential distribution range. Carrying capacity in these open areas is primarily determined by the limits of the zone of security rather than ecological bounds

Breeding and Possible Problems

Indicators of breeding performance over the last four years are also given in Table II. Known births and deaths show that there have been 3½ times more births than deaths over the period and an approximate 5% annual increase in numbers overall.

The limitations on breeding output in high density rhino populations require much further study: the relationship between the effect of a given density of rhino and other browsers on vegetation and the rate of population increase may be complex. For example, a very marked over-browsing of a favoured species (*Acacia drepanolobium*) by rhinos in a high density of 1-1½ per km^2 on Solio Ranch Game Reserve, a small 56 km^2 area, as yet has had little or no deleterious influence on their very high breeding output. However, rhino populations exceeding the ECC of large areas have clearly suffered detrimental effects. Reduced calving as density increased has been recorded in the Central Complex Reserves in Zululand.[3] During the late 1960s, for areas of Tsavo National Park where rhinos were in a very high density of 0.9-1.4 rhino per km^2, Goddard noted reduced cow-calf ratios and lower percentages of calves compared to the values for animals living in low density areas.[4]

Recruitment rates recorded in the sanctuaries in recent years have varied considerably. An exceptionally high annual birth-rate of 15% from 1980-1986 at Solio Ranch, where virtually every adult female had a calf at foot, compares with a low recruitment of 2½% from 1986-89 at Laikipia Ranch, where there have been twice as many adult males as adult females and poor breeding performance from the latter. Solio Ranch has achieved a 12% net annual rate of increase while Nairobi National Park rhino population has grown at an annual rate of only 3% since stocking ceased in 1968.[5] Annual rates of recruitment for other parks and reserves and at various dates are shown in Table III.

Under present conditions the total capacity of the Kenya rhino sanctuaries is about 680 rhinos and, at a high 10% rate of recruitment, this figure could be easily bred from the present nucleus of 285 rhinos within the next ten years. By the turn of the century and certainly thereafter, the emphasis must be on restocking the large areas of former rhino distribution that remain in both highland and lowland areas of Kenya such as the

Table II
The Black Rhinoceros in Kenya: Management and Overall Breeding Performance from 1986 to 1989

SANCTUARY: TYPE and Name	Total	Management: Area of Sanctuary km^2	Management: Density of Rhinos km^{-2}	Management: Management Level	Management: Carrying Capacity[6]	Management: Existing Surplus of Rhinos	Breeding: Known Sex Ratio Male/Female	Breeding: % of Adult Cows with Calves	Breeding: % of Calves in Population	Births & Deaths: Total Births 1986-89	Births & Deaths: Total Births in 1989	Births & Deaths: Total Deaths 1986-89	Births & Deaths: Total Deaths in 1989	Census Rating[7]
RING-FENCED														
Nakuru NP	20	142	0.13	71	53	0	1.57	40	10.0	2	0	1	0	1
Ngulia RS	9	73	0.12	73	55	0	0.17	40	22.2	2	2	1	2	1
Solio GR*	58	56	1.04	56	42	16	0.87	84	27.6	17	5	1	0	1
Lewa Downs RS*	13	40	0.33	26	20	0	0.30	100	38.5	4	0	0	0	1
Ol Jogi GR*	10	73	0.14	20	15	0	1.25	67	20.0	3	1	1	1	1
Ol Pejeta GR*	4	93	0.04	93	70	0	-	-	0.0	0	0	0	0	1
	114	1135	0.10	337	253	16	0.88	73	24.7	28	8	4	3	
PART-FENCED														
Nairobi NP	57	117	0.49	60	45	12	0.93	50	15.8	12	2	5	1	1
Aberdare NP[S]	37	70	0.53	50	(50)	0	0.67	56	28.0	5	0	0	0	1
Laikipia R*	43	397	0.11	100	(100)	0	1.53	40	9.3	5	1	2	1	1
	137	584	0.23	210	195	12	1.02	46	13.1	22	3	7	2	
UNFENCED														
Masai Mara GR	25	1690	0.01	80	(80)	0	0.64	55	24.0	7	0	1	0	1
Amboseli NP	9	390	0.02	50	(50)	0	1.67	50	11.1	2	2	1	0	1
	34	2080	0.02	130	130	0	0.82	54	20.6	9	2	2	0	
TOTALS	285	3410	0.08	679	580	28	0.93	58	18.2	59	13	13	5	

NP = National Park GR = Game Reserve RS = Rhino Sanctuary R = Ranch * = Private Land [S] = Aberdares National Park Salient

Table III
Annual Recruiment Rates of Black Rhinoceros Populations

Area	Recruitment rate %	Authority
Olduvai Gorge	7.2	Goddard[8]
Ngorongoro Crater	7.0	Goddard[8]
Tsavo National Park	10.9	Goddard[9]
	8.2	Western and Sindiyo[10] (from Goddard[9] data)
Amboseli National Park	6.8	Western and Sindiyo[10]
Kruger National Park	9.0	Hall-Martin[11]
Hluhluwe Game Reserve	5.3	Hitchins and Anderson[12]
Umfolozi Game Reserve	11.0	Hitchins and Anderson[12]
Addo Elephant National Park	9.6	Hall-Martin[13]
Ndumu Game Reserve	8-9	Conway and Goodman[14]
Solio Ranch Game Reserve	15.0	Brett[15]

Aberdares and Tsavo National Parks. Ngulia sanctuary provides an example of a possible management approach. It is located deep inside Tsavo and has a fence designed purely to contain rhino for breeding while anti-poaching patrols maintain a zone of security extending far beyond the sanctuary area: surplus rhinos can simply be released to restock the surrounds and breed with the 'wild' population.

Managing a Metapopulation

Apart from the necessities of continuing to protect rhinos within sanctuaries and ensuring the integrity and security of future dispersal areas, other long-term management guidelines have already been recommended for maintaining demographic stability and genetic variability in rhino populations. These recommendations include ensuring that 15-20 unrelated breeding animals are gathered together to found a new population, that the habitat is capable of carrying at least 200 rhinos, and that one or two unrelated adults are moved into each population every generation or 6 to 15 years. The latter will involve the movement of animals between the Kenya sanctuaries as well as the capture and translocation of outliers.

However, there are a number of practical difficulties involved with moving rhinos between populations and some are enumerated below: the list should not be considered exhaustive:

1. In an area with a high rhino density there is often aggression between introduced rhinos and residents. When confined in small, ring-fenced sanctuaries, dominant males may be very aggressive and this behaviour is not confined only to males.[16] In Nakuru National Park a sub-adult female introduced from Solio Ranch in 1987 was so repeatedly attacked by an unknown rhino assailant that she had to be translocated. High levels of aggression, predominantly between adult males, has been recorded in artificially high density populations such as that in Addo Elephant National Park where there were 2 to 5 rhinos per km^2.[17]

2. The degree of success in breeding to be expected of rhinos brought into an area is unknown; particularly for males introduced to confined areas where mating is exclusive to one or a few dominant males.

3. The suitability of a particular rhino for immobilization varies and often relates to age and sex: females may be heavily pregnant or have small calves at foot. The home range of the animal is also a factor in deciding whether to capture: areas close to rivers or swamps make successful darting problematic.

4. The availability of animals of the required sex is limited: females are in great demand for improving breeding in all rhino areas.

5. There will be differences in habitat between donor and recipient areas: the browse species available, diseases such as trypanosomiasis, minerals, heat, disturbance, etc. all can influence the success of a translocation.[18]

6. There are many difficulties with the 'rescue'-type capture of outlier rhinos. The remoteness and inaccessibility of the animals and the typically unsuitable terrain make capture operations very expensive, if they are feasible at all.

7. There is risk of mortality during immobilization and translocation. Capture related death rates have been close to 5% in Kenya since 1984.

A 3rd generation three year-old female black rhino born in Solio Ranch Game Reserve

8. After release, the rhino may wander or stray into unprotected areas.

9. Owners of sanctuaries on private land have personal preferences and often form an attachment to particular animals.

The first three of these difficulties might be overcome by appropriate 'predictive' management, for example by moving young animals between sanctuaries in the hope they will eventually breed, or introducing rhinos only into low density populations. Young animals, particularly sub-adults, are the 'easiest' animals for translocation in any case. 'Swops' of breeding males between small sanctuaries where single males dominate and breed may also be feasible, but have not been attempted yet in Kenya. When stocking rhino sanctuaries, choosing unoccupied ranges as release points for new inhabitants may also relieve subsequent conflict. Solio Ranch Game Reserve was stocked with 23 rhinos over a ten year period, with animals released in many locations; only one sub-adult male was subsequently killed in fighting.

It has become clear that in the short term, demographic problems of age and sex bias in small populations can quickly limit their breeding performance. The pronounced preponderance of males in the indigenous Laikipia Ranch population has severely limited the number of calves born in recent years and, as part of a 'swop' of breeding males with Ol Jogi, the removal of the dominant male from Lewa Downs has resulted in there being no matings in this sanctuary for at least two years through lack of a capable successor.

Information and Research

With the largely anecdotal nature of many of the important past events in different rhino sanctuaries, it could be rewarding if the AERSG would serve as a focus for such limited information as is available since it strongly influences management decisions. The data would provide a basis for decision rules in management and, in addition, criteria for the selection of sanctuary areas. Given limited funds, sound assessment of the genetic value of translocations, which each cost approximately US$ 10,000 in Kenya in 1989, will become increasingly important as will a dispassionate appraisal of the effectiveness, in breeding terms, of rescuing outliers as opposed to moving others between sanctuaries.

Detailed population viability analyses (PVA) are required to enable interactive management of the small sanctuary rhino populations in Kenya, and to make the best use of inviable or 'doomed' outliers when they can be captured. Data now exist, and monitoring is sufficient in many of the sanctuaries for such PVAs to be made. Collection of material for genetic analyses of these populations and outliers could allow the genetic value of these animals to be assessed and, perhaps, future levels of inbreeding to be determined.

Further study of rhino in well-monitored areas can provide facts relating to the proportion of males breeding, their turnover, generation times, mortality curves, and other characteristics and structures. In turn, this will enable for each sanctuary a better estimation of the effective population size, Ne, a measure of the competence with which each population of N rhinos can propagate its reserves of genetic variation to the next generation, and how this is influenced by sex ratio, age structure, habitat and confinement. From available information for Kenyan sanctuaries, N_e/N ratios are in the range 0.2-0.4, with seven of the populations having ratios of about 0.4, and lower ratios of 0.2 and 0.3 in Lewa Downs and Ol Jogi where single dominant males monopolise breeding.

Conclusion

Crucial to the success of the existing rhino sanctuaries is continued security and this will largely depend on the maintenance of fencing, anti-poaching surveillance and monitoring. The sanctuaries can only be considered a complete success when surpluses of rhino bred there have restocked the former areas of distribution such as Tsavo. Despite such errors as the abortive Meru National Park sanctuary, the achievements to date are encouraging. In spite of occasional poaching of animals outside sanctuaries, the total number of black rhinos in Kenya is slowly increasing. The expenditure of the largest part of conservation funds for black rhino on small sanctuaries is beginning to show success in terms of breeding output, results which would not have been realized if the limited amount of money had been spread more thinly.[19]

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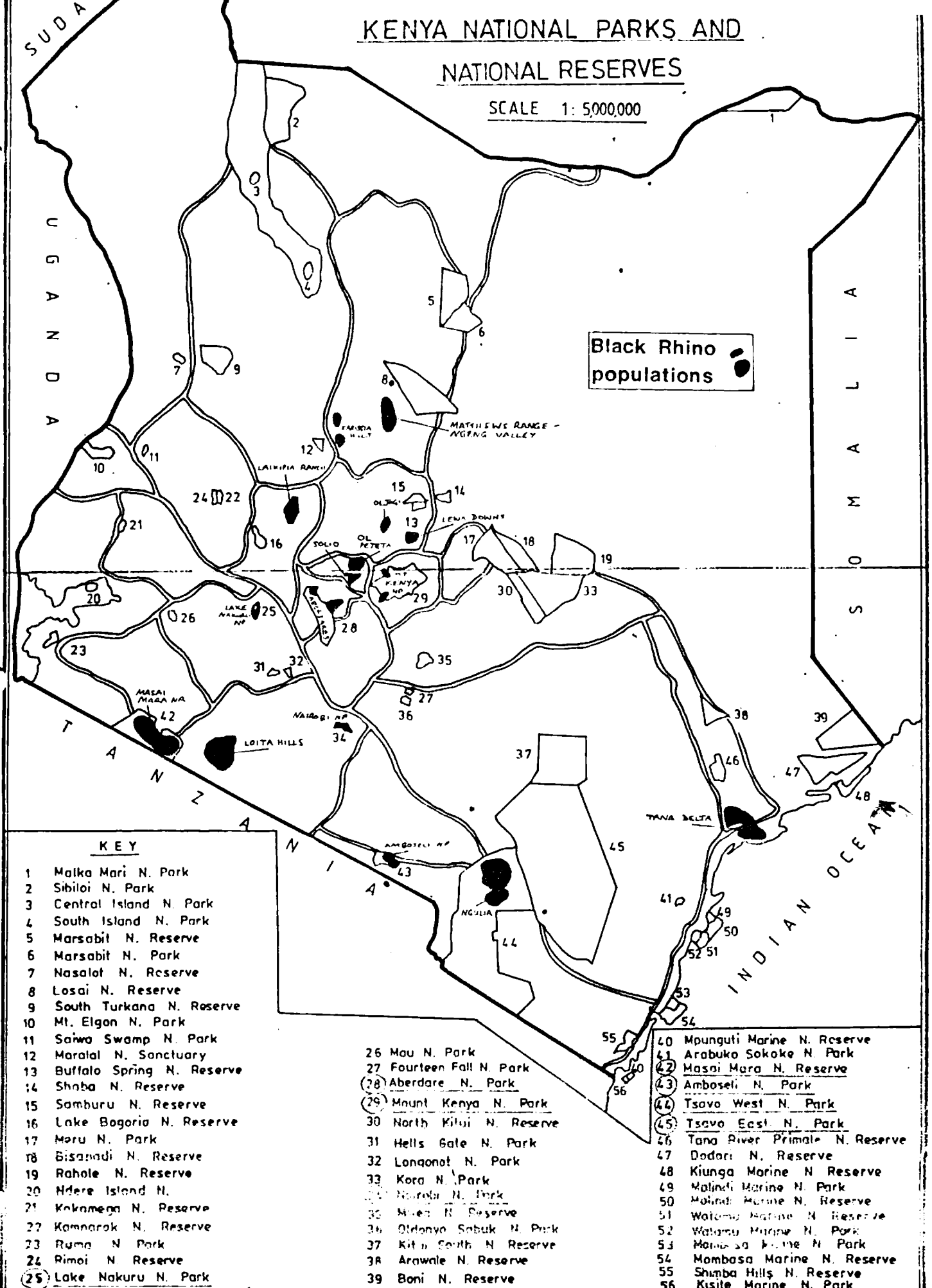

Compiled and Drawn By F.N. Muchiri

Rhino Area: Type & Name	----Males----- AD	SA	CF	ST	----Females--- AD	SA	CF	ST	--Unknown Sex-- AD	SA	CF	ST	TOT	-----Management------ A	D	CC	ML	S	---Breeding--- SR	%CC	%C	1986-90 +	-	1990 +	-	Trans-90 In	Out	CR
RING-FENCED:																														
Nakuru NP	11	2	1	14	8	2	2	12			2	2	28	142	0.20	71	53		1.17	63	17.8	6		4		4		1
Ngulia RS	1	1	1	3	4	3		7			1	1	11	73	0.15	73	55		0.43	14	9.0	3	2	1		1		1
Solio R GR	14	4	6	24	21	2	4	27			5	5	56	56	1.00	56	42	14	0.89	71	26.8	23	6	6	1		6	1
Lewa Downs R RS	2	2		4	5	2	3	10					14	40	0.35	26	20		0.28	43	21.4	4	1		1	2		1
Ol Jogi R GR	2	2	1	5	3	1	1	5			1	1	11	73	0.15	20	15		1.00	100	27.2	4	1	1				1
Ol Pejeta R GR	2	2		4	1	3		4					8	93	0.09	93	70		1.00	0	0.0					5		1
Total	32	13	9	54	42	13	10	65	0	0	9	9	128	477	0.27	339	255	14	0.83	67	21.9	40	10	12	2	12	6	
PART-FENCED:																												
Nairobi NP	18	4	7	29	18	9	4	31			1	1	61	117	0.52	60	45	16	0.94	67	19.7	18	2	6			5	1
Aberdare NP	8	1	1	10	10	3	2	15	12		3	15	40	70	0.57	50	(50)		0.67	56	28.0	8		3				2
Laikipia R	18	5		23	10	4	1	15	3	1	2	6	44	397	0.11	100	(100)		1.53	30	6.8	6	1	1				1
Total	44	10	8	62	38	16	7	61	15	1	6	22	145	584	0.25	210	195	16	1.02	55	14.5	32	3	10	0	0	5	
UNFENCED:																												
Masai Mara NR	4	4	4	12	9	1	2	12					24	1690	0.01	50	(50)		1.00	67	37.5	11	2	4	2			1
Amboseli NP	2	1		3	2	1	1	4					7	390	0.02	50	(50)		0.75	50	14.3	3	3	1	1			1
Total	6	5	4	15	11	2	3	16	0	0	0	0	31	2080	0.01	100	100		0.94	47	22.6	14	5	5	3	0	0	
TOTALS	82	28	21	131	91	31	20	142	15	1	15	31	304	3141	0.10	649	550	30	0.92	62	18.4	86	18	27	5	12	11	

Key:
AD=Adults (>6 y.o.)
SA=Subadults (4-6 y.o.)
CF=Calves (<4 y.o.)
ST=Subtotal (Sex)
TOT=Population total
A=Area of rhino reserve (sq km)
D=Density of rhino (per sq km)
CC=Carrying Capacity (Brett (1989) estimate)
ML=Management Level
S=Existing Surplus of Rhino (number of rhino exceeding ML (TOT-ML), available for translocation
SR=Known Sex Ratio (No.Males/No.Females)
%CC=Percentage of Adult Female (Cow) Rhinos with Calves
%C=Percentage of Calves in population
'+'=Total No. of Births for stated period
'-'=Total No. of Deaths for stated period
Trans-90=Total No. of translocations In and Out of sanctuary in 1990
CR=Census Rating (Du Toit 1989)
NP=National Park
NR=National Reserve
GR=Game Reserve
R=Private Ranch

Table 1 - Population Statistics for the black rhino in Kenya sanctuaries (at the end of 1990), and overall breeding performance from 1986 to 1990

Rhino Area: Type & Name	----Males----- AD	SA	CF	ST	----Females--- AD	SA	CF	ST	--Unknown Sex-- AD	SA	CF	ST	TOT
RING-FENCED:													
Lake Nakuru NP	11	2	1	14	8	2	2	12			2	2	28
Ngulia RS	1	1	1	3	4	3		7			1	1	11
Solio R GR	14	4	6	24	21	2	4	27			5	5	56
Lewa Downs R RS	2	2		4	5	2	3	10					14
Ol Jogi R GR	2	2	1	5	3	1	1	5			1	1	11
Ol Pejeta R GR	2	2		4	1	3		4					8
Total	32	13	9	54	42	13	10	65	0	0	9	9	128
PART-FENCED:													
Nairobi NP	18	4	7	29	18	9	4	31			1	1	61
Aberdare NP	8	1	1	10	10	3	2	15	12		3	15	40
Laikipia R	18	5		23	10	4	1	15	3	1	2	6	44
Total	44	10	8	62	38	16	7	61	15	1	6	22	145
UNFENCED:													
Masai Mara NR	4	4	4	12	9	1	2	12					24
Amboseli NP	2	1		3	2	1	1	4					7
Total	6	5	4	15	11	2	3	16	0	0	0	0	31
TOTALS	82	28	21	131	91	31	20	142	15	1	15	31	304

OTHER AREAS (OUTLIERS):

Tsavo West NP	15
Tsavo East NP	1
Mt Kenya NP	10
Aberdares NP North	4
Loita Hills	12
Ngeng Valley	20
Karissia Hills/Barsaloi	6
Tana River-Garsen-Lamu	12
Jilori-Chacama	1
Tharaka-Kiagu Hill	1
Ndotos-Losai	1
Chyulu Hills North	1
Orphans	5
Total	88
KENYA MINIMUM TOTAL	392

Key: AD=Adults (>6 y.o.)
SA=Subadults (4-6 y.o.)
CF=Calves (<4 y.o.)
ST=Subtotal (Sex)
TOT=Population total

Population Statistics for black rhinos in Kenya (at the end of 1990)

KENYA RHINO PROJECT
POPULATION STATISTICS
SEPTEMBER 1991.

RHINO AREA	MAD	MSA	MCF	MST	FAD	FSA	FCF	FST	UAD	USA	UCF	UST	TOTAL
** RING FENCE													
NAKURU PARK	11	2	1	14	8	2	2	12	0	0	3	3	29
NGULIA SANCTUARY	2	0	1	3	3	3	0	6	0	0	2	2	11
SOLIO RANCH	14	4	6	24	21	2	4	27	0	0	6	6	57
LEWA DOWNS	2	2	0	4	5	2	4	11	0	0	0	0	15
OL JOGI RANCH	2	2	1	5	3	1	1	5	0	0	1	1	11
OL PEJETA RANCH	2	2	0	4	1	3	0	4	0	0	0	0	8
** Subtotal **	33	12	9	54	41	13	11	65	0	0	12	12	131
** PART FENCE													
NAIROBI PARK	19	6	8	33	18	5	4	27	0	0	1	1	61
ABERDARE PARK	8	1	1	10	10	3	2	15	12	0	3	15	40
LAIKIPIA RANCH	18	5	0	23	10	4	1	15	3	1	2	6	45
** Subtotal **	45	12	9	66	38	12	7	57	15	1	6	22	146
** UNFENCED													
MASAI MARA	4	4	4	12	9	1	2	12	0	0	0	0	24
AMBOSELI PARK	2	1	0	3	2	1	1	4	0	0	0	0	7
** Subtotal **	6	5	4	15	11	2	3	16	0	0	0	0	31
*** Total ***	84	29	22	135	90	27	21	138	15	1	18	34	308

NB.

MAD Male Adult
MSA Male sub-adult
MCF Male calf
MST Male subtotal
FAD Female adult
FSA Female subtotal
FCF Female calf
FST Female subtotal
UAD Un-identified adult
USA Un-identified sub-adult
UCF Un-identified calf
UST Un-identified subtotal

	1990	IN	OUT	BIRTHS	DEATHS	1991
SANCTUARIES/PROTECTED:						
NAIROBI NP	61	0	1	3	1	62
SOLIO GR	56	0	0	3	0	59
ABERDARES NP	40	0	0	2	0	42
LAIKIPIA R	44	0	7	1	0	38
LAKE NAKURU NP	28	0	0	2	1	29
MASAI MARA NR	24	1	0	1	0	26
LEWA DOWNS RS	14	1	1	1	4	11
NGULIA RS	11	1	0	0	0	12
OL JOGI GR	11	0	0	1	1	11
OL PEJETA GR	8	1	1	1	1	8
AMBOSELI NP	7	0	2	0	2	3
TOTAL	304	4	12	15	10	304
OTHER PROTECTED:						
TSAVO WEST	15	0	0	1	0	16
LOITA HILLS	12	0	0	0	0	12
NGENG VALLEY	15	0	0	0	0	15
MT KENYA NP	10	0	0	0	0	10
ABERDARES N	4	0	0	0	0	4
ORPHANS	5	1	0	0	0	6
TOTAL	61	1	0	1	0	63
OUTLIERS:						
TANA RIVER	12	0	0	0	0	12
KARISSIAS	6	0	0	0	0	6
LOUNIEK	0	5	0	0	0	5
KENO	0	4	0	0	0	4
RUMURUTI FOR	0	2	0	0	0	2
MOYALE	2	0	0	0	0	2
KIAGU	1	0	0	0	1	0
JILORI-CHACAMA	1	0	0	0	0	1
CHYULUS N	1	0	0	0	0	1
TOTAL	23	11	0	0	0	33
KENYA TOTAL	388	16	12	16	11	401

SOLIO RANCH GAME RESERVE BLACK RHINO LIST
24-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
F3	4501	F	20		0		0
F3 CALF 2	4502	M	3	F3	4501	M8?	4523
F8	4503	F	7	F5?	0		0
F4	4504	F	15		0		0
F4 CALF 2	4505	F	2	F4	4504	M8?	0
F1 LAMURIA	4506	F	20		0		0
F1 CALF 4	4507	M	3	LAMURIA F1	4506	M8	4523
M2 RUDI	4508	M	22		0		0
F12 LAMURIA	4509	F	20		0		0
F12 CALF 3	4510	M	3	LAMURIA 2 F12	4509		0
F13	4511	F	9	LAMURIA 2 F12	4509		0
F6	4512	F	15		0		0
F6 CALF 1	4513	M	3	F6	4512	M4?	4514
M4 BORAN BULL	4514	M	25		0		0
F7 RIDGEBACK	4515	F	20		0		0
F7 CALF 3	4516	M	3	RIDGEBACK F7	4515		0
M16	4517	M	15		0		0
M5 RED TANK	4518	M	20		0		0
F5	4519	F	20		0		0
F5 CALF 4	4520	F	3	F5	4519	M8	4523
M6 3 HORNS	4521	M	15		0		0
F9 OLD NARIBO	4522	F	35		0		0
M8	4523	M	20		0		0
M7	4524	M	20		0		0
M17	4525	M	0	F11?	4530		0
M9 LONG LEGS	4526	M	8		0		0
M10	4527	M	15		0		0
F2 LAMURIA 3	4528	F	20		0		0
F2 CALF 2	4529	M	2	F2 LAMURIA 3	4528		0
F11	4530	F	30		0		0
F11 CALF 2	4531	F	4	F11	4530		0
M14 SOBAT	4532	M	15		0		0
M11	4533	M	15		0		0
F14	4534	F	20		0		0
F14 CALF 3	4535	F	3	F14	4534		0
M13	4536	M	6		0		0
F15	4537	F	6		0		0
F16	4538	F	15		0		0
F16 CALF 1	4539	M	3	F16	4538	M15?	4549
M12	4540	M	15	F7	4515		0
M1	4541	M	15		0		0
M17	4542	F	6	F7	4515		0
F20	4543	F	20		0		0
F10	4544	F	15		0		0
F10 CALF 1	4545	?	2	F10	4544		0
F18	4546	F	15		0		0
F18 CALF	4547	F	5	F18	4546		0
M3	4548	M	15		0		0
M15 MARIO	4549	M	25		0		0
F19	4550	F	20		0		0
F19 CALF 2	4551	?	3	F19	4550	M16	4517
F21	4552	F	20		0		0

SOLIO RANCH GAME RESERVE BLACK RHINO LIST
24-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
F21 CALF 2	4553	M	3	F21	4552		0
F22	4554	F	8	F12?	4509		0
F23	4555	F	20		0		0
F24	4556	F	15		0		0
F24 CALF 1	4557	F	1	F24	4556	M11 ?	4533
M18	4558	M	15		0		0
STROPPIE	4601	F	20		0		0
HOSHIM	4600	M	17		0		0
BONZO	4900	M	0	F1 LAMURIA	4506		0
455	4901	F	12		0		0
452	4902	M	12		0		0
451	4903	F	20		0		0
453	4904	F	20		0		0
453 CALF 1	4905	M	1	453	4904		0
MIA F20 CALF	4559	F	5	F20	4543		0
F22 CALF 1	4560	?	1	F22	4554		0
F1 CALF 5	4561	F	1	F1 LAMURIA	4506	M8	4523
F20 CALF 2	4562	?	0	F20	4543		0
F4 CALF 3	4563	?	0	F4	4504	M8	4523
F7 CALF 4	4564	?	0	F7	4515		0
F14 CALF 4	4565	?	0	F14	4534	M11 ?	4533

SOLIO RANCH RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	13	19	0	32
SUBADULTS	2	4	2	8
CALVES	9	4	6	19
TOTAL	24	27	8	59

NAIROBI NP BLACK RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
NAIROBI	1	M	27		0		0
MIRIAM	2	F	29		0		0
LILIAN	4	F	8	MIRIAM	2	NAIROBI	1
MARK	5	M	9		0		0
MATTHEW	7	M	10	SUSIE	6		0
FATUMA	8	F	18		0		0
KHALI	10	F	31		0		0
CAMPIE	11	M	5	KHALI	10		0
STELLA	12	F	33		0		0
KADOGO	13	F	5	STELLA	13		0
OBSERVATION	14	M	11		0		0
MUKOYETI	15	M	11		0		0
CHIRO	16	F	9		0		0
CHRISTOPHER	17	M	4	CHIRO	16		0
NDICHU	18	M	12		0		0
RICHARD	19	M	12		0		0
HERIN	20	F	13		0		0
KYELA	21	M	5	HERIN	20		0
TITUS	22	M	13		0		0
DUROKO	23	M	13		0		0
KINYANJUI	24	M	14		0		0
JEE	25	F	14		0		0
KOSKEI	26	M	20		0		0
MOSHI	27	F	15		0		0
BEHEWA	28	F	3	MOSHI	27	NAIROBI	1
KIMELEL	29	M	21		0		0
KING	30	M	15	DAPHNE	31		0
DAPHNE	31	F	22		0		0
SVEDA	32	F	3	DAPHNE	31		0
ORMANYI	33	F	23		0		0
WAIRIMU	34	F	5	ORMANYI	33	RICHARD/TIM	0
BILL	35	M	6		0		0
HOOKIE	36	F	16		0		0
MUKOROFI	37	M	16		0	KINUTHIA	49
SARAH	39	F	17		0		0
LYNDA	40	F	3	SARAH	39		0
HYRAX	41	M	17		0		0
MURRAM	43	M	35		0		0
ERIC	44	M	24		0		0
CATHERINE	45	F	25		0		0
CAROL	46	F	5	KATHERINE	45		0
NANCY	47	F	18		0		0
NDUNGI	48	M	2	NANCY	47		0
KINUTHIA	49	M	26		0		0
TIM	50	M	19		0		0
JEREMY	54	M	3	MAIN GATE	53		0
WANGARE	55	F	27		0		0
WANJIKU	56	F	3	WANGARE	55	KIMELEL	29
KISEMBE	57	M	18		0		0
MORAIRA	58	M	18		0		0
FLORENCE	59	F	19		0		0
BOMAS	60	M	18		0		0

NAIROBI NP BLACK RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
MOSES	61	M	2	HERIN	20	KOSKEI/DURUKO	0
GICHUKI	62	M	3	FATUMA	8	NAIROBI	1
MBAASI	63	M	2	CATHERINE	45	MURRAM	43
MOSONGO	64	M	3	KHALI	10	KIMELEL	29
ANN	65	F	2	SARAH	39	KINUTHIA	49
DAIDAI	66	F	2	MIRIAM	2	NAIROBI	1
SISO	67	M	1	LILIAN	4	NAIROBI	1
MAX	68	M	0	MOSHI	27	NAIROBI	1
ADAM	69	M	0	HOOKIE	36		0
FLORENCE'S CALF	70	F	0	FLORENCE	59		0
STELLA'S CALF	71	M	2	STELLA	12	KIMELEL	29

NAIROBI NP BLACK RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	21	17	0	38
SUBADULTS	2	5	0	7
CALVES	9	7	2	18
TOTAL	32	29	2	63

LAKE NAKURU NP BLACK RHINO POPULATION LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
AMBONI	501	M	15	JUNO	2506		0
KISERIAN	502	M	20		0		0
TATU	503	M	10		0		0
RIDGEBACK	504	M	8	F9 OLD NARIBO	4522		0
NDERIT	505	M	13		0		0
MWIKALI	506	F	19		0		0
JEBUNGEI	508	F	10		0		0
MAJOR MWANGI	509	M	9		0		0
WANGARI	510	F	10		0		0
NDUKU	511	F	11		0		0
NYAHURURU	512	M	7		0		0
RODNEY	513	M	15		0		0
SINDANO	514	M	12		0		0
MAMA WINNIE	515	F	12		0		0
WANGARI	516	F	11		0		0
WACHIRA	517	M	11		0		0
MWENDE	518	F	30		0		0
KISEE	519	M	20		0		0
KAGIRI	521	M	3	MWIKALI	506	MARIO M15	4549
NG'ANG'A	525	M	4		0		0
CALF	526	?	2	JEBUNGEI	508		0
WINNIE MANDELA	527	F	0	MAMA WINNIE	515		0
JAMBI	3	F	4	MIRIAM	2	NAIROBI	1
SIHOHO	9	M	4	FATUMA	8	NAIROBI	1
SUZIE	6	F	8		0		0
JUDY	52	F	6		0		0
0516 CALF 1	528	?	2		516		0
CALF	529	F	1	WANGARI 1	510		0
KYELA	530	F	0	SUZIE	6	NAIROBI	1
MBURUGU	531	M	0	MWIKALI	506		0
	0		0		0		0

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	10	8	0	18
SUBADULTS	3	2	0	5
CALVES	1	3	2	6
TOTAL	14	13	2	29

MASAI MARA NATIONAL RESERVE BLACK RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
MARY	1501	F	20		0		0
MAMA KAYAI	1502	F	20		0		0
SUSAN	1504	F	15		0		0
NUMBER SIXTEEN	1505	F	15		0		0
MTOTO WA FATUMA	1506	F	15	FATUMA	0	KIPANGA	1517
WANJIRU	1507	F	10	MARY	1501	AMUKATWENDE	1514
GATHONI	1508	F	8	MARY	1501	UMEME	1515
KAYAI	1509	F	10	MAMA KAYAI	1502	AMUKATWENDE	1514
CHEBRECH	1510	F	8	MAMA KAYAI	1502	UMEME	1515
HELICOPTER	1511	F	6	NUMBER SIXTEEN	1505	UMEME	1515
NAISHURU	1512	F	3	HALIMA	1503	KIOKO	1516
CHEPKOSKEI	1513	F	3	MAMA KAYAI	1502	AMUKATWENDE	1514
AMUKATWENDE	1514	M	20		0		0
UMEME	1515	M	20		0		0
KIOKO	1516	M	15		0		0
KIPANGA	1517	M	15		0		0
KEN	1518	M	5	SUSAN	1504	AMUKATWENDE	1514
PERTET	1519	M	5	MAMA KAYAI	1502	UMEME	1515
PAUL	1520	M	5	MARY	1501	UMEME	1515
CHARLIE	1521	M	3	MARY	1501	UMEME	1515
CALF	1523	F	2	NUMBER SIXTEEN	1511	UMEME	1515
KARANJA	1524	M	20		0		0
CALF	1526	F	1	KAYAI	1509		0
CALF	1528	M	1	WANJIRU	1507		0
CALF	1529	M	1	MTOTO WA FATUMA	1506		0
CALF	1530	M	0	SUSAN	1504		0

MASAI MARA RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	5	9	0	14
SUBADULTS	4	1	0	5
CALVES	4	3	0	7
TOTAL	13	13	0	26

OL JOGI GAME RESERVE BLACK RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
OL JOGI	3501	M	20		0		0
MAMA SAFI	3502	F	20		0		0
MAMA KALI	3503	F	20		0		0
JAMES	3505	M	8	MAMA KALI	3503	OL JOGI	3501
MALAIKA	3506	F	7	MAMA SAFI	3502	OL JOGI	3501
EPON	3507	M	6	MAMA KALI	3503	OL JOGI	3501
AMORU	3508	M	4	MAMA KALI	3503	OL JOGI	3501
EKILE	3509	M	4	MAMA SAFI	3502	OL JOGI	3501
LENANA	3510	M	2	MAMA KALI	3503	OL JOGI	3501
NO NAME	3511	F	1	MAMA SAFI	3502	OL JOGI	3501
SHATOOSH	3512	F	8	SOLIO COW	0	SOLIO BULL	0

OL JOGI BLACK RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	2	3	0	5
SUBADULTS	3	1	0	4
CALVES	1	1	0	2
TOTAL	6	5	0	11

LEWA DOWNS RANCH - NGARE SERGOI SANCTUARY RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
SHABA	2503	F	15		0		0
STUMPY	2504	F	25		0		0
SOLIA	2505	F	18		0		0
JUNO	2506	F	30		0		0
MAWINGO	507	F	7	SOLIO COW	0	SOLIO BULL	0
SAMIA	2508	F	6	SOLIA	2505	SOLIO BULL	0
JUNIPER	2509	F	3	JUNO	2506	NGOTHO	2501
KELELE	2510	M	10	RONGAI	2502	MWEIGA BULL	0
JILALE	2513	F	3	RONGAI	2502	NGOTHO	2501
ZARIA	2514	F	3	SOLIA	2505	NGOTHO	2501
CALF	2516	F	0	SOLIA	2505	KELELE	2510

LEWA DOWNS RANCH RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	1	5	0	6
SUBADULTS	0	2	0	2
CALVES	0	3	0	3
TOTAL	1	10	0	11

NGULIA RHINO SANCTUARY BLACK RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
KIBWEZI 1	5001	F	25		0		0
KIBWEZI 2	5002	F	20		0		0
KIBWEZI 3	5003	F	15		0		0
TAITA 1	5004	F	20		0		0
TAITA 2	5005	F	15		0		0
NGULIA	5007	M	15		0		0
CALF 1	5008	M	5		0		0
CALF 2	5009		4		0		0
CALF 3	5010		3		0		0
CHRIS GACAHU	42	M	8		0		0
MISS MAKTAU	5011	F	15		0		0
SIMON	51	M	10	MAIN GATE	53		0

NGULIA RHINO SANCTUARY - BLACK RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	3	6	0	9
SUBADULTS	1	0	1	2
CALVES	0	0	1	1
TOTAL	4	6	2	12

LAIKIPIA RANCH

BLACK RHINO POPULATION BREAKDOWN

28-10-91

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	18	10	1	29
SUBADULTS	2	23	2	7
CALVES	0	1	1	2
TOTAL	20	14	4	38

ABERDARE NATIONAL PARK

BLACK RHINO POPULATION BREAKDOWN

SAMPLE OF 33 RHINOS IDENTIFIED AT THE ARK LODGE

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	8	12	0	20
SUBADULTS	2	3	0	5
CALVES	3	5	0	8
TOTAL	13	20	0	33

Rhino Area: Type & Name	Males AD	Males SA	Males CF	Males ST	Females AD	Females SA	Females CF	Females ST	Unknown Sex AD	Unknown Sex SA	Unknown Sex CF	Unknown Sex ST	TOT	Management A	Management D	Management CC	Management ML	Management S	Breeding SR	Breeding %CC	Breeding %C	1986-90 +	1986-90 -	1990 +	1990 -	Trans-90 In	Trans-90 Out	CR
RING-FENCED:																												
Lake Nakuru NP	11	2	1	14	8	2	2	12			2	2	28	142	0.20	71	53		1.17	63	17.8	6		4		4		1
Ngulia RS	1	1	1	3	4	3		7			1	1	11	73	0.15	73	55		0.43	14	9.0	3	2	1		1		1
Solio R GR	14	4	6	24	21	2	4	27			5	5	56	56	1.00	56	42	14	0.89	71	26.8	23	6	6	1		6	1
Lewa Downs R RS	2	2		4	5	2	3	10					14	40	0.35	26	20		0.28	43	21.4	4	1		1	2		1
Ol Jogi R GR	2	2	1	5	3	1	1	5			1	1	11	73	0.15	20	15		1.00	100	27.2	4	1	1				1
Ol Pejeta R GR	2	2		4	1	3		4					8	93	0.09	93	70		1.00	0	0.0					5		1
Total	32	13	9	54	42	13	10	65	0	0	9	9	128	477	0.27	339	255	14	0.83	67	21.9	40	10	12	2	12	6	
PART-FENCED:																												
Nairobi NP	18	4	7	29	18	9	4	31			1	1	61	117	0.52	60	45	16	0.94	67	19.7	18	2	6			5	1
Aberdare NP	8	1	1	10	10	3	2	15	12		3	15	40	70	0.57	50	(50)		0.67	56	28.0	8		3				2
Laikipia R	18	5		23	10	4	1	15	3	1	2	6	44	397	0.11	100	(100)		1.53	30	6.8	6	1	1				1
Total	44	10	8	62	38	16	7	61	15	1	6	22	145	584	0.25	210	195	16	1.02	55	14.5	32	3	10	0	0	5	
UNFENCED:																												
Masai Mara NR	4	4	4	12	9	1	2	12					24	1690	0.01	50	(50)		1.00	67	37.5	11	2	4	2			1
Amboseli NP	2	1		3	2	1	1	4					7	390	0.02	50	(50)		0.75	50	14.3	3	3	1	1			1
Total	6	5	4	15	11	2	3	16	0	0	0	0	31	2080	0.01	100	100		0.94	47	22.6	14	5	5	3	0	0	
TOTALS	82	28	21	131	91	31	20	142	15	1	15	31	304	3141	0.10	649	550	30	0.92	62	18.4	86	18	27	5	12	11	

Key:
AD=Adults (>6 y.o.)
SA=Subadults (4-6 y.o.)
CF=Calves (<4 y.o.)
ST=Subtotal (Sex)
TOT=Population total
A=Area of rhino reserve (sq km)
D=Density of rhino (per sq km)
CC=Carrying Capacity (Brett (1989) estimate)
ML=Management Level
S=Existing Surplus of Rhino (number of rhino exceeding ML (TOT-ML), available for translocation
SR=Known Sex Ratio (No.Males/No.Females)
%CC=Percentage of Adult Female (Cow) Rhinos with Calves
%C=Percentage of Calves in population
'+'=Total No. of Births for stated period
'-'=Total No. of Deaths for stated period
Trans-90=Total No. of translocations In and Out of sanctuary in 1990
CR=Census Rating (Ou Toit 1989)
NP=National Park
NR=National Reserve
GR=Game Reserve
R=Private Ranch

Population Statistics for the black rhino in Kenya sanctuaries (at the end of 1990), and overall breeding performance from 1986 to 1990

Rhino Area: Type & Name	Males AD	Males SA	Males CF	Males ST	Females AD	Females SA	Females CF	Females ST	Unknown Sex AD	Unknown Sex SA	Unknown Sex CF	Unknown Sex ST	TOT
RING-FENCED:													
Lake Nakuru NP	11	2	1	14	8	2	2	12			2	2	28
Ngulia RS	1	1	1	3	4	3		7			1	1	11
Solio R GR	14	4	6	24	21	2	4	27			5	5	56
Lewa Downs R RS	2	2		4	5	2	3	10					14
Ol Jogi R GR	2	2	1	5	3	1	1	5			1	1	11
Ol Pejeta R GR	2	2		4	1	3		4					8
Total	32	13	9	54	42	13	10	85	0	0	9	9	128
PART-FENCED:													
Nairobi NP	18	4	7	29	18	9	4	31			1	1	61
Aberdare NP	8	1	1	10	10	3	2	15	12		3	15	40
Laikipia R	18	5		23	10	4	1	15	3	1	2	6	44
Total	44	10	8	62	38	16	7	61	15	1	6	22	145
UNFENCED:													
Masai Mara NR	4	4	4	12	9	1	2	12					24
Amboseli NP	2	1		3	2	1	1	4					7
Total	6	5	4	15	11	2	3	16	0	0	0	0	31
TOTALS	82	28	21	131	91	31	20	142	15	1	15	31	304

OTHER AREAS (OUTLIERS):	
Tsavo West NP	15
Tsavo East NP	1
Mt Kenya NP	10
Aberdares NP North	4
Loita Hills	12
Ngeng Valley	20
Karissia Hills/Barsaloi	6
Tana River-Garsen-Lamu	12
Jilori-Chacama	1
Tharaka-Kiagu Hill	1
Ndotos-Losai	1
Chyulu Hills North	1
Orphans	5
Total	88
KENYA MINIMUM TOTAL	392

Key:
AD=Adults (>6 y.o.)
SA=Subadults (4-6 y.o.)
CF=Calves (<4 y.o.)
ST=Subtotal (Sex)
TOT=Population total

Population Statistics for black rhinos in Kenya (at the end of 1990)

Rhino Area: Type & Name	----Males----- AD	SA	CF	ST	----Females--- AD	SA	CF	ST	--Unknown Sex-- AD	SA	CF	ST	TOT	-----Management------ A	D	CC	ML	S	---Breeding--- SR	%CC	%C	1986-90 +	-	1990 +	-	Trans-90 In	Out	CR
RING-FENCED:																													
Nakuru NP	11	2	1	14	8	2	2	12			2	2	28	142	0.20	71	53		1.17	63	17.8	6		4		4		1
Ngulia RS	1	1	1	3	4	3		7			1	1	11	73	0.15	73	55		0.43	14	9.0	3	2	1		1		1
Solio R GR	14	4	6	24	21	2	4	27			5	5	56	56	1.00	56	42	14	0.89	71	26.8	23	6	6	1		6	1
Lewa Downs R RS	2	2		4	5	2	3	10					14	40	0.35	26	20		0.28	43	21.4	4	1		1	2		1
Ol Jogi R GR	2	2	1	5	3	1	1	5			1	1	11	73	0.15	20	15		1.00	100	27.2	4	1	1				1
Ol Pejeta R GR	2	2		4	1	3		4					8	93	0.09	93	70		1.00	0	0.0					5		1
Total	32	13	9	54	42	13	10	65	0	0	9	9	128	477	0.27	339	255	14	0.83	67	21.9	40	10	12	2	12	6	
PART-FENCED:																													
Nairobi NP	18	4	7	29	18	9	4	31			1	1	61	117	0.52	60	45	16	0.94	67	19.7	18	2	6			5	1
Aberdare NP	8	1	1	10	10	3	2	15	12		3	15	40	70	0.57	50	(50)		0.67	56	28.0	8		3				2
Laikipia R	18	5		23	10	4	1	15	3	1	2	6	44	397	0.11	100	(100)		1.53	30	6.8	6	1	1				1
Total	44	10	8	62	38	16	7	61	15	1	6	22	145	584	0.25	210	195	16	1.02	55	14.5	32	3	10	0	0	5	
UNFENCED:																													
Masai Mara NR	4	4	4	12	9	1	2	12					24	1690	0.01	50	(50)		1.00	67	37.5	11	2	4	2			1
Amboseli NP	2	1		3	2	1	1	4					7	390	0.02	50	(50)		0.75	50	14.3	3	3	1	1			1
Total	6	5	4	15	11	2	3	16	0	0	0	0	31	2080	0.01	100	100		0.94	47	22.6	14	5	5	3	0	0	
TOTALS	82	28	21	131	91	31	20	142	15	1	15	31	304	3141	0.10	649	550	30	0.92	62	18.4	86	18	27	5	12	11	

Key:
AD=Adults (>6 y.o.)
SA=Subadults (4-6 y.o.)
CF=Calves (<4 y.o.)
ST=Subtotal (Sex)
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CR=Census Rating (Du Toit 1989)
NP=National Park
NR=National Reserve
GR=Game Reserve
R=Private Ranch

Table 1 - Population Statistics for the black rhino in Kenya sanctuaries (at the end of 1990), and overall breeding performance from 1986 to 1990

Rhino Area: Type & Name	----Males----- AD	SA	CF	ST	----Females--- AD	SA	CF	ST	--Unknown Sex-- AD	SA	CF	ST	TOT
RING-FENCED:													
Lake Nakuru NP	11	2	1	14	8	2	2	12			2	2	28
Ngulia RS	1	1	1	3	4	3		7			1	1	11
Solio R GR	14	4	6	24	21	2	4	27			5	5	56
Lewa Downs R RS	2	2		4	5	2	3	10					14
Ol Jogi R GR	2	2	1	5	3	1	1	5			1	1	11
Ol Pejeta R GR	2	2		4	1	3		4					8
Total	32	13	9	54	42	13	10	65	0	0	9	9	128
PART-FENCED:													
Nairobi NP	18	4	7	29	18	9	4	31			1	1	61
Aberdare NP	8	1	1	10	10	3	2	15	12		3	15	40
Laikipia R	18	5		23	10	4	1	15	3	1	2	6	44
Total	44	10	8	62	38	16	7	61	15	1	6	22	145
UNFENCED:													
Masai Mara NR	4	4	4	12	9	1	2	12					24
Amboseli NP	2	1		3	2	1	1	4					7
Total	6	5	4	15	11	2	3	16	0	0	0	0	31
TOTALS	82	28	21	131	91	31	20	142	15	1	15	31	304

OTHER AREAS (OUTLIERS):	
Tsavo West NP	15
Tsavo East NP	1
Mt Kenya NP	10
Aberdares NP North	4
Loita Hills	12
Ngeng Valley	20
Karissia Hills/Barsaloi	6
Tana River-Garsen-Lamu	12
Jilori-Chacama	1
Tharaka-Kiagu Hill	1
Ndotos-Losai	1
Chyulu Hills North	1
Orphans	5
Total	88
KENYA MINIMUM TOTAL	392

Key: AD=Adults (>6 y.o.)
SA=Subadults (4-6 y.o.)
CF=Calves (<4 y.o.)
ST=Subtotal (Sex)
TOT=Population total

Population Statistics for black rhinos in Kenya (at the end of 1990)

KENYA RHINO PROJECT
POPULATION STATISTICS
SEPTEMBER 1991.

RHINO AREA	MAD	MSA	MCF	MST	FAD	FSA	FCF	FST	UAD	USA	UCF	UST	TOTAL
** RING FENCE													
NAKURU PARK	11	2	1	14	8	2	2	12	0	0	3	3	29
NGULIA SANCTUARY	2	0	1	3	3	3	0	6	0	0	2	2	11
SOLIO RANCH	14	4	6	24	21	2	4	27	0	0	6	6	57
LEWA DOWNS	2	2	0	4	5	2	4	11	0	0	0	0	15
OL JOGI RANCH	2	2	1	5	3	1	1	5	0	0	1	1	11
OL PEJETA RANCH	2	2	0	4	1	3	0	4	0	0	0	0	8
** Subtotal **	33	12	9	54	41	13	11	65	0	0	12	12	131
** PART FENCE													
NAIROBI PARK	19	6	8	33	18	5	4	27	0	0	1	1	61
ABERDARE PARK	8	1	1	10	10	3	2	15	12	0	3	15	40
LAIKIPIA RANCH	18	5	0	23	10	4	1	15	3	1	2	6	45
** Subtotal **	45	12	9	66	38	12	7	57	15	1	6	22	146
** UNFENCED													
MASAI MARA	4	4	4	12	9	1	2	12	0	0	0	0	24
AMBOSELI PARK	2	1	0	3	2	1	1	4	0	0	0	0	7
** Subtotal **	6	5	4	15	11	2	3	16	0	0	0	0	31
*** Total ***	84	29	22	135	90	27	21	138	15	1	18	34	308

NB.

MAD Male Adult
MSA Male sub-adult
MCF Male calf
MST Male subtotal
FAD Female adult
FSA Female subtotal
FCF Female calf
FST Female subtotal
UAD Un-identified adult
USA Un-identified sub-adult
UCF Un-identified calf
UST Un-identified subtotal

	1990	IN	OUT	BIRTHS	DEATHS	1991
SANCTUARIES/PROTECTED:						
NAIROBI NP	61	0	1	3	1	62
SOLIO GR	56	0	0	3	0	59
ABERDARES NP	40	0	0	2	0	42
LAIKIPIA R	44	0	7	1	0	38
LAKE NAKURU NP	28	0	0	2	1	29
MASAI MARA NR	24	1	0	1	0	26
LEWA DOWNS RS	14	1	1	1	4	11
NGULIA RS	11	1	0	0	0	12
OL JOGI GR	11	0	0	1	1	11
OL PEJETA GR	8	1	1	1	1	8
AMBOSELI NP	7	0	2	0	2	3
TOTAL	304	4	12	15	10	304
OTHER PROTECTED:						
TSAVO WEST	15	0	0	1	0	16
LOITA HILLS	12	0	0	0	0	12
NGENG VALLEY	15	0	0	0	0	15
MT KENYA NP	10	0	0	0	0	10
ABERDARES N	4	0	0	0	0	4
ORPHANS	5	1	0	0	0	6
TOTAL	61	1	0	1	0	63
OUTLIERS:						
TANA RIVER	12	0	0	0	0	12
KARISSIAS	6	0	0	0	0	6
LOUNIEK	0	5	0	0	0	5
KENO	0	4	0	0	0	4
RUMURUTI FOR	0	2	0	0	0	2
MOYALE	2	0	0	0	0	2
KIAGU	1	0	0	0	1	0
JILORI-CHACAMA	1	0	0	0	0	1
CHYULUS N	1	0	0	0	0	1
TOTAL	23	11	0	0	0	33
KENYA TOTAL	388	16	12	16	11	401

SOLIO RANCH GAME RESERVE BLACK RHINO LIST
24-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
F3	4501	F	20		0		0
F3 CALF 2	4502	M	3	F3	4501	M8?	4523
F8	4503	F	7	F5?	0		0
F4	4504	F	15		0		0
F4 CALF 2	4505	F	2	F4	4504	M8?	0
F1 LAMURIA	4506	F	20		0		0
F1 CALF 4	4507	M	3	LAMURIA F1	4506	M8	4523
M2 RUDI	4508	M	22		0		0
F12 LAMURIA	4509	F	20		0		0
F12 CALF 3	4510	M	3	LAMURIA 2 F12	4509		0
F13	4511	F	9	LAMURIA 2 F12	4509		0
F6	4512	F	15		0		0
F6 CALF 1	4513	M	3	F6	4512	M4?	4514
M4 BORAN BULL	4514	M	25		0		0
F7 RIDGEBACK	4515	F	20		0		0
F7 CALF 3	4516	M	3	RIDGEBACK F7	4515		0
M16	4517	M	15		0		0
M5 RED TANK	4518	M	20		0		0
F5	4519	F	20		0		0
F5 CALF 4	4520	F	3	F5	4519	M8	4523
M6 3 HORNS	4521	M	15		0		0
F9 OLD NARIBO	4522	F	35		0		0
M8	4523	M	20		0		0
M7	4524	M	20		0		0
M17	4525	M	0	F11?	4530		0
M9 LONG LEGS	4526	M	8		0		0
M10	4527	M	15		0		0
F2 LAMURIA 3	4528	F	20		0		0
F2 CALF 2	4529	M	2	F2 LAMURIA 3	4528		0
F11	4530	F	30		0		0
F11 CALF 2	4531	F	4	F11	4530		0
M14 SOBAT	4532	M	15		0		0
M11	4533	M	15		0		0
F14	4534	F	20		0		0
F14 CALF 3	4535	F	3	F14	4534		0
M13	4536	M	6		0		0
F15	4537	F	6		0		0
F16	4538	F	15		0		0
F16 CALF 1	4539	M	3	F16	4538	M15?	4549
M12	4540	M	15	F7	4515		0
M1	4541	M	15		0		0
M17	4542	F	6	F7	4515		0
F20	4543	F	20		0		0
F10	4544	F	15		0		0
F10 CALF 1	4545	?	2	F10	4544		0
F18	4546	F	15		0		0
F18 CALF	4547	F	5	F18	4546		0
M3	4548	M	15		0		0
M15 MARIO	4549	M	25		0		0
F19	4550	F	20		0		0
F19 CALF 2	4551	?	3	F19	4550	M16	4517
F21	4552	F	20		0		0

SOLIO RANCH GAME RESERVE BLACK RHINO LIST
24-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
F21 CALF 2	4553	M	3	F21	4552		0
F22	4554	F	8	F12?	4509		0
F23	4555	F	20		0		0
F24	4556	F	15		0		0
F24 CALF 1	4557	F	1	F24	4556	M11 ?	4533
M18	4558	M	15		0		0
STROPPIE	4601	F	20		0		0
HOSHIM	4600	M	17		0		0
BONZO	4900	M	0	F1 LAMURIA	4506		0
455	4901	F	12		0		0
452	4902	M	12		0		0
451	4903	F	20		0		0
453	4904	F	20		0		0
453 CALF 1	4905	M	1	453	4904		0
MIA F20 CALF	4559	F	5	F20	4543		0
F22 CALF 1	4560	?	1	F22	4554		0
F1 CALF 5	4561	F	1	F1 LAMURIA	4506	M8	4523
F20 CALF 2	4562	?	0	F20	4543		0
F4 CALF 3	4563	?	0	F4	4504	M8	4523
F7 CALF 4	4564	?	0	F7	4515		0
F14 CALF 4	4565	?	0	F14	4534	M11 ?	4533

SOLIO RANCH RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	13	19	0	32
SUBADULTS	2	4	2	8
CALVES	9	4	6	19
TOTAL	24	27	8	59

NAIROBI NP BLACK RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
NAIROBI	1	M	27		0		0
MIRIAM	2	F	29		0		0
LILIAN	4	F	8	MIRIAM	2	NAIROBI	1
MARK	5	M	9		0		0
MATTHEW	7	M	10	SUSIE	6		0
FATUMA	8	F	18		0		0
KHALI	10	F	31		0		0
CAMPIE	11	M	5	KHALI	10		0
STELLA	12	F	33		0		0
MADOGO	13	F	5	STELLA	13		0
OBSERVATION	14	M	11		0		0
MUKOYETI	15	M	11		0		0
CHIRO	16	F	9		0		0
CHRISTOPHER	17	M	4	CHIRO	16		0
NGICHU	18	M	12		0		0
RICHARD	19	M	12		0		0
HERIN	20	F	13		0		0
KYELA	21	M	5	HERIN	20		0
TITUS	22	M	13		0		0
DUROKO	23	M	13		0		0
KINYANJUI	24	M	14		0		0
JEE	25	F	14		0		0
KOSKEI	26	M	20		0		0
MOSHI	27	F	15		0		0
BEHEWA	28	F	3	MOSHI	27	NAIROBI	1
KIMELEL	29	M	21		0		0
KING	30	M	15	DAPHNE	31		0
DAPHNE	31	F	22		0		0
SYEDA	32	F	3	DAPHNE	31		0
ORMANYI	33	F	23		0		0
WAIRIMU	34	F	5	ORMANYI	33	RICHARD/TIM	0
BILL	35	M	6		0		0
HOOKIE	36	F	16		0		0
MUKOROFI	37	M	16		0	KINUTHIA	49
SARAH	39	F	17		0		0
LYNDA	40	F	3	SARAH	39		0
HYRAX	41	M	17		0		0
MURRAM	43	M	35		0		0
ERIC	44	M	24		0		0
CATHERINE	45	F	25		0		0
CAROL	46	F	5	KATHERINE	45		0
NANCY	47	F	18		0		0
NDUNGI	48	M	2	NANCY	47		0
KINUTHIA	49	M	26		0		0
TIM	50	M	19		0		0
JEREMY	54	M	3	MAIN GATE	53		0
WANGARE	55	F	27		0		0
WANJIKU	56	F	3	WANGARE	55	KIMELEL	29
KIGEMBE	57	M	18		0		0
MORAIRA	58	M	18		0		0
FLORENCE	59	F	19		0		0
BOMAS	60	M	18		0		0

NAIROBI NP BLACK RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
MOSES	61	M	2	HERIN	20	KOSKEI/DURUKO	0
GICHUKI	62	M	3	FATUMA	8	NAIROBI	1
MBAASI	63	M	2	CATHERINE	45	MURRAM	43
MOSONGO	64	M	3	KHALI	10	KIMELEL	29
ANN	65	F	2	SARAH	39	KINUTHIA	49
DAIDAI	66	F	2	MIRIAM	2	NAIROBI	1
SISO	67	M	1	LILIAN	4	NAIROBI	1
MAX	68	M	0	MOSHI	27	NAIROBI	1
ADAM	69	M	0	HOOKIE	36		0
FLORENCE'S CALF	70	F	0	FLORENCE	59		0
STELLA'S CALF	71	M	2	STELLA	12	KIMELEL	29

NAIROBI NP BLACK RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	21	17	0	38
SUBADULTS	2	5	0	7
CALVES	9	7	2	18
TOTAL	32	29	2	63

LAKE NAKURU NP BLACK RHINO POPULATION LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
AMBONI	501	M	15	JUNO	2506		0
KISERIAN	502	M	20		0		0
TATU	503	M	10		0		0
RIDGEBACK	504	M	8	F9 OLD NARIBO	4522		0
NDERIT	505	M	13		0		0
MWIKALI	506	F	19		0		0
JEBUNGEI	508	F	10		0		0
MAJOR MWANGI	509	M	9		0		0
WANGARI	510	F	10		0		0
NDUKU	511	F	11		0		0
NYAHURURU	512	M	7		0		0
RODNEY	513	M	15		0		0
SINDANO	514	M	12		0		0
MAMA WINNIE	515	F	12		0		0
WANGARI	516	F	11		0		0
WACHIRA	517	M	11		0		0
MWENDE	518	F	30		0		0
KISEE	519	M	20		0		0
KAGIRI	521	M	3	MWIKALI	506	MARIO M15	4549
NG'ANG'A	525	M	4		0		0
CALF	526	?	2	JEBUNGEI	508		0
WINNIE MANDELA	527	F	0	MAMA WINNIE	515		0
JAMBI	3	F	4	MIRIAM	2	NAIROBI	1
SIHOHO	9	M	4	FATUMA	8	NAIROBI	1
SUZIE	6	F	8		0		0
JUDY	52	F	6		0		0
0516 CALF 1	528	?	2		516		0
CALF	529	F	1	WANGARI 1	510		0
KYELA	530	F	0	SUZIE	6	NAIROBI	1
MBURUGU	531	M	0	MWIKALI	506		0
	0		0		0		0

MASAI MARA NATIONAL RESERVE BLACK RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
MARY	1501	F	20		0		0
MAMA KAYAI	1502	F	20		0		0
SUSAN	1504	F	15		0		0
NUMBER SIXTEEN	1505	F	15		0		0
MTOTO WA FATUMA	1506	F	15	FATUMA	0	KIPANGA	1517
WANJIRU	1507	F	10	MARY	1501	AMUKATWENDE	1514
GATHONI	1508	F	8	MARY	1501	UMEME	1515
KAYAI	1509	F	10	MAMA KAYAI	1502	AMUKATWENDE	1514
CHEBRECH	1510	F	8	MAMA KAYAI	1502	UMEME	1515
HELICOPTER	1511	F	6	NUMBER SIXTEEN	1505	UMEME	1515
NAISHURU	1512	F	3	HALIMA	1503	KIOKO	1516
CHEPKOSKEI	1513	F	3	MAMA KAYAI	1502	AMUKATWENDE	1514
AMUKATWENDE	1514	M	20		0		0
UMEME	1515	M	20		0		0
KIOKO	1516	M	15		0		0
KIPANGA	1517	M	15		0		0
KEN	1518	M	5	SUSAN	1504	AMUKATWENDE	1514
PERTET	1519	M	5	MAMA KAYAI	1502	UMEME	1515
PAUL	1520	M	5	MARY	1501	UMEME	1515
CHARLIE	1521	M	3	MARY	1501	UMEME	1515
CALF	1523	F	2	NUMBER SIXTEEN	1511	UMEME	1515
KARANJA	1524	M	20		0		0
CALF	1526	F	1	KAYAI	1509		0
CALF	1528	M	1	WANJIRU	1507		0
CALF	1529	M	1	MTOTO WA FATUMA	1506		0
CALF	1530	M	0	SUSAN	1504		0

MASAI MARA RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	10	8	0	18
SUBADULTS	3	2	0	5
CALVES	1	3	2	6
TOTAL	14	13	2	29

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	5	9	0	14
SUBADULTS	4	1	0	5
CALVES	4	3	0	7
TOTAL	13	13	0	26

OL JOGI GAME RESERVE BLACK RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
OL JOGI	3501	M	20		0		0
MAMA SAFI	3502	F	20		0		0
MAMA KALI	3503	F	20		0		0
JAMES	3505	M	8	MAMA KALI	3503	OL JOGI	3501
MALAIKA	3506	F	7	MAMA SAFI	3502	OL JOGI	3501
EPON	3507	M	6	MAMA KALI	3503	OL JOGI	3501
AMORU	3508	M	4	MAMA KALI	3503	OL JOGI	3501
EKILE	3509	M	4	MAMA SAFI	3502	OL JOGI	3501
LENANA	3510	M	2	MAMA KALI	3503	OL JOGI	3501
NO NAME	3511	F	1	MAMA SAFI	3502	OL JOGI	3501
SHATOOSH	3512	F	8	SOLIO COW	0	SOLIO BULL	0

LEWA DOWNS RANCH - NGARE SERGOI SANCTUARY RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
SHABA	2503	F	15		0		0
STUMPY	2504	F	25		0		0
SOLIA	2505	F	18		0		0
JUNO	2506	F	30		0		0
MAWINGO	507	F	7	SOLIO COW	0	SOLIO BULL	0
SAMIA	2508	F	6	SOLIA	2505	SOLIO BULL	0
JUNIPER	2509	F	3	JUNO	2506	NGOTHO	2501
KELELE	2510	M	10	RONGAI	2502	MWEIGA BULL	0
JILALE	2513	F	3	RONGAI	2502	NGOTHO	2501
ZARIA	2514	F	3	SOLIA	2505	NGOTHO	2501
CALF	2516	F	0	SOLIA	2505	KELELE	2510

OL JOGI BLACK RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	2	3	0	5
SUBADULTS	3	1	0	4
CALVES	1	1	0	2
TOTAL	6	5	0	11

LEWA DOWNS RANCH RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	1	5	0	6
SUBADULTS	0	2	0	2
CALVES	0	3	0	3
TOTAL	1	10	0	11

NGULIA RHINO SANCTUARY BLACK RHINO LIST
28-10-91

NAME	ID	SEX	AGE	MOTHER	ID	FATHER	ID
KIBWEZI 1	5001	F	25		0		0
KIBWEZI 2	5002	F	20		0		0
KIBWEZI 3	5003	F	15		0		0
TAITA 1	5004	F	20		0		0
TAITA 2	5005	F	15		0		0
NGULIA	5007	M	15		0		0
CALF 1	5008	M	5		0		0
CALF 2	5009		4		0		0
CALF 3	5010		3		0		0
CHRIS GACAHU	42	M	8		0		0
MISS MAKTAU	5011	F	15		0		0
SIMON	51	M	10	MAIN GATE	53		0

NGULIA RHINO SANCTUARY - BLACK RHINO POPULATION BREAKDOWN

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	3	6	0	9
SUBADULTS	1	0	1	2
CALVES	0	0	1	1
TOTAL	4	6	2	12

LAIKIPIA RANCH

BLACK RHINO POPULATION BREAKDOWN

28-10-91

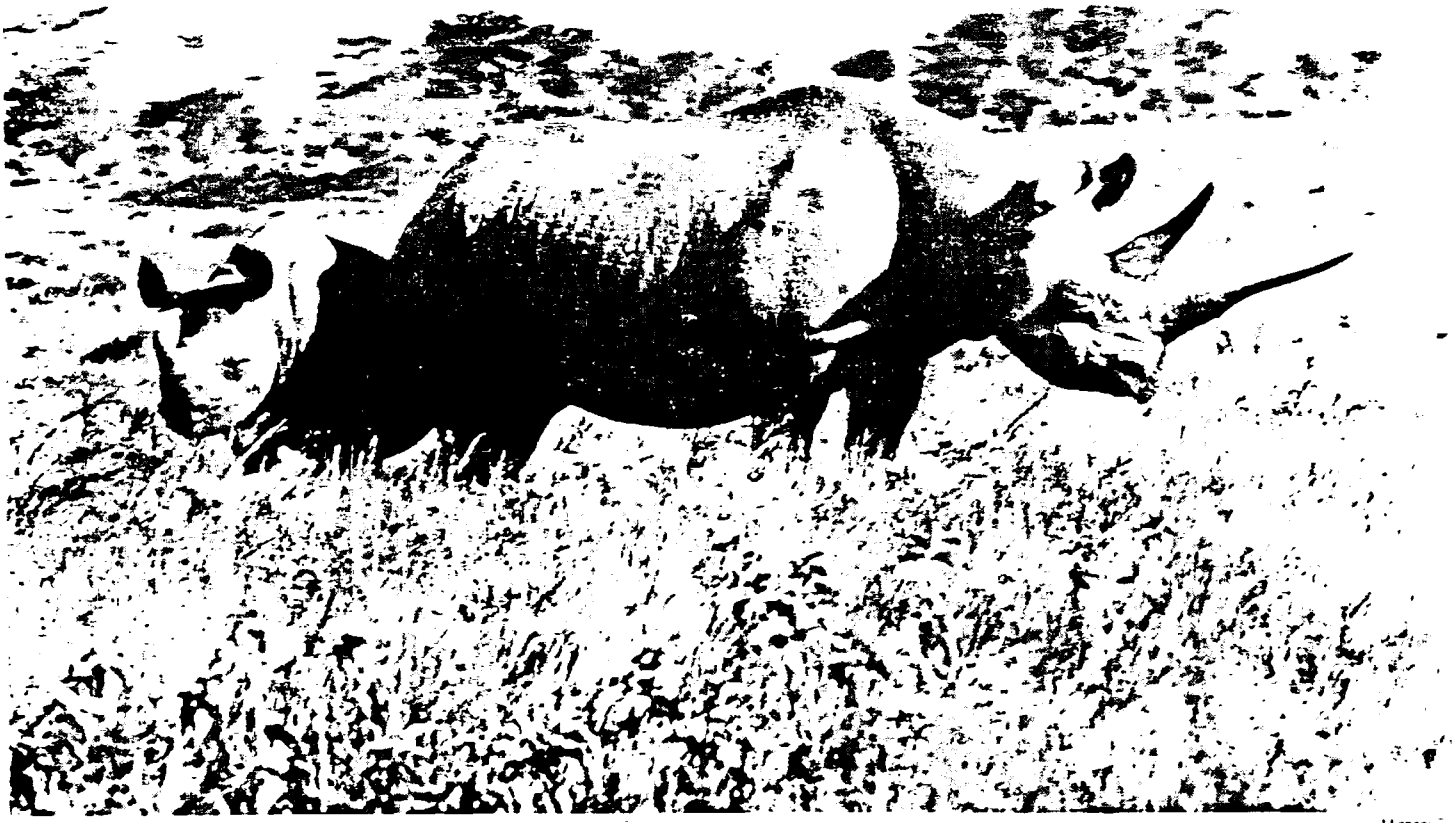
	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	18	10	1	29
SUBADULTS	2	23	2	7
CALVES	0	1	1	2
TOTAL	20	14	4	38

ABERDARE NATIONAL PARK

BLACK RHINO POPULATION BREAKDOWN

SAMPLE OF 33 RHINOS IDENTIFIED AT THE ARK LODGE

	MALES	FEMALES	UNKNOWN SEX	TOTAL
ADULTS	8	12	0	20
SUBADULTS	2	3	0	5
CALVES	3	5	0	8
TOTAL	13	20	0	33



Mother and calf.

Are Kenya's rhinos recovering?

by Rob Brett

After the dramatic plunge in Kenya's rhino numbers in the 1970s, specially protected rhino sanctuaries have been established around the country. How successful have these been?

It is difficult today to imagine how numerous, and how expendable black rhinos once were in most parts of Kenya. In 1902 Meinerzhagen had to shoot 17 on Nyeri ridge in three days because they were a nuisance. J. A. Hunter cleared out 1,088 more 'nuisances' for settlement in a small area of Makueni in 1946–48. Old hands still reminisce about 'those days, on a morning's drive in this area, one would be unlucky if one didn't see 14 rhinos before breakfast', or, 'those days, one didn't give them a second thought'. In those days they got in the way of development. They used to charge at trains. They were a nuisance.

More recently, particularly during the 1970s, they became worth slaughtering for their horns, almost to the point of extinction in most of Kenya's 'protected areas' like the Tsavo and Meru National Parks where they were once exceptionally numerous. Their numbers dwindled from tens of thousands to as low as a few hundreds in 15 years. Only 30 years ago, Tsavo Park alone used to support at least twice the number of black rhino that are now left in the world today.

Although the black rhino was clearly a highly successful 'model' of a large herbivore for tens of millions of years of evolution, as is evidenced by its persistence over evolutionary time and the sheer numbers that are still remembered, it was not capable of adapting to snares, spears, dogs and guns. Its daily routine of movements within a relatively small area, returning often to favourite watering points, salt licks, or *Euphorbia* trees, made it such an easy target for man.

But a few rhinos have managed to avoid even the most determined efforts to track and kill them. Isolated in small pockets all around Kenya, they have survived against all odds with little or no protection. If one considers the attributes a rhino needs to avoid being poached, the handful of rhinos that remained in Tsavo Park in the 1980s certainly had them, probably moving continually over large areas, and being largely nocturnal. In general, the fewer rhinos there are living in a large area, the larger are their ranges, and the more they move.

Arthur Christians

Clockwise from the top: Favoured habitat of dense bushland makes a back-drop for this black rhino.

An immobilised black rhino is kept cool while being outfitted with a radio transmitter.

Ian Douglas Hamilton

particularly if the browse is very seasonal in quality and distribution, and water supplies are irregular.

Around 1984 when Kenya started its policy of creating specially protected rhino sanctuaries, it became clear that if anyone was to do anything to save the few rhinos that remained in poached-out areas like Tsavo, it was important to decide whether to capture the remaining animals and move them to sanctuaries where they could breed with other rhinos, or whether, in the knowledge that they were keeping in touch with other rhinos and breeding successfully, to leave them where they were and protect them *in situ*.

Crucial questions to answer were: How do rhinos stay in touch with each other over such large areas? Would the males and females meet each other at the appropriate moment, for mating to take place? At what point do isolated rhinos become 'doomed', not necessarily because of the likelihood of their being poached, but because they will die out without breeding more rhinos to replace them?

It was these questions that I hoped to tackle in four years of monitoring work on Ol Ari Nyiro Ranch, in Laikipia. This 100,000 acre ranch still has free-living black rhinos that live much as they always did in dense bush on the sides of impenetrable rocky gorges, the last substantial remnant of a continuous black rhino population which previously spread across the Laikipia plateau to Mount Kenya. Due to the effective anti-poaching work of the general manager of the ranch, Colin Francombe, and his security patrols, and the custodianship of owner Kuki Gallmann, over 40 rhinos still remain.

Since most of the remaining rhinos in Kenya are found in their favoured habitat of dense bushland or forest, where they are seldom seen, it is often difficult to know what is happening to a population; for example, to determine whether there is successful breeding, or whether there are occasional undetected instances of poaching. The Laikipia project was largely conceived with the idea of developing the methods necessary to monitor rhino movements without seeing them, and training up the personnel necessary for monitoring in other areas of Kenya.

These methods included identifying and ageing rhinos from the wrinkle marks and measurements of their tracks, and monitoring their breeding state from hormone levels measured in urine samples collected in the bush. The object was to obtain as much information about a 'natural' rhino population for comparison with rhinos living in the

relatively artificial conditions in ring-fenced sanctuaries. For any rhino population, it is essential to monitor total numbers, sexes, approximate ages, births, deaths, and matings, in order to judge how effective conservation measures are.

The Laikipia rhinos proved to be unusual in that there were almost twice as many males as females, and so breeding relative to the total number of rhinos on the ranch was poor. The rhinos were widely spread over half of the ranch area of 400 square kilometres, and several ranged very widely, often going on dangerous excursions over the ranch boundary where the likelihood of being killed by Pokot poachers was very high indeed.

Rhinos certainly have less perception of the boundaries of protected areas than do elephants, and some of these wandering rhinos appeared oblivious to the grave danger they were in when they wandered off the ranch (see box). It is likely that these wanderers, mostly males, were going off in search of non-existent females, or perhaps returning to areas where they were born.

For the future of the Laikipia rhinos, it will be essential to build barriers on the ranch boundaries to prevent them from wandering off. This is one of several rhino projects for which Michael Werikhe is walking across the USA this year. If the rhinos continue to stray from Ol Ari Nyiro ranch, more will be poached, and the rhinos will thin out on the ranch so much that breeding will suffer further, and the population will not replace itself.

In normal rhino society, although there are clearly dominant male rhinos which occupy large home ranges overlapping the ranges of several females, other subordinate males cohabit the same areas without conflict, presumably as long as it is understood who is 'boss'. But as the density of rhinos in an area drops, individual large males have less chance to exert their authority and monopolise matings with female rhinos moving within their range. Here the number of 'sneaky' matings from other males in the area increases, and it is more of a lottery which male manages to track up an adult female on heat, and perhaps mate, if the male is persistent in the face of a female's usually aggressive reaction to his advances.

In places where the density of rhinos is much higher, such as Solio Ranch Game Reserve or Nairobi National Park, dominant males moving within a smaller area have more control over females which are coming on heat, and can spend the necessary few days on the tail of whichever females are 'imminent', so that no chance of a mating is missed. This ensures that most females are mated at the first opportunity, usually over a year after the birth of the previous calf, and calving rates are high.

However, as we have been seeing recently on Solio and in Nairobi Park, female rhinos can sometimes breed almost 'too' quickly, by mating again very early after the last birth. This means that a calf is pushed away by the mother upon the arrival of the new-born when it is too young to look after itself very well (just over two years old). These calves usually rejoin their mothers later, but for the time they have been rejected at this age, they lose condition, look a bit lost, and often team up with other young rhinos in a similar predicament. On Solio one young female pushed out too early formed an unlikely friendship with a large adult white rhino, spending long periods standing in the middle of grass plains grazed short by white rhinos, perhaps wondering where the browse was. It is hard to complain about high breeding rates in rhinos though, especially if all the calves do eventually come through to maturity in good shape.

Apart from providing complete protection for rhinos, Kenya's policy of building rhino sanctuaries was aimed at breeding up rhino numbers as fast as possible in these areas. Two rhino conservation areas, Nairobi National Park and Solio Ranch Game Reserve, have shown how successfully rhinos can breed and grow in numbers within small areas. Both areas are now called sanctuaries, but were stocked with rhinos long before the term was coined. Their respective success is due to the foresight of the board of the former Kenya National Parks, and of the

Requiem for Mainda

by Kuki Gallmann (An extract from my diary)

Laikipia, 24 November, 1989

Today Mainda, one of our male black rhino, has been speared to death by a Pokot tribesman, just inside the ranch boundary, on the Kutua hills. When I heard the news on the radio, I just could not believe it. This is the first incident of poaching in about ten years.

Mainda was the first rhino Rob Brett had immobilised and outfitted with a radio transmitter, back in 1987, on a breathless July day, a fine young male who kept going out of the boundary looking for a female.

Batteries do not last forever. Another radio was fixed when the first one eventually stopped working. It sent signals that allowed Rob to locate him, asleep below some lelechwa bush during the day, or trotting off out of Ol Ari Nyiro in his restless search for a companion. Our anti-poaching team went after him several times, far into the hills, and pushed him back again and again to where he was safe.

And why should Mainda have known of man-made boundaries to safety? No fence, no ditch mark that environment. The hills look the same, the food is still there along the slopes of the Makutan Gorge where he was born. Perhaps a female waits, yet unclaimed by the dominant males of Ol Ari Nyiro, which do not let him breed. In his drowsy existence, which follows ancient patterns, why should he know that all other free-ranging rhino in Laikipia have been killed long ago? That danger, born of hunger, ignorance and greed, lurks in wait where our protection cannot reach?

Ol Ari Nyiro is now an island. Surrounded by settlement where little wilderness has been left: perhaps a shy, nocturnal hare? a scared dik dik? a clever duiker which has managed to escape the snare? a cunning scuttling snake? the birds free as the wind, and which, like the wind, know no boundary?

I can so well see what happened.

Mainda trots about, sniffing high, intoxicated with the fresh scent of growing things, tender sprouts of new leaves, euphorbia, spiky and sweet. The heat makes him drowsy. The welcoming shade of a lelechwa bush waits for his noon rest. He stops, unaware that someone carefully, slowly, step by step, parting with trembling hands the crackling shrubs, is prowling towards him. The wind carries no smell of danger: the hunter knows better.

In a flash of incomprehensible pain, the spear is deep into his side.

Twice, it was the dart of the friendly gun which made him, after a brief sharp pain, dizzy, comatose and oblivious. Buried deep in the foggy memory of his life experiences, are hushed human voices, the busy shadows of people working around him inserting needles into his thick hide, drops into his half-open eyes to keep them moist, pouring water on his back and head to keep him cool. Fixing an annoying little device to his ear, which will allow that pale young human to find him always, asleep in the thick bush in the heat of the day. Soon it was over and he was free again.

Now it is somehow different. There is not the noise of the small red plane circling above to check on him, the pain gets sharper, deeper, tearing away at his tender intestines, cutting through veins and arteries, reaching down to the life core of his being.

Instinctively he turns and runs back to the familiar land, covered in sanseveria and aloe, of his native country, up slopes of rolling stones and thick green euclea, where friendly humans dressed in green follow him every day, and the one with the shiny antenna which always finds him. Blood pours out of his body, weakening his trot. Urgent, hostile steps pursue him, running, uncaring now about making any noise; the sharp stench of humans, which means danger, fills his nostrils; whispers, closer, much closer. They stop suddenly. He has gone back too far into the protected area where no poacher dares to come.

Dizziness comes finally in the dark of night, a red flash blots his sight, he dives crashing into a last bush. Then silence.

Only later, in the morning, when all the blood and his poor wasted life have gone, they come and they surround him; the small humans, silent, subdued, like people are who are sad, who have lost a battle. They come with all their gear to help and save. They have tracked his blood spoor up steep valleys and hills, they found him, they call him softly. Too late. He is dead.

Laikipia, 27 November, 1989

Our anti-poaching unit captured the man who killed Mainda. An extraordinary achievement, which took them three days and three nights of searching. They tracked him back; his spear identified him. He is now in jail, one rhino has gone, the world goes on as before.

Laikipia, 15 December, 1989

Today I drove up to the Kutua to check on the proposed site for the stone wall that we must build to prevent other rhinos from going out into dangerous area.

The place looks the same, but for the new scar made by the twisting red road we cut through miles of murram soil up and down steep cliffs, to allow the security people to reach as soon as possible that wild remote area of Ol Ari Nyiro.

The place looks the same, but, in African style, it now has the name of the most memorable event which took place within its barren and dramatic cliffs. That area in the Kutua is now called Mainda.

... rhinos

owners of Solio Ranch, Mr and Mrs Parfet.

Between June 1963 and March 1968, Nairobi National Park was stocked with at least 27 rhinos moved in by John King from the Darajani/Kiboko areas, the Nyeri forest, and the Athi and Kapiti plains. There were then about six resident rhinos in the park, and counts by Patrick Hamilton in August 1968 confirmed the presence of between 27 and 33 rhinos. A further 10-14 rhinos were introduced between 1978 and 1980 from the Nyeri forest and Mt. Kenya.

Considering the numbers that were introduced, the population has in fact taken a very long time to breed up to the present total of just under 60 rhinos, increasing at only three per cent over that time. There has undoubtedly been some loss of rhinos to poaching and wandering out of Nairobi Park since 1968. However the rhinos in the park now are breeding very well indeed, almost every adult female with a calf at foot. Last year, six baby rhinos had been born in the park by November.

Nairobi park is one of the few areas in Kenya were one can almost be guaranteed to see rhinos, particularly in the open Athi Basin at the south-east corner of the park. The population can now support limited transfers to stock other parks and sanctuaries. This not only benefits the recipient areas, but it also ensures that the number of rhinos in Nairobi Park never reaches a carrying capacity where either the rhino's food reserves are adversely affected, the breeding output is reduced by over-population, or the rhinos start to wander out of the park in dangerous numbers.

The ring-fenced Solio Ranch Game Reserve was stocked with 23 rhinos between 1970 and 1980, which, like most of the original Nairobi Park rhinos, came from many different areas of Kenya, including the Tsavo region, the Nyeri forest and the ranch-land surrounding Solio. Even in 1980, the rhinos numbered more than 30, and from then on the population grew at an astonishing 12 per cent per annum (15 per cent annual recruitment) to over 80 rhinos by 1987. It became obvious that there was a dangerous over-population which was depleting the browse in the reserve, especially the favoured rhino browse of whistling thorn, *Acacia drepanolobium*. (I have always wondered whether black rhinos enjoy the mouthful of ants they get when they bite through an acacia gall).

Fifteen rhinos were moved out of Solio in late 1987 to stock the new Lake Nakuru rhino sanctuary, and at least 10 have been moved to rhino sanctuaries on other private ranches since then. What is interesting is that the over-population of rhinos on Solio had a marked negative effect on the browse reserves, but little or no effect on the breeding rate. This has remained very high, with at least five rhinos born every year since 1987.

Apart from the good rhino habitat, the other important factor in the success of rhinos at Solio has been the general lack of disturbance to the rhinos; in short, a lot of peace and quiet. In order to hold the numbers below carrying capacity and allow the browse to recover, at least 15 more black rhinos will be moved out of Solio in the next few months to supply other rhino sanctuaries.

Four rhino births have been recorded in Lake Nakuru rhino sanctuary since the introduction of 17 black rhinos in 1987. Three females and one male were recently moved in from Nairobi Park, correcting the bias in sex ratio towards males. If the female rhinos at Nakuru start to breed as often as the Solio and Nairobi females, Nakuru will soon become another 'showcase' area for black rhinos. More white rhinos will be introduced into Nakuru Park from Solio Ranch in 1991 to start a breeding herd. White rhinos are highly visible, and should improve further the rhino-viewing at Nakuru Park.

Other rhino sanctuaries stand a good chance of duplicating the success of the Solio and Nairobi rhinos. The Ngulia rhino sanctuary in Tsavo West has recently been enlarged to over 70 square kilometres, and, when more rhinos are introduced next year, this sanctuary will have the best hope of stai ing the restocking of the dense bushland the surrounding areas of Tsavo West Par The Ngulia sanctuary fence is design purely to contain rhinos in one area breeding, while the security is dependent anti-poaching cover over a much w ar Once the rhinos have bred and ir ed numbers in the area, the fence can be open up and the rhinos released to slowly reste the surrounding area, and breed with the r 'wild' rhinos that still live in the vicinity.

The Ngare Sergoi rhino sanctuary Lewa Downs ranch has already proved a success in breeding rhinos, with only a sli hiccough because of the lack of a compete breeding male over the last two years. Pejeta Game Sanctuary is now being stock with at least 20 black rhinos, has rhi habitat very similar to that of Solio, a could eventually hold up to 100 rhinos.

Of the fenced rhino sanctuaries bu since 1984, many owe their existence a success to the fund-raising efforts of ma donor organisations, and the personal co tributions of private landowners. There h also been successful co-operation betwe the then Wildlife Conservation and Manag ment Department (WCMD), the priva land owners, donor organisations and NG in several rhino conservation projects Kenya since 1984, largely orchestrated WCMD officer, Peter Jenkins.

There are still a number of isolated, no breeding, unprotected rhinos that need to b captured and brought into sanctuaries, n just for their own protection but for the potential contribution to breed mo rhinos, particularly if they are fe ales come from a rhino area from which there h been little genetic contribution to secu rhino populations. For example, there is or lonely female rhino which for the last fi years has been living on a forested hi completely surrounded by settlement, Tharaka, Meru District.

Many of the rhinos living outsi sancturies such as this female are difficult ar very costly to capture. If a helicopter necessary, the cost of capturing and movi

White rhinos guarded by a Ranger in Meru National Park (soon after wiped-out by poachers).

one rhino to a sanctuary may now fall in the region of $15,000 per animal. Funds for translocating such 'doomed' animals are badly needed, and it is hoped that some will result from Michael Werikhe's walk. Because of high capture and translocation costs, and the limited funds available for the purpose, it is even more important to assess the cost-effectiveness of such rescue operations besides the satisfaction and accomplishment of saving an individual rhino.

Of the 400 black rhinos alive in Kenya today, 300 are now located in 11 relatively secure areas: 130 within the ring-fenced rhino sanctuaries, 140 in areas which are partly fenced (e.g. Nairobi National Park), and the remaining 30 in open parks and reserves (Masai Mara National Reserve, Amboseli National Park). The rhino populations in these 11 areas have grown at 5 per cent in the last four years, and if security and fencing are maintained, and the rhinos are correctly managed to avoid over-population, there is every chance of doubling that rate of increase to 10 per cent, the present rate in Nairobi Park and Solio Ranch.

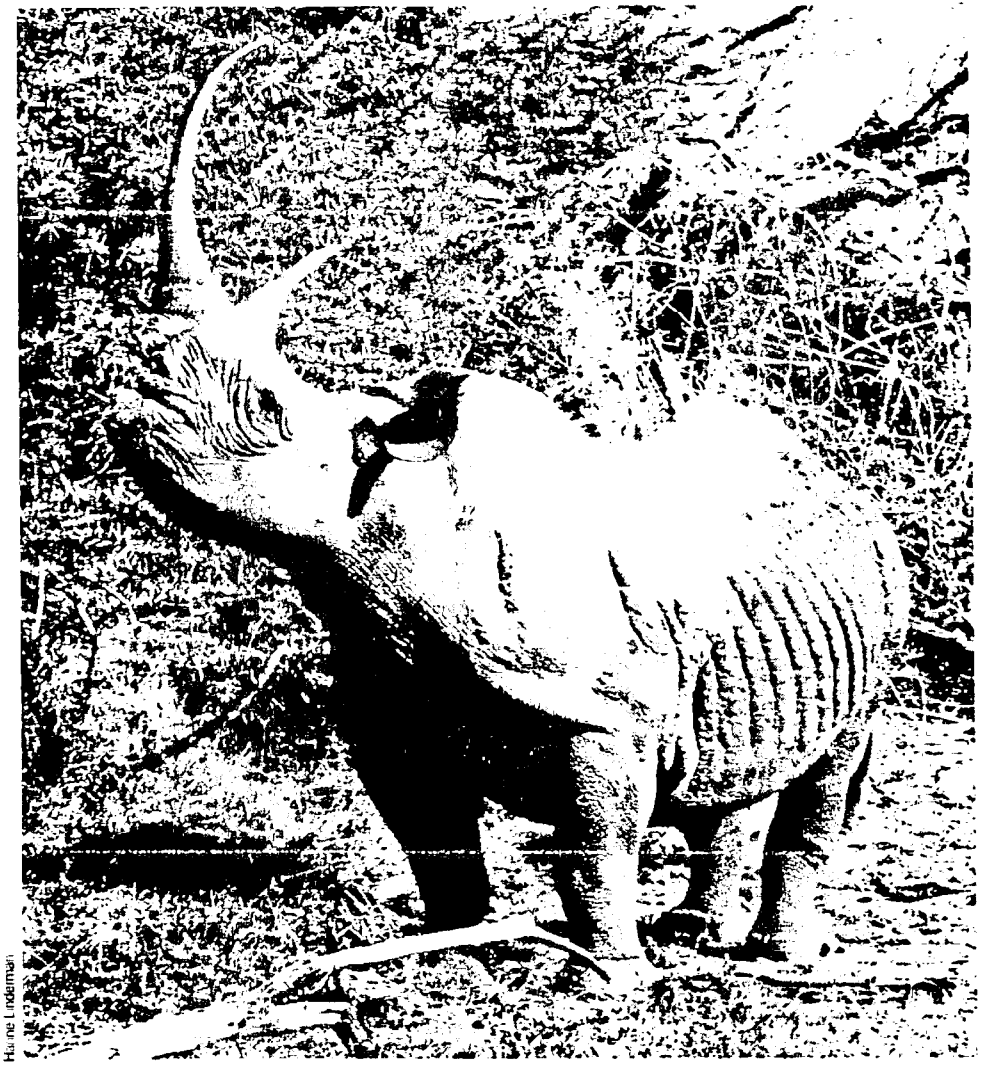
The long-term future of the black rhino in Kenya will depend on the restocking of rhinos in unrestricted parks and reserves, and the present programme can only be judged a success when this has been achieved. It is only these large unconfined areas which are capable of holding the thousands of rhinos which are genetically self-sufficient for hundreds of years, requiring only protection from poaching and little if any management.

If managed correctly, each of the present enclosed sanctuaries could provide a continuous supply of perhaps five rhinos per sanctuary per year after building up their own numbers. Those which are not surrounded by settlement, and which adjoin larger areas of rhino habitat, could release rhinos out of their fences to colonise surrounding areas which are sufficiently protected.

The policy must continue to be to breed up rhinos as fast as possible to near capacity for a given area, but to remove surplus animals before there is any over-population that would reduce food reserves or calving rates, so that maximum breeding output is maintained.

The objectives stated above are idealistic ones, though not, I believe, over-optimistic. The long-term security of rhinos in the larger release areas, such as Tsavo, will obviously depend on a number of questions, to which this article does not have answers.

It appears that efforts to control the global rhino horn trade have had local successes, but little general influence on the demand, and in particular, the incentives to poachers in the remaining rhino areas across Africa. The drop in rhino poaching in East Africa must be mainly attributable to diminishing returns and reduced supply of horns from fewer, better protected rhinos, rather than control of the trade and reduced demand. There are still two thousand rhinos in Zimbabwe, a sufficient number with large enough populations to stimulate commercial poaching for the rhino alone as long as the Far East medicine markets continue to be



Hanne Lindeman

Fine-horned rhino browsing on favoured acacia.

Johan W Elzenga

Lone rhino living outside sanctuary is difficult and costly to capture.

Like this rhino with a radio transmitter, they must continue to be highly protected for the present.

untouched by the public opinion which helped to curtail the ivory trade.

If the demand for rhino horn continues, will the pressure on rhinos ever let up? If the drop in ivory prices in East Africa does substantially reduce elephant poaching, will there be less rhino poaching as a result of its link to the latter? If rhino populations do recover, and there are enough rhinos to afford the luxury of hunting again, would public opinion and concern and the rhino charities they support allow it?

The rhino, still less any African wildlife department, cannot afford to depend forever on charity from overseas. Its conservation must be linked to sustainable revenues from parks and reserves. How many more rhino crises can be supported? Will Michael Werikhe be walking for years to come?

For the present we may have no choice but to maintain and breed rhinos in the fenced sanctuaries. But will we always have the resources to maintain the fences or the security? Will there be practical and workable means of tying tourism revenues to improving the livelihood of people in the same area, so that maintaining that revenue is realised to be more beneficial than poaching, which would then become equivalent to killing a goose that lays golden eggs?

If this comes about, then I believe there are prospects that there may once again be thousands rather than hundreds of black rhinos in Kenya. Success will only really be achieved when the sanctuaries become less important, and many fences are dismantled. Fewer rhinos will be given names, rhino studbooks would be put in storage, and there will be enough rhinos around for anecdotes to be told about how once again, rhinos have become a nuisance.

Rob Brett did a degree in Zoology at Oxford University and then spent two years in Tsavo West National Park studying naked mole-rats for a PhD from London University. he spent four year working in Laikipia on monitoring and protecting black rhino for the Gallmann Memorial Foundation (see *Swara*, January/February 1987) and the World Wildlife Fund. He is now Rhino Co-ordinator for Kenya Wildlife Service.

KENYA WILDLIFE SERVICE

A POLICY FRAMEWORK AND DEVELOPMENT PROGRAMME 1991-96

ANNEX 7
SPECIAL ISSUES:
THE CONSERVATION OF
ELEPHANTS AND RHINOS

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K E N Y A W I L D L I F E S E R V I C E

POLICY FRAMEWORK AND DEVELOPMENT PROGRAMME, 1991-96

ANNEX 7A

RHINO CONSERVATION AND MANAGEMENT

November 1990

PREFACE

This report is one of eleven annexes to the report by Kenya Wildlife Service entitled "Policy Framework and Development Programme, 1991-1996", produced in November 1990. It analyses in greater detail some of the issues, policies and investment plans described in the Main Report.

The full list of annexes to the Main Report is:

1. Organisational structure and management.
2. Revenue sources.
3. Development and management of tourism in Parks.
4. National Park and Reserve planning.
5. Wildlife education and visitor services.
6. Community conservation and wildlife management outside Parks and Reserves.
7. Special issues: the conservation of elephants and rhinos.
8. Research programme.
9. Analysis of capital investment needs.
10. Land use planning and management in Kenya.
11. Programme impacts: three case studies.

ACKNOWLEDGEMENTS

This is a report of the Kenya Wildlife Service. It was written by R. A. Brett and E. W. Wanjohi (KWS Staff). The report benefited from consultations with other members of KWS, KWS consultants and representatives from donor organisations and NGO's contributing to rhino conservation in Kenya.

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ANNEX 7A

RHINO CONSERVATION AND MANAGEMENT

1.1 INTRODUCTION

Since the turn of the century, the black rhinoceros has declined dramatically in both the extent of its range and its numbers in sub-Saharan Africa. In recent years the black rhino has become extinct, or is nearing extinction, in 12 African countries, and its numbers have dropped 90% across the continent in the last 17 years. The black rhino is now only found in reasonable numbers (i.e. at least 100) in Zimbabwe (2000), South Africa (600), Namibia (390), Kenya (400) and Zambia (100).

Poaching for the horn has been, and continues to be the major cause of the decline of the black rhino. Despite sustained efforts to control the trade in rhino products, particularly horn, there has been little reduction in the poaching pressure on the black rhino in Africa as a result. The substantial black rhino populations remaining in Zimbabwe have been under intense pressure from Zambian poachers since 1985. In general, the diminishing returns from fewer poachable rhinos have not stopped the trade, reduced the price of rhino horn on world markets, nor the incentive to poach. A poacher can sell a pair of rhino horns for more than a year's salary at the set minimum wage for his country; this will be on average less than 5% of the retail price of those same horns in Far Eastern markets (ca. $4000/kg).

The decline in the black rhino has been particularly severe in Eastern Africa, where the very large National Parks and Reserves such as Tsavo NP and the Selous GR each used to hold more black rhinos than currently survive on the whole continent. Tanzania's black rhinos may number less than 60 animals, and Uganda and Somalia probably have less than 10 animals between them. The black rhinoceros dropped in numbers in Kenya from an estimated 20,000 in 1970 to probably under 500 animals in the early 1980's. Throughout the 1970's and early 1980's, Kenya's black rhinos were poached in all areas, inside and outside of Parks and Reserves, with few restrictions and little law enforcement. In addition to the removal of most of the black rhinos in lowland areas (e.g. Tsavo NP, Meru NP) by well-organised Somali poachers, the most rhinos from highland rhino populations were slaughtered by corrupt elements within the former WCMD as much by local poachers.

In Kenya it was eventually recognised that the only hope for protecting the remaining black rhinos lay in concentrating within smaller areas the resources and anti-poaching security which had previously been spread to thinly to be effective. From 1984, the WCMD embarked on a policy of translocation of black rhinos into specially protected areas, which now come under the general heading of 'sanctuaries'. Within these relatively small areas, many of which are completely enclosed by specially designed

electric fences with alarms, most of the country's black rhinos have been protected from poaching and have bred up in numbers. Rhino sanctuaries have been stocked largely with unprotected rhinos, often isolated animals from outlying areas, or with surplus rhinos from two areas which were stocked with black rhinos in the late 1960's and early 1970's and have since neared their respective carrying capacities, namely Nairobi NP and Solio Ranch. The latter demonstrated the potential of protecting and breeding up black rhinos within a fenced sanctuary.

Kenya now holds the only substantial wild populations of the north eastern ecotype/subspecies of the black rhinoceros (Diceros bicornis michaeli), now numbering 380-400 animals. 300 of these are located in 11 well-protected areas, which include (or are contained within) 6 national parks or reserves (Nairobi NP, Lake Nakuru NP, Tsavo West NP (Ngulia rhino sanctuary), Aberdares NP Salient, Amboseli NP and Masai Mara GR) and 5 sanctuaries on private land (Solio, Lewa Downs, Ol Jogi, Ol Pejeta and Laikipia ranches). Six of these areas are ring-fenced (four on private land), three are partially fenced, and two are open parks or reserves. The status of these 11 populations at the end of 1989 is shown in Table 1. There are 80-100 additional rhinos located in outlying areas, most of which are outside the National Parks and Reserves, and are the less well protected remnants of larger poached-out rhino populations. None of these populations is larger that 20 animals, and most are inviable in the long term and would benefit from capture and translocation into sanctuaries.

In the last four years it has become clear that the 'sanctuary' policy has been a success, and in the short term holds the best hope for recovery of the black rhino in East Africa, particularly in view of the desperate position for this species in neighbouring countries. Apart from South Africa, Kenya is the only country where black rhino are known to be increasing in numbers. If the black rhino populations in Southern Africa, particularly in Zimbabwe, continue to suffer the reductions that Kenya suffered, they will probably also have to adopt the same policy and increase the number of small rhino populations specially protected as a backup to efforts to control poaching of the larger populations. In Kenya, black rhinos located in sanctuaries have suffered little poaching and have shown an annual increase in numbers of about 5%. This is about half the rate of increase that could be obtained once all the sanctuaries, particularly those which are fenced, have been stocked with a sufficient number of rhinos, particularly females, in order to ensure high calving rates.

All black rhinos in Kenya are owned by the Kenya Government. However, a large part of the limited success achieved can be attributed to the efforts and foresight of private landowners, particularly in the Laikipia and Meru Districts, who invested substantial resources in protecting black rhinos on their land while rhino populations in Parks and Reserves were being heavily poached. Since 1984 there has been an exceptional coalition between the private sector, NGO's and donor organisations which

realised, the potential of rhino sanctuaries, and the WCMD/KWS. Surplus rhinos bred up in privately owned sanctuaries have been used to stock new sanctuaries in National Parks, and surplus rhinos from both private land and Parks and Reserves will continue to be used to complete the stocking of new sanctuaries in both sectors. With continued cooperation all Kenya's relatively small black rhino populations can be managed interactively to enable the best breeding opportunities and potential for restocking Parks and Reserves within the KWS system.

In addition to Kenya's black rhinos there are approximately 60 white rhinos in Kenya, all of the southern race (Ceratotherium simum simum). Evidence from fossils and cave paintings in Kenya and Northern Tanzania suggests that the white rhino was widespread and a part of the East African savanna fauna until 2000 years ago, or less, when it was probably displaced by pastoralists who could easily kill such tame animals. The reintroduction of white rhinos into Kenya, all of which were imported from South Africa in the 1970's, cannot therefore be judged as a case of bringing in an 'exotic' species. All but one of the white rhinos are at present located on private land and are privately owned. KWS will be conserving this species along side the black rhino, and establishing small populations in enclosed Parks with appropriate ecotype, particularly those with good potential for tourist viewing. Once sufficient numbers of white rhinos have been bred up in such Parks, KWS may generate revenues from sale of animals to the private sector in Kenya, or to other Governments or parties outside Kenya.

The modest recovery of the black rhinoceros so far achieved in sanctuaries in Kenya is one significant success story which will be given the local and international publicity it deserves. The demonstration that an African wildlife department, with assistance from outside donors, has been able to turn around the decline of an endangered animal such as the black rhino is of great importance for generating the confidence of future donors in KWS being able to do the same for the elephant. Information on the steady increase in numbers, and successful management of the black rhino in Kenya will be used extensively in KWS's local education programmes, and in promotional material put out by KWS in the local and international media.

Rhino Area: Type & Name	----Males----- AD	SA	CF	ST	----Females--- AD	SA	CF	ST	--Unknown Sex-- AD	SA	CF	ST	TOT	-----Management------ A	D	CC	HL	S	---Breeding--- SR	%CC	%C	1986-9 +	-	1989 +	-	CR
RING-FENCED:																											
Nakuru NP	8	3		11	5	2		7			2	2	20	142	0.13	71	53		1.57	40	10.0	2		1		1
Ngulia RS	1			1	5	1		6			2	2	9	73	0.12	73	55		0.17	40	22.2	2	2	1	2	1
Solio R GR	16	2	8	26	19	5	6	30			2	2	58	56	1.04	56	42	16	0.87	84	27.6	17	5	1	0	1
Lewa Downs R RS	1	1	1	3	5	1	4	10					13	40	0.33	26	20		0.30	100	38.5	4				1
Ol Jogi R GR	1	3	1	5	3	1		4			1	1	10	73	0.14	20	15		1.25	67	20.0	3	1	1	1	1
Ol Pejeta R GR	2	2		4									4	93	0.04	93	70		-	-	0.0					1
Total	29	11	10	50	37	10	10	57	0	0	7	7	114	1135	0.10	337	253	16	0.88	73	24.7	28	8	4	3	
PART-FENCED:																											
Nairobi NP	15	9	3	27	18	8	5	29			1	1	57	117	0.49	60	45	12	0.93	50	15.8	12	2	5	1	1
Aberdare NP	7	1	2	10	9	3	3	15				12	37	70	0.53	50	(50)		0.67	56	28.0	5				2
Laikipia R	19	3	1	23	10	4	1	15	3		2	5	43	397	0.11	100	(100)		1.53	40	9.3	5	1	2	1	1
Total	41	13	6	60	39	13	9	59	3		3	18	137	584	0.23	210	195	12	1.02	46	13.1	22	3	7	2	
UNFENCED:																											
Masai Mara GR	5	1	3	9	11	1	2	14	1		1	2	25	1690	0.01	80	(80)		0.64	55	24.0	7		1		1
Amboseli NP	4	1		5	2	1		3			1	1	9	390	0.02	50	(50)		1.67	50	11.1	2	2	1		1
Total	9	2	3	14	13	2	2	17	1	0	2	3	34	2080	0.02	130	130		0.82	54	20.6	9	2	2	0	
TOTALS	79	26	19	124	89	25	21	133	4	0	12	29	285	3410	0.08	679	580	28	0.93	58	18.2	59	13	13	5	

Key:
AD=Adults(>6 y.o.)
SA=Subadults(4-6 y.o.)
CF=Calves (<4 y.o.)
ST=Subtotal (Sex)
TOT=Population total
A=Area of rhino reserve (sq km)
D=Density of rhino (per sq km)
CC=Carrying Capacity (Brett (1989) estimate)
ML=Management Level
S=Existing Surplus of Rhino (number of rhino exceeding ML, available for translocation
SR=Known Sex Ratio (No.Males/No.Females)
%CC=Percentage of Adult Cow Rhino with Calves
%C=Percentage of Calves in population
'+'=Total No. of Births for stated period
'-'=Total No. of Deaths for stated period
CR=Census Rating (Du Toit 1989)
NP=National Park
GR=Game Reserve
R=Private Ranch

Table 1 - Population Statistics for the black rhinoceros in Kenya (at the end of 1989), and overall breeding performance from 1986 to 1989

2.1 AIMS

2.2 Short term: 1991-1995

1. To protect the black rhinoceros (north east African ecotype: Diceros bicornis michaeli) and white rhinoceros (southern ecotype: Ceratotherium simum simum) in all areas of Kenya.

2. To protect all viable populations of black rhinoceros in sanctuaries: areas where there are special developments in place (e.g. electric fencing, intensive anti-poaching/surveillance) for this purpose.

3. To establish breeding populations in those areas with appropriate numbers and diversity of founders, in order to breed up 500 black rhinoceros by 1995.

4. To establish a breeding population of the white rhinoceros (Ceratotherium simum simum) in Lake Nakuru NP.

2.3 Medium term: 1996-2000

4. To maintain achievement of objectives 1., 2., 3. and 4.

5. To attain a target for 680 black rhinoceros by 2000, roughly the absolute ecological carrying capacity of the presently established sanctuaries in Kenya.

6. Given a surplus of black rhinoceros bred up in the sanctuary areas, to continue to 'harvest' surplus rhinoceros from sanctuaries on a basis of maximum sustained yield in order to reintroduce black rhinoceros to areas of their former range, particularly in areas where successful recolonisation and fast breeding are likely; also to recolonise the surrounding areas of sanctuaries by releasing animals from within enclosures, so that restocking results, and, if security is sufficient and breeding output high, so that fencing can eventually be removed.

2.4 Long term: 2000 onwards

7. To develop and conserve in the long term a genetically viable population of at least 2000 black rhinoceros of the northeast african ecotype (Diceros bicornis michaeli) in their natural habitat, this being the minimum number to ensure the survival of this species in Kenya in the long term.

8. To encourage the continued protection and breeding of white rhinoceros (Ceratotherium simum simum) on private land and enclosed National Parks.

3.1 RHINO CONSERVATION & MANAGEMENT PROGRAMME

3.2 Management of existing populations

The Kenya Wildlife Service will continue the programme of construction of the presently planned sanctuaries, and of stocking these areas with surplus rhinos from areas already at or approaching carrying capacity, or with unprotected rhinos from outlying areas.

The black rhinos in Kenya can be roughly divided into those which are found in hot, low altitude bushland which is infested with tsetse flies which infect the rhinos with trypanosomes (e.g. Tsavo NP, Meru NP), and rhinos those found in cooler, higher altitude areas (e.g. Aberdare NP), where the tsetse fly does not occur. 60% of the black rhinos in sanctuaries are part of 'hybrid' populations located in highland areas (e.g. Nairobi NP, Solio Ranch), but which were stocked with large numbers of animals from the Tsavo area in the 1960's.

Kenya's total rhino population is too low (380-400) to allow separate management of the upland and lowland rhino populations for genetic reasons, in particular the very small numbers of 'pure' lowland black rhino populations. For these reasons Kenya's black rhinos will be treated for management purposes as one population. Although the feasibility of routinely moving upland rhinos to lowland tsetse-infested areas has not yet been fully established (i.e. the ability of upland rhinos to become resistant to infection with trypanosomes after translocation: see section 5.5), the intention is to move large numbers of surplus rhinos from the sanctuaries, most of which are located in highland areas, to restock the large areas of unrestricted lowland rhino habitat that are still capable of supporting thousands of black rhino (e.g. Tsavo NP).

The following general management policy in rhino sanctuaries will be adopted:

1. All rhinos will be managed for maximum breeding output so that numbers of rhinos increase as fast as possible.

2. Maximum breeding rates will be maintained when numbers approach the carrying capacity of sanctuaries, particularly those which are totally enclosed, by translocating out a maximum sustained yield of rhinos to other rhino conservation areas which satisfy certain criteria (see Section 3.2.1).

3. Surplus rhinos moved out of existing sanctuaries will be used to complete the stocking of the remaining planned sanctuaries. Once all sanctuaries have reached or exceeded their management levels, surpluses will be used to restock larger areas of unrestricted rhino habitat in the National Parks and Reserves which used to hold large numbers of black rhino (e.g. Tsavo NP, Aberdares NP, Mt Kenya NP, Meru NP), depending on sufficient security in these recipient areas and all other criteria (see Section 3.2.1).

4. All rhino populations and their habitat requirements will be monitored in order to achieve 2.

Managing existing rhino populations for maximum sustained yield will be achieved by removing animals above 75% of the ecological carrying capacity (ECC) for each area, equivalent to a management level (ML) or optimum stocking rate. Numbers will be permitted to build up by 5-10 animals, depending on overall population size, before removals take place. These periodic removals would optimise the efficiency and cost-effectiveness of the removal operations, would minimise the disturbance to the animals and would allow time for annually repeated surveys to provide reliable population trends.

The ecological carrying capacities and hence the 75% management levels set for each area will be based on minimum rhino numbers required to reduce (a), breeding output, and (b), food resources, and will take into account the density and movements of rhino, the quality of the rhino habitat, and the numbers of other browsing herbivore species. These have been estimated for the 11 major rhino conservation areas in Kenya, and they are listed in Table 1. It can be seen that two areas of upland Kenya, Solio Ranch and Nairobi NP, already have surpluses of rhino exceeding management levels available for translocation to other rhino conservation areas.

It should be stressed that the policy of breeding up black rhinos in relatively small sanctuaries has been, and will continue to be a vital holding action in reversing the decline in rhino numbers, and that the ultimate objective is to use the sanctuary populations as a 'breeding bank' of actively managed rhinos for provision of a continuous supply of surplus rhinos to restock the much larger, unrestricted areas of rhino habitat. It is these areas which are capable of supporting the minimum viable populations of rhino (e.g. 2000 rhinos) which no longer require active management to maintain their genetic variation, and reduce the probability of demographic instability or the risk of minor catastrophes.

Monitoring data accumulated on the numbers and densities of rhinos in each area, their breeding output at these densities and the impact on these numbers on the browse availability, will be used to feed back to the formation of decision rules about management of rhino numbers within sanctuaries, and the setting of carrying capacities and hence the equilibrium offtake for different rhino sanctuaries, particularly those enclosed by fencing.

3.3 The establishment of new rhino populations

3.3.1 Criteria for selection of new rhino areas

When assessing the suitability for new sanctuaries or reserves for stocking with black rhinos, the following guidelines will be observed:

-- The habitat must be suitable for rhinos, preferably with a previous history of a high density of black rhinos in the same area.

-- The poaching threat should not be severe, or if it is, effective control must be demonstrated. If rhinos are being moved to unrestricted or unfenced areas, the security, surveillance and monitoring in combination must be sufficient to demonstrate population growth despite occasional poaching of rhino.

-- The potential rate of increase of the rhino population in the recipient area must exceed that of the donor area

-- The potential effective founder population should be at least 10 rhinos, i.e. total founder population should be at least 20-25 rhinos.

-- The ecological carrying capacity should be at least 20 rhinos.

-- The number of founders should not exceed 50% of the ecological carrying capacity.

-- The current population size should not exceed 60% of the ecological carrying capacity.

-- There should be no disease or other health risk to the rhinos.

-- Current or proposed land-use must be compatible with conserving the species.

-- Small areas stocked (e.g. less that 100 sq km) should be fenced or have boundaries to prevent rhinos dispersing.

3.3.2 Selection of rhinos for translocation

The criteria for the selection of outlier rhinos for translocation and removal to sanctuary populations will be:

1. The rhino is in imminent danger of being poached.

2. The rhino is isolated from other rhinos, or is part of a 'doomed', inviable and/or potentially inbred group, which through translocation would become part of a viable population.

3. The rhino is not breeding, because of 2.
Other factors influencing the priority of individuals for translocation into sanctuaries are:

4. The cost of capture and translocation. Two capture operations of individual rhinos in remote areas in late 1989 and early 1990 cost $8,000 and $13,000 per rhino respectively, largely due to the necessity of using a helicopter. The high cost of catching an individual rhino in particularly difficult conditions may in some cases outweigh the small benefit to a recipient population (in terms of its contribution to improved breeding output) of catching and moving it there in the first place, particularly if the rhino is a male (see point 6.).

5. The rhino is of large genetic value, because of its remoteness from other populations, the habitat type and possible local adaptation of the rhino or 'store' of genetic variation. This factor is hard to quantify, but may become clearer following on-going genetic studies (see Section 5.4).

6. The rhino is a female. Females are particularly valuable in increasing breeding output in a recipient population.

3.4 Maintenance of genetic diversity

The following guidelines will be observed as far as possible:

1. New rhino populations will be founded by 20-25 rhinos, preferably unrelated breeding animals.

2. Founder populations will be allowed to expand as fast as possible to numbers exceeding the management level set for the area, but not exceeding its carrying capacity.

3. 1-2 rhinos (unrelated breeding animals) will be moved into each population every generation (6-15 years). This will involve the movement of rhinos between small sanctuary populations, as well as the capture and translocation of outlying unprotected rhinos into sanctuaries.

3.5 Rhinos, tourist viewing and revenues

All rhinos, whether black or white, are important and valuable species for tourist viewing, and may well provide as much viewing satisfaction to visitors as does the elephant. However the best rhino habitat is essentially dense bushland or forest, where rhinos are unlikely to be spotted away from particular places where the animals are attracted to water or salt licks (e.g. The Ark, Treetops). In general, the more open the habitat and the higher the density of rhinos, the more rhinos are likely to be seen, and therefore the more valuable they are for tourist viewing. Rhinos are among the most sought after species for

viewing by all tourists visiting KWS Parks and Reserves. This factor has probably increased with the endangered status and general scarcity of rhinos.

Of the 380-400 black rhinos remaining in Kenya, only about 140 animals are regularly visible in the more open Parks and Reserves. These include (in approximate order of viewing probability):

Nairobi NP	62
Masai Mara GR	28
Aberdares NP (Ark & Treetops)	20
Lake Nakuru NP	23
Amboseli	8
Mt Kenya NP/Forest Reserve (Mountain Lodge)	4

It is difficult to assess how much tourism revenues from different parks such as the above are dependent on the presence, and more importantly, the visibility of black rhinos. But there must be a major contribution to gate revenues from these, particularly when the areas are known and publicised as rhino sanctuaries. Lake Nakuru NP gate receipts have climbed steadily since 1987 when rhinos were introduced from Solio Ranch.

Although there are only 7 black rhinos left in Amboseli NP, most of these are easy to find, and safari companies can almost 'guarantee' showing them to their clients. Each animal is enormously valuable as a result. Much the same situation exists in the Ngorongoro Crater Conservation Area in Tanzania. One can virtually guarantee to see rhino in Nairobi NP because of their high density and the particular 'tameness' of many well known rhinos to the proximity of vehicles. Because of the rhinos viewing value, the policy for managing rhinos and moving rhinos between populations will be adapted to maintain high rhino densities in the present and future 'showcase' rhino sanctuaries, such as Nairobi NP and Lake Nakuru NP.

In the several private land rhino sanctuaries, land owners are already making money out of tourism coupled to conservation of the black rhino. In KWS sanctuaries or protected areas where rhinos are less visible due to the dense vegetation or forest, tourists can be attracted to game viewing lodges where rhinos are attracted by salt or water (e.g. The Ark). Similar camps or lodges could benefit from the introduction of rhinos into protected areas in the future. Rhinos are more valuable in the more open 'showcase' rhino sanctuaries (e.g. Nairobi NP), especially at high numbers, but this value will have to be weighed against the need to breed up rhinos in areas of better rhino habitat where higher densities could be supported.

When assessing the pros and cons of moving particular rhinos out of areas which are near carrying capacity and which have good rhino viewing (e.g. Nairobi NP), in order to reduce the potential negative impact on tourist viewing, the intention is to select

those animals for translocation which are more secretive, or with home ranges located in dense bush, where they are largely inaccessible to tourist viewing. Many rhinos do become habituated to the presence of vehicles and general disturbance, and become in general much less aggressive, and many of these are well known by the drivers of tourist vehicles, and thus can almost be 'guaranteed' to their clients. These popular rhinos are clearly not good candidates for translocation.

In general rhino numbers in prime viewing areas would not be adversely affected by translocations of 'surplus' rhinos to other protected areas, as the densities at which rhinos are moved out should be large enough to ensure good viewing, especially in populations in open reserves nearing carrying capacity.

3.6 Rhinos on private land

All black rhino in Kenya, including those on private land, are the property of the Kenya Government, and the Kenya Wildlife Service will make and implement all decisions necessary to their survival in Kenya, in particular the maintenance of sufficient security. If the criteria for holding black rhino on private land are satisfied (Section 3.2.1), and the areas rank sufficiently high in priority over Parks and Reserves for receiving rhinos in the first place, private land owners will be encouraged to generate funds for their protection and management, particularly through tourism in these areas.

White rhinos in Kenya are the property of the landowner, they may be purchased and sold at mutually agreed prices, inside or outside of the Republic of Kenya. However all decisions over their sale, management and protection must be made with the approval of, and in consultation with KWS. KWS will enforce management decisions for the white rhino on private owners, particularly if they in any way compromise or conflict with measures to conserve the black rhino in Kenya.

4.1 RHINO CONSERVATION & MANAGEMENT REQUIREMENTS

In order to maintain the recovery of the small populations of black rhino in Kenya, total security for these is vital. Depending on the location and characteristics of different areas, security depends on different factors (e.g. anti-poaching, fencing and alarms) and the aspects to the poaching threat (e.g. distance to political (or National) boundary, security status of region, previous incidence of poaching).

The Kenya Wildlife Service will place the security of all rhino populations as a highest priority. However all populations will be regularly rated for poaching threat, in addition to biological and genetic status, and if in the future the security of any rhino population is judged to have deteriorated sufficiently, whole rhino populations may be captured and translocated to safer

areas (which do satisfy the criteria of Section 3.2.1), where feasible.

Existing rhino sanctuaries vary considerably in size and 'design' particularly in relation to security. For example, the Lake Nakuru Rhino Sanctuary is Lake Nakuru NP, where, apart from rhino monitoring patrols and other rhino-specific activities, there is a large overlap with the normal park management. The fence around Lake Nakuru NP is important as much for the Park, and surrounding human inhabitants, as for the rhino. In contrast, the Ngulia rhino sanctuary is a smaller fenced area deep within the Tsavo West National Park. The fence here is designed purely to contain rhino, and has no other purpose. The security, however, is dependent on anti-poaching by the Tsavo NP Field Force over a much wider area, which of course covers elephant and other wildlife, and is not rhino-specific. Thus in different sanctuaries, there are different areas of overlap with normal parks management.

Although KWS staff involved in the rhino conservation programme are in many cases employed in rhino-specific activities (e.g. fence maintenance, rhino monitoring), as rhino numbers do build up in sanctuaries, and more rhino are released in operations to restock unrestricted areas of Parks and Reserves, the security and management requirements for rhinos in different areas will steadily merge more fully with the normal requirements of Parks and Reserves, as they did in the past.

The requirements of the most important KWS-managed rhino conservation areas are listed in Appendix 7A.1, containing all items necessary for the maintenance of rhino surveillance and fencing in these areas. Also crucial to the maintenance of maximum breeding output of rhinos in all areas is an extensive programme of translocations of rhinos between sanctuaries and into sanctuaries from outlying areas. These translocation requirements are listed in Appendix 7A.2.

A KWS fencing unit is to be formed to oversee the maintenance all fence barriers in the KWS areas, and particularly of rhino fencing. The proposed establishment of this unit, and the stores of equipment and supplies necessary for this unit are listed in Appendix 7A.4.

5.1 RHINO RESEARCH PROGRAMME

5.2 Rhino monitoring

Successful management of the black rhino populations for maximum sustained breeding output and avoidance of overpopulations depends on detailed population monitoring. A system of monitoring of the rhino populations in sanctuaries is already in place, aimed primarily at obtaining the following information:

-- Absolute population sizes in each area.

-- Population performance indicators annually.

-- Recruitment rate to each population.

-- Personal history records of all rhinos.

-- Details of all matings, births and mortalities.

-- Identities of breeding animals.

-- Confirmation of the presence and health of individual rhinos.

Rhino surveillance personnel in the major rhino areas collect information from daily vehicle and foot patrols, and record this in record books drawn up for the purpose. Staff in private land rhino areas will be required to monitor their rhino populations in order to obtain the minimum information required to identify all individuals, regularly census and establish population trends. Most of the black rhino in the protected areas are identifiable from individual features (e.g. horn shape), and individual identification is the basis of all monitored information. All animals immobilised for translocation, tagging or treatment are ear-notched to assist future identification.

5.3 Vegetation monitoring and food resources

The most important components of the diet and browse preferences of black rhino in all major conservation areas will be identified. A long-term regime of monitoring the browse availability will be initiated, especially in confined ring-fenced areas. The impact of other browsing herbivores and their influence on the food resources available for rhino will be assessed in each area.

Vegetation monitoring in rhino sanctuaries will concentrate on the following:

-- Routine ground photography of enclosed areas from fixed points/cairns (N,S,E,W directions) in wet and dry seasons. Use of these points for long-term transects.

-- Rhino diet identification - key browse species.

-- Browse availability: Line transects, exclosure plots, Bush/tree heights, browse levels and stem diameters, crown diameters, woody vegetation cover.

Collaborating institutions:
National Museums of Kenya - East African Herbarium
University of Nairobi - Botany Department
Moi University, Eldoret
Wildlife Conservation International
University of Bayreuth - Germany

5.4 Ecological monitoring in rhino sanctuaries

The successful management of rhino sanctuaries and other small parks/reserves, particularly those enclosed by fencing, other confines, and/or surrounded by human settlement, will depend critically on detailed ecological monitoring. Particular attention should be paid to assessment vegetation status (see Section 5.2), and the numbers and population dynamics of several species of, perhaps competing, grazing and browsing herbivores.

Judging by the events that have taken place already in fenced rhino sanctuaries on private land in the last 10-15 years (e.g. Solio Ranch Game Reserve, Lewa Downs Rhino Sanctuary, Ol Jogi Ranch Game Reserve; Lake Nakuru NP, Nairobi NP), these systems are susceptible to major swings in the numbers of different species. For example: die-offs of eland, kudu, oryx & wart-hog in dry years; overpopulations of waterbuck and impala at low predator numbers; large increases in numbers of giraffe, zebra and buffalo in most areas; overbrowsing of favoured browse species by black rhino (made more acute by giraffe grazing at lower browse levels, after depleting reserves at their own level). These are all areas where elephant are absent.

In enclosed areas, there is a need for a monitoring system appropriate to the whole ecosystem. In rhino sanctuaries, priority is usually given to the requirements of the black rhino, i.e. complete protection for this species, maintaining the habitat conditions and population structure to promote maximum sustainable breeding output. This inevitably means that in many rhino sanctuaries, there are already major 'giraffe problems', which potentially or already are having negative effects on the food reserves available to the rhino. The management of numbers of predator species will be critical to controlling the degree of competition for numerous grazing or browsing species, which would compete less at lower numbers (e.g. separated browse levels).

Appropriate long-term vegetation monitoring will be carried out in all enclosed rhino sanctuary, and the numbers and inter-relationships of other major predator and herbivore species will be monitored, particularly number of potential competitors with the rhino. The susceptibility of enclosed areas to catastrophic events (e.g. disease, major fire) is potentially a big threat to the rhino populations they may contain.

Collaborating institutions:
Moi University, Eldoret
Wildlife Conservation International

5.5 Genetic studies

The Kenya Wildlife Service will continue to sample individual rhinos immobilised during translocation or treatment for blood and tissue. Each rhino requires assessment of levels of genetic variation or inbreeding, and more detailed analyses of genetic material can enable detection of degrees of relatedness between individual rhinos. These analyses can and will affect management decisions in the future, in particular those involving the choice of particular animals for translocations between sanctuaries in order to minimise inbreeding.

As data on the population dynamics, survivorship, individual life histories and breeding performance in well monitored rhino populations accumulate, the value of computer modelling and projections of the future performance and inbreeding levels in each will increase. Computer analyses of well known small rhino populations in Kenya are already providing indications of how soon action will have to be taken to avoid inbreeding. These will also allow Population Viability Analyses (PVA) to be undertaken.

Collaborating Institutions:
National Museums of Kenya - Institute of Primate Research
Centre for Reproduction of Endangered Species -
Zoological Society of San Diego
Institute of Zoology - Zoological Society of London

5.6 Disease resistance

Studies will continue on establishing the feasibility of routine translocations of black rhino from upland areas of Kenya, free of tsetse fly and trypanosomiasis, to lowland tsetse-infested sanctuaries or release areas. These involve the movement of a few selected 'guinea-pig' rhinos from upland sanctuaries (e.g. Solio Ranch, Nairobi NP) to lowland areas (e.g. Tsavo NP, Masai Mara GR), monitoring their infection by trypanosomes, and characterising the latter collected from rhino and from tsetse fly populations surveyed in the recipient area. Most of the successful rhino sanctuaries are located in non-fly areas, and most of the potential release areas for large numbers of rhino are located in tsetse fly/trypanosomiasis areas. As it is not yet confirmed that upland rhinos can easily adapt to translocation to tsetse fly areas, and large numbers of rhinos need to be moved, these studies are of particular importance to the future management.of the black rhino in Kenya.

Collaborating institutions:
ICIPE

5.7 Physiological monitoring

Recent advances in non-invasive methods of monitoring the levels of reproductive hormones in wild rhinos have enabled diagnosis of pregnancy in females, and the identification of breeding males. Hormones are measured in samples of urine, saliva and blood, when obtainable. It is difficult to detect pregnancy visually in female black rhino, and early diagnosis can be of considerable assistance is assessing breeding performance and planning translocations. The identification of breeding males is very useful in assessing the genetic contribution of individuals in small populations, and hence preventing single animals from over-representation in the gene-pool in future generations or inbreeding. Further development of monitoring methods and assays of suitable reproductive hormones will continue in laboratories in Kenya, and in the field.

Collaborating institutions:

National Museums of Kenya - Institute of Primate Research
Institute of Zoology - Zoological Society of London
German Primate Centre
Centre for Reproduction of Endangered Species -
Zoological Society of San Diego

5.8 Nutrition

Particular conservation areas for the black rhino in Kenya are known to suffer from deficiencies of certain minerals in the soil and browse (e.g. Lake Nakuru NP). Mineral studies will continue in these areas in order to assess the potential impact of these deficiencies on the health and breeding of rhinos in these areas, and the need for mineral supplements.

Collaborating institutions:

Imperial College, London
National Museums of Kenya - East African Herbarium

6.0 RHINO RESEARCH REQUIREMENTS

Research on Kenya black rhino will concentrate on rhino population and vegetation monitoring. In most areas the monitoring work will be undertaken by the officers in charge of the rhino surveillance units, who are also in charge of management and security in each area. Thus there will be a direct link between the monitoring information and its use in rhino management.

At present the rhino surveillance officers in the three of the four major KWS rhino areas (Nairobi NP, Lake Nakuru NP, Tsavo Ngulia Rhino Sanctuary) are trained biology graduates, and their assistants are Park Assistants with experience of monitoring rhinos, plant identification and vegetation monitoring. Five more KWS surveillance officers, three of which are already posted to their respective rhino areas, will be trained in rhino population

and vegetation monitoring techniques, for application in areas not adequately covered at present (Aberdare NP, Amboseli NP, Masai Mara GR, Mt Kenya NP, Ngeng Valley). Three rhino monitoring officers will be trained in different aspects of research on black rhino biology and conservation in the next five years, one to PhD level, and two to MSc level.

The research requirements of the rhino conservation programme are listed in Appendix 7A.3

7.1 COLLABORATION WITH NEIGHBOURING COUNTRIES

7.2 Cross-border cooperation

In the Masai Mara GR and Amboseli NP, black rhinos from Kenya wander into Tanzania, and, particularly in the former case, their security is threatened as a result. Improved communication between KWS, TANAPA and the Tanzania Wildlife Division in these areas, and agreements of cross-border security and anti-poaching would improve the prospects of the survival of these international rhinos.

7.3 Provision of rhinos

As the status of the black rhino populations in neighbouring countries is so poor, if sufficient surplus rhino from sanctuaries become available, Kenya will be in a position to assist other countries with the donation, deposit or sale of individual black rhinos for breeding purposes, perhaps sponsored by donor agencies.

Tanzania has probably only about 50 black rhinos, the total population fragmented into very small sub-populations, none of which are viable in the long-term without input of unrelated animals. These could benefit from the inclusion of surplus males from Kenya, or eventually females if available, otherwise many of the small remnant populations are doomed. Somalia is reported to have 4-6 'doomed' rhinos near to the Kenya border. The black rhino in Uganda is probably extinct.

7.4 Other assistance

If Kenya cannot provide rhinos in the future, it could at least provide expertise to the wildlife departments of neighbouring countries wishing to conserve their black rhino populations, in the following areas:

-- Monitoring and census of rhino populations.

-- Capture expertise and assistance.

-- Population management.

-- Advice and assistance on construction of rhino sanctuaries.In the latter area, Kenya has had probably more experience and success than any other African country.

Although the policy has yet to be clearly defined to specific conservation areas, Tanzania in particular is planning to capture and translocate inviable 'pockets' of black rhinos remaining in the vast Selous GR to sanctuaries. Identification, monitoring and assessment of individual rhinos for capture, capture and transport of the rhinos, and planning and construction of rhino

sanctuary infrastructure in Tanzania could all benefit from input of expertise from Kenya.

Although there are as yet no established techniques of artificially enhancing breeding output, or artificial transfer of genetic material between rhino populations (e.g artificial insemination, embryo transfer), once these methods are feasible Kenya could assist neighbouring countries that have inviable or critically inbred rhino populations with provision of genetic material (semen, ova).

APPENDIX 7A.1

KENYA RHINO CONSERVATION PROGRAMME

(i) COSTS BY ZONE

All recurrent costs starting 1991, and continuing at same levels annually to 1996.
All capital demands immediate (1991), and probably non-recurring.

[Vehicle costs: Maintenance 25%, Depreciation 20%]

		JG	No	Kshs
KWS HQ	Staff	5	1	163 740
		6	1	140 640
	Total			304 380
	Transport			
	Capital			
	1 Suzuki LWB Pickup			300 000
	Recurrent			708 000
	Total			1 008 000
	Materials (Research)			
	Capital			90 540
	Recurrent			43 200
	Total			133 740
	TOTAL			**1 446 120**
NAIROBI ZONE	Staff	6	1	140 640
		11	2	126 240
		12	1	48 960
		13	1	42 720
		14	15	492 300
		15	12	274 320
	Total			1 125 180
	Transport			
	Recurrent			726 000
	Total			726 000
	Materials			
	Capital			241 180
	Recurrent			16 225
	Total			257 405
	TOTAL			**2 108 585**

COSTS BY ZONE (continued)

RIFT VALLEY ZONE	Staff	6	1	140 640
		9	1	90 660
		11	1	63 120
		12	2	97 920
		13	5	213 600
		14	26	853 320
		15	15	342 900
	Total			1 802 160
	Transport			
	Recurrent			987 600
	Total			987 600
	Materials			
	Capital			121 180
	Recurrent			16 225
	Total			137 405
	Casuals			120 000
	TOTAL			**3 077 165**
SOUTH KENYA ZONE	Staff	6	1	140 640
		9	1	90 660
		13	4	170 880
		14	21	689 220
		15	10	228 600
	Total			1 320 000
	Transport			
	Capital			
	1 Suzuki LWB Pickup			300 000
	Recurrent			1 434 000
	Total			1 734 000
	Materials			
	Capital			541 180
	Recurrent			16 225
	Total			557 405
	Casuals			120 000
	TOTAL			**3 731 405**

COSTS BY ZONE (continued)		JG	No	Kshs
MOUNTAINS ZONE	Staff	9	1	90 660
		12	1	48 960
		13	4	170 880
		14	19	623 580
		15	20	457 200
	Total			1 391 280
	Transport			
	Capital			
	1 Suzuki LWB Pickup			300 000
	3 Motorbikes			150 000
	Recurrent			828 000
	Total			1 278 000
	Materials			
	Capital			391 180
	Recurrent			16 225
	Total			407 405
	TOTAL			**3 125 645**
NORTH KENYA ZONE	Staff	11	1	63 120
		12	1	48 960
		13	1	42 720
		14	15	492 300
	Total			647 100
	Transport			
	Recurrent			519 000
	Total			519 000
	TOTAL			**1 166 100**
RHINO TRANSLOCATIONS (Annual recurrent)				**1 800 000**
FENCING UNIT	Staff	9	1	90 660
		13	2	85 440
		15	4	131 280
	Total			307 380
	Transport			
	Capital			
	1 L/Rover Petrol Pickup			900 000
	Recurrent			519 000
	Total			1 419 000
	Materials			
	Capital			73 160
	Total			73 160
	TOTAL			**1 799 540**

(ii) COSTS BY FUNCTION
(excludes KWS HQ Staff & Transport)

	JG	No	Kshs
RHINO SURVEILLANCE/MONITORING			
Staff	6	3	491 220
	9	2	181 320
	11	2	126 240
	12	5	244 800
	13	10	427 200
	14	95	3 117 900
Total		117	4 588 680
Transport			
Capital			300 000
Recurrent			3 117 600
Total			3 417 600
Materials			
Capital			900 540
Recurrent			43 200
Total			943 740
Casuals			120 000
TOTAL			**9 070 020**
RHINO FENCE MAINTENANCE (including Fence Unit) (Total length of fencing: 186 km (1990), increasing to 228 km (1991))			
Staff	9	1	90 660
	11	2	126 240
	13	6	256 320
	14	6	196 920
	15	57	1 303 020
Total		72	1 973 160
Transport			
Capital			1 350 000
Recurrent			1 083 000
Total			2 433 000
Materials			
Capital			484 720
Recurrent			64 900
Total			549 620
Casuals			120 000
TOTAL			**5 075 780**
RHINO TRANSLOCATIONS (Annual recurrent)			**1 800 000**

(iii) DETAILED COSTS BY AREA

KWS HQ

A. Staff

Title	JG	No
Project Coordinator (Senior Biologist)	5	1
Project Officer (Biologist I)	6	1
Personnel Total		2

B. Transport

Capital (Kshs '000):

Vehicle Type	Cost	No
Suzuki 4WD LWB Pickup	300	1

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
Suzuki 4WD LWS Pickup	147	60	207	1
L/Rover Diesel S/Wagon	321	180	501	1
Total			1 008	

NAIROBI ZONE

NAIROBI NP

RHINO SURVEILLANCE

A. Staff

Title	JG	No
Warden/Biologist I	6	1
Asst Warden III	11	1
Sergeant	12	1
Rangers	14	12
Drivers	14	2

B. Transport

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
L/Rover Petrol Pickup	339	180	519	1

C. Materials

Item	Unit cost	No	Total cost
Capital:			
VHF Radios	30 000	4	120 000

FENCE MAINTENANCE
(Length of Fence: 25 km (1990), increasing to 36 km (1991))

A. Staff

Title	JG	No
Asst Warden III	11	1
Fence Foreman	13	1
Driver	14	1
Subordinate Staff	15	12
Total		15

B. Transport

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
Suzuki 4WD LWB Pickup	147	60	207	1

C. Materials

Item	Unit cost	No	Total cost
Capital:			
Voltmeters	3 520	3	10 560
Pliers	1 000	2	2 000
Rolls of Wire	2 280	4	9 120
Insulators	25	500	12 500
Posts	120	200	24 000
Jembes	100	5	500
Slashers	100	4	400
Hammers	100	2	200
Tents	9 000	6	54 000
Strainers	1 900	1	1 900
Rubber Gloves	100	3	1 200
Knapsack Sprayers	2 400	2	4 800
Recurrent:			
Herbicide: Hyvar-X	16 225/25kg	25 kg	16 225
Total			137 405

RIFT VALLEY ZONE

LAKE NAKURU NP

RHINO SURVEILLANCE

A. Staff

Title	JG	No
Warden/Ecologist I	6	1
Field Assistant	13	1
Sergeant	12	1
Corporals	13	2
Rangers	14	13
Drivers	14	2
Total		20

B. Transport

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
Suzuki 4WD LWB Pickup	147	60	207	1

FENCE MAINTENANCE
(Length of fence: 74 km)

A. Staff

Title	JG	No
Assistant Warden III	11	1
Foreman	13	1
Driver	14	1
Subordinate Staff	15	15

B. Transport

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
4WD LWB Pickup	147	60	207	1
Tractor	30	12	42	1
Gyromower	4	2	6	1
Total			255	

C. Materials

Item	Unit cost	No	Total cost
Capital:			
Voltmeters	3 520	3	10 560
Pliers	1 000	2	2 000
Rolls of Wire	2 280	4	9 120
Insulators	25	500	12 500
Posts	120	200	24 000
Jembes	100	5	500
Slashers	100	4	400
Hammers	100	2	200
Tents	9 000	6	54 000
Strainers	1 900	1	1 900
Rubber Gloves	100	3	1 200
Knapsack Sprayers	2 400	2	4 800
Recurrent:			
Herbicide: Hyvar-X	16 225/25kg	25 kg	16 225
Total			137 405

MASAI MARA GR

RHINO SURVEILLANCE

A. Staff

Title	JG	No
Assistant Warden I	9	1
Sergeant	12	1
Corporal	13	1
Rangers	14	10
Total		13

B. Transport

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
1 L/Cruiser 4WD Pickup	339	180	519	1

LOITA HILLS

RHINO SURVEILLANCE

A. Staff (local Masai employed on casual basis)

Title	No	Salary
Supervisor	1	24 000
Scouts	10	96 000
Total	11	120 000

B. Transport (Supervision from Masai Mara GR)

Vehicle	Maint & Fuel/month	Annual cost
L/Cruiser 4WD	550	6 600

SOUTH KENYA ZONE

TSAVO WEST NP - NGULIA RHINO SANCTUARY

RHINO SURVEILLANCE

A. Staff

Title	JG	No
Warden/Biologist I	6	1
Field Assistant	13	1
Sergeant	12	1
Corporals	13	1
Rangers	14	16
Total		20

B. Transport

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
Suzuki 4WD LWS Pickup	147	60	207	1
L/Rover Petrol Pickup	339	180	519	1
Total			726	

C. Materials: VHF Radios

Type	No	Unit cost	Total cost
Portable	5	30 000	150 000
Vehicle set	2	30 000	60 000
Base station	2	60 000	120 000
Total			330 000

FENCE MAINTENANCE
(Length of fence: 41 km)

A. Staff

Title	JG	No
Foreman	13	1
Subordinate Staff	15	10
Total		11

Title	Salary	No
Casual Labourers	120 000	10

B. Transport

Capital (Kshs '000):

Vehicle Type	Cost	No
Suzuki 4WD LWB Pickup	300	1

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
Suzuki 4WD LWS Pickup	147	60	207	1
L/Cruiser Diesel Pickup	321	180	501	1
Total			1 008	

C. Materials

Item	Unit cost	No	Total cost
Capital:			
Voltmeters	3 520	3	10 560
Pliers	1 000	2	2 000
Rolls of Wire	2 280	4	9 120
Insulators	25	500	12 500
Posts	120	200	24 000
Jembes	100	5	500
Slashers	100	4	400
Hammers	100	2	200
Tents	9 000	6	54 000
Strainers	1 900	1	1 900
Rubber Gloves	100	3	1 200
Knapsack Sprayers	2 400	2	4 800
Recurrent:			
Herbicide: Hyvar-X	16 225/25kg	25 kg	16 225
Total			137 405

AMBOSELI NP

RHINO SURVEILLANCE

A. Staff

Title	JG	No
Assistant Warden I	9	1
Corporals	13	1
Rangers	14	4
Drivers	14	1
Total		7

B. Transport

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
Suzuki 4WD LWB Pickup	147	60	207	1

C. Materials: VHF Radios

Type	No	Unit cost	Total cost
Portable	2	30 000	60 000
Vehicle set	1	30 000	30 000
Total		60 000	90 000

MOUNTAINS ZONE

ABERDARES NP

RHINO SURVEILLANCE

A. Staff

Title	JG	No
Assistant Warden I	9	1
Field Assistant	13	1
Sergeant	12	1
Corporals	13	1
Rangers	14	12
Drivers	14	2
Total		18

B. Transport

Capital (Kshs '000):

Vehicle Type	Cost	No
Suzuki 4WD LWB Pickup	300	1

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
Suzuki 4WD LWS Pickup	147	60	207	1
L/Rover Petrol Pickup	339	180	519	1
Total			1 026	

C. Materials: VHF Radios

Type	No present	No required	Unit cost	Total cost
Portable	0	6	30 000	180 000
Vehicle set	0	1	30 000	30 000
Base station	0	1	60 000	60 000
Total				270 000

FENCE MAINTENANCE
(Length of fence: 37 km (1990), increasing to 68 km (1991))

A. Staff

Title	JG	No
Foreman	13	1
Subordinate Staff	15	20

B. Transport

Capital (Kshs '000):

Vehicle Type	Cost	No
Motorbike	150	3

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
Motorbikes	72	30	102	3
Total			252	

C. Materials

Item	Unit cost	No	Total cost
Capital:			
Voltmeters	3 520	3	10 560
Pliers	1 000	2	2 000
Rolls of Wire	2 280	4	9 120
Insulators	25	500	12 500
Posts	120	200	24 000
Jembes	100	5	500
Slashers	100	4	400
Hammers	100	2	200
Tents	9 000	6	54 000
Strainers	1 900	1	1 900
Rubber Gloves	100	3	1 200
Knapsack Sprayers	2 400	2	4 800
Recurrent:			
Herbicide: Hyvar-X	16 225/25kg	25 kg	16 225
Total			137 405

MT KENYA NP

RHINO SURVEILLANCE

A. Staff

Title	JG	No
Field Assistant	13	1
Corporal	13	1
Rangers	14	5
Total		7

NORTH KENYA ZONE

MATTHEWS RANGE - NGENG VALLEY
(FOREST RESERVE)

RHINO SURVEILLANCE

A. Staff

Title	JG	No
Assistant Warden III	11	1
Sergeant	12	1
Corporal	13	1
Rangers	14	15
Total		18

B. Transport

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
L/Cruiser Petrol Pickup	339	180	519	1

APPENDIX 7A.2

RHINO TRANSLOCATIONS
(65 Black rhino, 15 White rhino)

Numbers of translocations and Costs over 5 years 1991-1995
Administered through KWS HQ

Area	Number of rhino	Cost per rhino (Kshs)	Cost per year (Kshs)	Cost for 5 yrs (Kshs)
TO				
Lake Nakuru NP	20	70 000	280 000	1 400 000
Tsavo Ngulia	10	250 000	500 000	2 500 000
	20	70 000	280 000	1 400 000
Aberdares NP	5	70 000	70 000	350 000
	3	250 000	150 000	750 000
Amboseli NP	10	70 000	140 000	700 000
Ol Pejeta	15	70 000	140 000	700 000
	2	250 000	100 000	500 000
Lewa Downs	5	70 000	70 000	350 000
Total	90		1 800 000	9 000 000
FROM				
Nairobi NP	30	70 000	420 000	2 100 000
Unprotected Areas	15	250 000	750 000	3 750 000
Solio Ranch	45	70 000	630 000	3 150 000
Total	90		1 800 000	9 000 000

APPENDIX 7A.3

RESEARCH

Administered through KWS HQ

A. Staff
(Overlaps with Rhino surveillance/security)

A. RHINO SANCTUARIES:
Nairobi NP, Lake Nakuru NP, Aberdare NP, Tsavo West NP

1	Biologists (BSc level)	4
2	Technicians - Field Assistants (have a knowledge of vegetation identification & monitoring)	4

B. OTHER AREAS (to be trained)

1	Masai Mara GR - Biologist (BSc level), NCO	2
2	Amboseli NP - AW I, Park Assistant	2
3	Mt Kenya NP - NCO	1
4	Matthews Range/Ngeng Valley - AW III, 2 NCOs	3
TOTAL		16

B. Materials

Capital:

Item	Number	Unit cost(Kshs)	Total Cost(Kshs)
Binoculars	18	4600	82 800
Dictaphones	3	2580	7 740

Recurrent:

Film & processing:	Annual cost (Kshs)
4 x 5 x 12 x 180/-	43 200
Total	133 740

APPENDIX 7A.4

KWS FENCING UNIT

A. Staff

Title	JG	No
Assistant Warden I	9	1
Fence Technicians	13	2
Subordinate Staff	14	4
Total		7

B. Transport

Capital (Kshs '000):

Vehicle Type	Cost	No
L/Rover 4WD Petrol Pickup	900	1

Recurrent (Kshs '000):	Fuel & Maint.	Deprn.	Total	No
L/Rover Petrol Pickup	339	180	519	1
Total			1 419	

C. Materials

Capital:

Item	Unit cost	No	Total cost
Voltmeters	3 520	3	10 560
Tents	9 000	6	54 000
Strainers	1 900	2	3 800
Knapsack Sprayers	2 400	2	4 800
Total			73 160

Lake Nakuru Black Rhinoceros Sanctuary

Christopher Lever

In an attempt to stem the decline of the black rhinoceros Diceros bicornis *in Kenya, the Rhino Rescue Charitable Appeal Trust was formed in England in 1985. Within a year work on the first sanctuary, in the Lake Nakuru National Park, had begun. The sanctuary was opened in 1987, when 17 rhinos from Mr Courtland Parfet's private ranch at Solio joined the two animals already in Nakuru. A further 11 females are due to be added to the park shortly. Rhino Rescue, of which the author is a patron and trustee, is also developing its own education programme, and is contributing to other rhino sanctuaries in Kenya.*

The decline of the black rhinoceros *Diceros bicornis* in Africa is well documented (Western and Vigne, 1985). It is now mainly confined to isolated pockets in the east and south-east of the continent and in Namibia. In Kenya the black rhinoceros population has fallen from 18,000-20,000 in 1970 to 511 in 1987, a decline of over 97 per cent. In the last 7 years the population has dropped from 1500, a decrease of 66 per cent (IUCN, 1988). In addition to poaching, another reason for the decline of the black rhino is the rapid growth in the human population. At around 4 per cent per annum Kenya, for example, has one of the highest growth rates in the world. With increasing reclamation of land for farming and demand for wood as fuel and building material, the rhino's distribution has shrunk dramatically.

In an attempt to stem this disastrous decline, the Rhino Rescue Charitable Appeal Trust was formed in England in December 1985, under the presidency of HRH Prince Bernhard of The Netherlands. The aim of the Trust is to help the government of Kenya achieve the objective of its rhino conservation strategy plan to build fenced sanctuaries for the beleaguered animals.

In March 1986 an appeal was launched in the House of Lords in London; this proved so successful that within a year sufficient funds had been raised to begin construction of the first sanctuary. The site chosen was the Lake Nakuru National Park in the central Rift Valley, 140 km north-west of Nairobi.

Lake Nakuru (Figure 1) is a shallow alkaline soda lake 7·1 sq km in extent, bordered on the west by a steep and rugged wall of the Rift Valley, with volcanic cliffs rising to 2743 m, and on the east by a salt-dome hill. The lake is encircled by swamps, and the surrounding land supports an arid transitional savannah, with the lake's marginal grasslands of salt

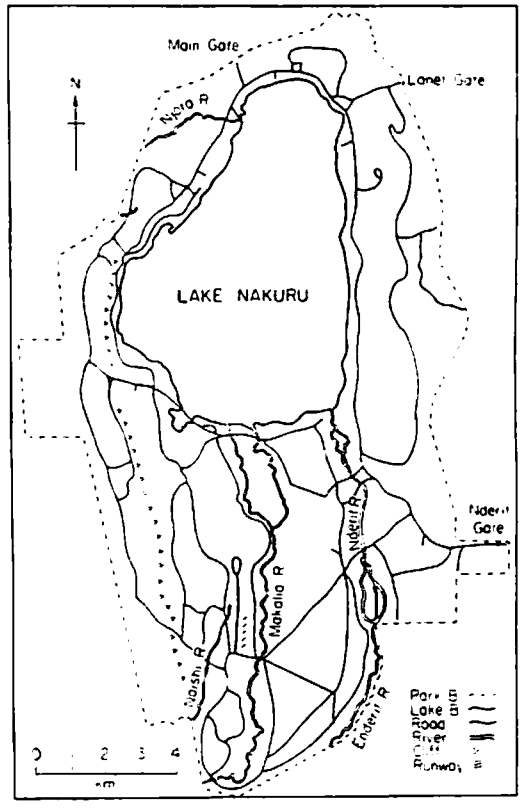


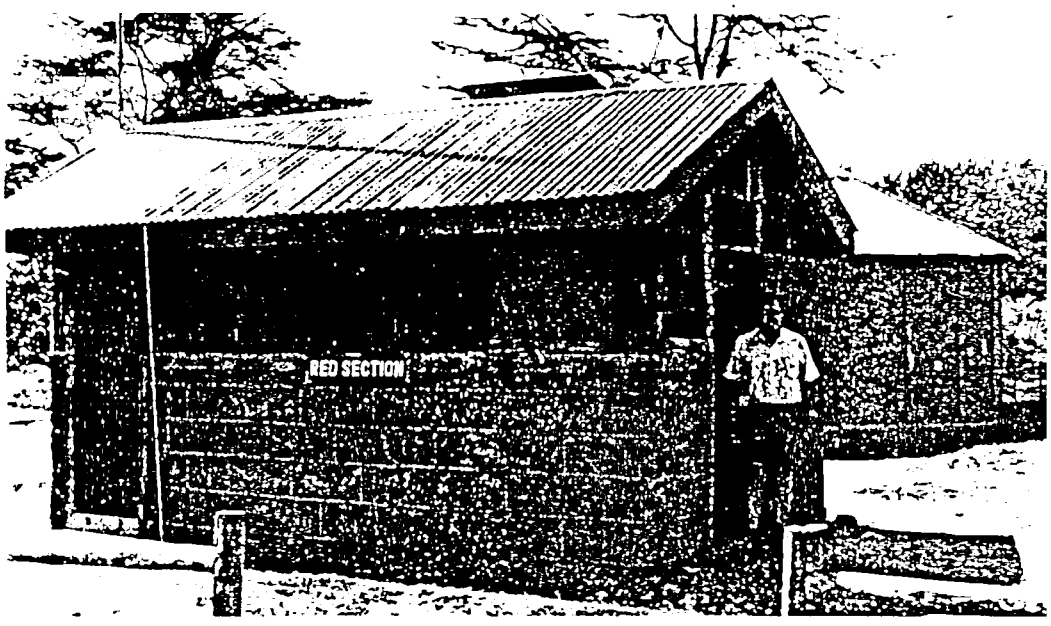
Figure 1. Map showing Lake Nakuru National Park.

grass *Sporobolus spicatus* and sedge *Cyperus laevigatus* giving way to grasslands of *Hyparrhenia hirta* and in the lower areas Rhodes grass *Chloris gayana*. On the higher ground are found: xerophyte forests of *Acacia xanthophloea*, olive *Olea hochstetteri*, and *Croton dichogamus*; *Euphorbia candelabrum* forest; and bush country dominated by the composites, mulelechwa *Tarchonanthus camphoratus* and *Psiadia arabica* (IUCN, 1987). All this is prime rhino habitat.

With financial contributions from private individuals and other conservation organizations, generous donations of materials and services from elsewhere, and £300,000 provided by the Trust itself, work was begun on enclosing the 200-sq-km park surrounding the lake and the lake itself. A 74-km-long, 3-m-high, 12-stranded electrified fence was built, consisting of 11,038 wooden posts, many driven into stony ground, and 888 km of high-tensile steel wire strung through 33,114 electrical insulators. Every 15 km there is a manned guard post equipped with automatic anti-tamper alarms, solar panels to provide electrical power, and radio communications. Every alternate wire on the fence is electrified; the 700 non-lethal volts they provide have proved enough to deter intruders and to keep rhinos within the sanctuary, but are not sufficient to prevent olive baboons *Papio anubis*, who have learned how to avoid the electrified wires, from climbing over the fence.

Bulldozers have been used to create a firebreak along the fence outside the sanctuary and a maintenance road on the inside. Within the sanctuary a further 60 km of patrol tracks and bridges have been driven through the bush to provide access for mobile patrols. Each patrol has been equipped with a radio for communication with the Trust's headquarters, comprising the administrator's house, stores, maintenance facilities, a radio room and an office. Nearby are the holding pens, where the rhinos are acclimatized on their arrival at Nakuru before being released into the wild, and a release ramp.

Three rivers feed Lake Nakuru, which has no outlet, but they run only for some three months a year, thus making the water development aspect of the project of great importance. With financial assistance from other



Guard post

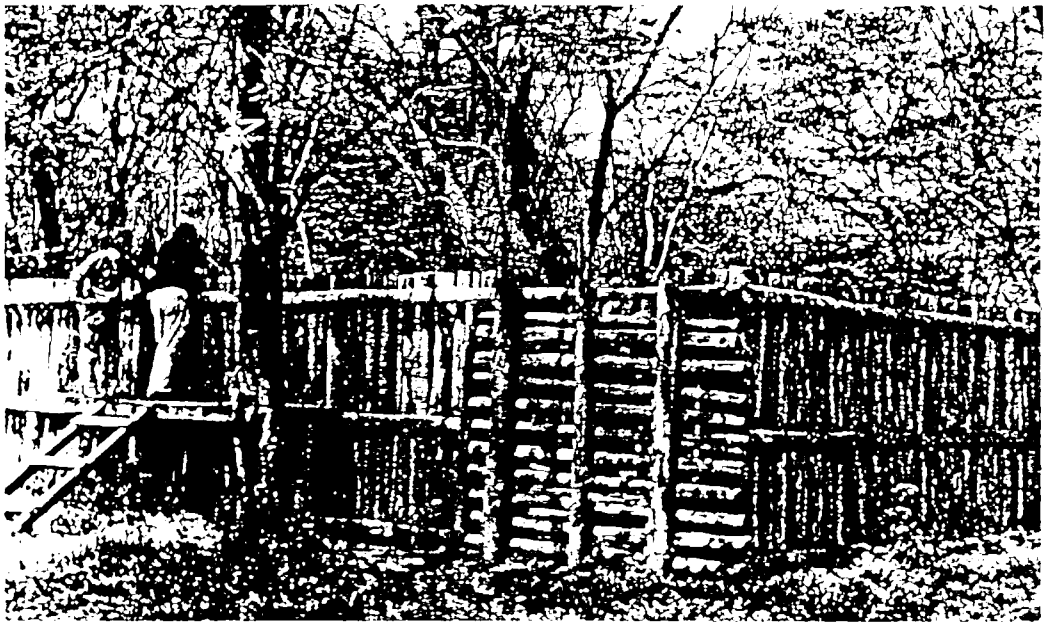
conservation groups, natural waterholes in the sanctuary have been enlarged, deep boreholes sunk and piped water laid on to drinking troughs. Rhino Rescue has also helped to finance the construction of two 12-million-gallon dams, using machinery supplied by the Kenyan Government under the supervision of the West German Water Development Agency. Surveys of the park's volcanic soil, which is interspersed with alkaloid deposits, have revealed deficiencies in copper and cobalt; this has been remedied by the introduction of appropriate licks.

On a visit to Nakuru in March 1989 I was able to see the Trust operating at first hand. The value of the firebreak outside the perimeter fence was shown to good effect when it, and the combined fire-fighting ability of the Trust's personnel and the park's staff, alone prevented the spread into the sanctuary of a dangerous bush fire from the neighbouring estate of Lord Delamere. Camping in the park at the time was a party of young people of several nationalities from Operation Raleigh, and a detachment from the band of the Grenadier Guards, both of whom, under the direction of a corporal from the Royal Engineers, were rendering sterling service to the Trust by helping to construct a bridge over a deep ravine.

Conservation alone, however, is not enough. To ensure the ultimate success of any project, people, and especially children, must be taught to appreciate the value and importance to them of wildlife and natural habitats. To this end, Rhino Rescue is developing its own education programme. This began with talks to school children visiting Nakuru; these proved so popular that a four-wheel-drive vehicle fitted with a television screen will shortly be acquired, which will enable the Trust to visit local schools and show films about African wildlife. Later a generator will be purchased, thus allowing the unit to travel further afield and give film shows to outlying schools.

The Trust has undertaken to fund the major part of the running costs of the sanctuary (estimated to total around £75,000 per annum) for an initial period of 3 years. It has installed its own administrator to protect and administer its investment, and to liaise with the park authorities.

Rhino Rescue has also undertaken to fund a



Holding pen.

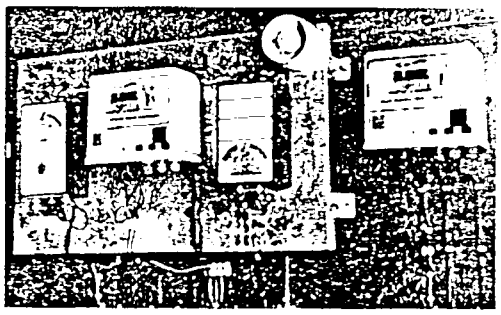
Administration building

further increase in the size of the rhino sanctuary started by the Zoo Check Charitable Trust in 1985 at Ngulia near Mtito Andei in the Tsavo West National Park, 190 km south-east of Nairobi, where the erection of a further 20 km of fencing will increase the total area of this sanctuary to some 60 sq km. Shortly after the first three female rhinos, caught near Kibwezi and Taveta, were freed in Tsavo, a male broke in through the perimeter fence, and has remained there ever since. Recently another male, who had killed two white rhinos *Ceratotherium simum* at Ol Jogi, and had subsequently been de-horned, was translocated to Ngulia, where he in turn was killed by one of the resident rhinos. This unfortunate occurrence adds cogency to the many arguments against the de-horning of rhinos, certainly in Kenya, as a solution to the problem confronting conservationists. Since 1985 two rhino calves have been born at Ngulia, where the total number of rhinos in the sanctuary is now 10, and where a similar number from Solio (see below) is due to be added shortly.

Thanks to a generous donation from the David Shepherd Conservation Foundation, Rhino Rescue has also contributed to the construction of a further sanctuary in the Salient of the Aberdare National Park, a little over 100 km due north of Nairobi.

No account of the campaign to save the black rhino would be complete without mentioning the contributions of such individuals as Dr Esmond Bradley Martin, an American geographer and one of the patrons of Rhino Rescue, who is working to abolish the illegal trade in rhino (and elephant) products, and the efforts of Mr Michael Werikhe to raise funds for the rhino by his sponsored long-distance walks through Europe and East Africa.

Only 18 months after the launch of the Rhino Rescue Appeal, the first black rhinos were released in Nakuru, to join the two already within the National Park. Seventeen animals were transferred from the private Solio ranch near Nyeri, (which in addition to supporting a population of no fewer than 85 black rhinos also contains a group of 30 introduced white rhinos) owned by an American, Mr Courtland E. Parfet, another patron of the Trust. The founding stock was deliberately kept low to encourage the animals to breed more freely.



Automatic anti-tamper alarm system at guard post.

Without the foresight of Mr Parfet in creating his private sanctuary at Solio, the work of the Trust would not have been possible.

Records are maintained on each animal at Nakuru, and its social behaviour and interaction with other rhinos are carefully monitored; this is important to prevent stress, which could lead to fighting. Black rhinos are not gregarious creatures and problems can arise if populations become too great for a given area. Even when the population is not large, difficulties can arise. Shortly after the rhinos were transferred from Solio to Nakuru, an immature female was attacked and injured by an adult female. After treatment of her wounds in the holding pens she was released, only to be attacked and injured again. On the second occasion she rather touchingly returned to the holding pens for treatment of her own accord, and after recovery was transferred from Nakuru to a private sanctuary. If and when the population at Nakuru becomes too great, surplus animals will also be transferred to other public or private sanctuaries.

When a rhino is shot with a tranquillizing dart, placed in a holding pen and allowed to become settled in its surroundings, it normally becomes accustomed to people looking after it within 3 or 4 days, and after a week can be transported by vehicle to its new home.

The policy of the Kenyan Government of constructing fenced and well patrolled rhino sanctuaries within its national parks is to be commended. If the new sanctuaries on public land prove as successful as those on private ranches, they will have gone a long way towards halting the demise of the black rhino in Kenya.

A further 11 female black rhinos from Solio are due to be added to Nakuru shortly, which is now home to 19 animals (11 males, seven females and one calf born since the sanctuary was formed), and several of the females are believed to be in calf. From this breeding nucleus at Nakuru, which it is estimated can hold at least 60 adult rhinos, the future of the species in Kenya, where in 1988 for the first time in many years more rhinos were born than were killed, now seems assured. In time it is hoped that some animals can safely be returned to the wild in other unfenced national parks. This is Rhino Rescue's ultimate objective. That such a magnificent creature should ever be allowed to disappear from the earth is surely unthinkable.

In the second phase of its Appeal, Rhino Rescue is aiming to raise a capital fund of £750,000, the income from which would enable the Trust to fund the Nakuru sanctuary's annual running costs indefinitely. Donations can be sent to: Rhino Rescue, P. O. Box 1, Saxmundham, Suffolk IP17 3JT, UK.

Acknowledgments

I should like to thank Count and Countess Coreth for their hospitality at Nakuru and Count Coreth, the founder of Rhino Rescue, for his comments on my MS. My thanks are also due to Mrs Daphne Sheldrick for her personal communication.

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Sir Christopher Lever, Newell House, Winkfield, Windsor, Berkshire SL4 4SE, UK.

Threats to Aberdare Rhinos: Predation versus Poaching

Claudio Sillero-Zubiri and Dada Gottelli

The black rhino, *Diceros bicornis*, once common in most sub-Saharan countries, has suffered a most serious decline since about the middle of this century and now faces extinction throughout its range. Until recently it was abundant in many parts of Kenya. During the 1970s, poaching, stimulated by the illegal trade in rhino horn, turned into a massive-scale operation. In 1985 Jenkins estimated less than 400 rhinos remained in Kenya in populations large enough for their management.[1]

Declining Trend of the Abedare Rhino Population

The Aberdare National Park (ANP) was famous in the past for its very high density of rhinos. This was particularly true for the Salient, a 70 km^2 wedge-shaped area of forest stretching down the eastern Aberdare slopes and separated from the densely populated farmland by a moat and electric fence. The then warden, F.W. Woodley, in a personal comment, estimated the rhino population of the entire Park to be in the order of 450 during the early 1970s. Sadly, they have been decimated by poachers during the last decade. The 1982 ANP census counted 132 rhinos in the area and the present population is well under 50. It is possible that the Salient rhino population alone has been reduced by as much as 80 percent of its former level.[2] We estimated a rhino population for the Salient of 30 in 1987, which agreed with the estimate by the ANP Rhino Surveillance Unit. Approximately five more occurred in northern ANP.[3]

Today, in spite of the dramatic decrease in rhino numbers, the ANP is probably the only National Park in Kenya with a genetically viable population of native black rhinos.[4] However, their numbers are already below the recommended threshold to minimize loss of genetic variability in a population.[5]

Rhino Sightings at Forest Lodges

The Salient with its two forest lodges, the Ark and Treetops, is one of the best places in Kenya to watch black rhinos. The records of animals seen at the lodges' salt-licks have proved useful in providing information on long-term trends in animal populations of the area. Rhino sightings indicate a dramatic reduction in numbers, especially at Treetops where up to 1978 an average of eight to ten rhinos visited the salt-lick every night. From 1979 to the present there has been a steady decline of sightings. An average of 1.48 rhinos were seen at the salt-lick on 31% of the nights between July 1986 and June 1987. All these sightings correspond to a male and a cow with calf making regular visits.

The Ark and its surroundings hold the highest concentration of rhinos in the ANP. Trends of rhino sightings at the Ark are less clear-cut, with daily records oscillating but totalling nearly 1,000 a year. At least 20 rhinos are frequent visitors to its salt-lick. The Ark area may have acted as a refuge for rhinos moving from places where poaching was heavy. Such an inflow of new animals may have kept the Ark records relatively constant, masking any significant decline of the population as a whole.

Predation in the Salient

Conservationists have expressed fears that spotted hyenas, *Crocuta crocuta*, could be killing rhino calves in the Salient. Since the late 1970s the Wildlife Conservation and Management Department (WCMD) has expressed concern about the effect that a high density of spotted hyenas might have on the herbivore species in the ANP forest, in particular on those endangered species such as bongo, *Tragelaphus eurycerus*, and black rhinos whose numbers have decreased rapidly in the last few years. The skyrocketing of hyena sightings at both forest lodges during the 1980s and the extent to which pack hunting became more conspicuous have also been a matter of concern. A field study was undertaken in 1986-87 to estimate the actual population of hyenas in the Salient and its effect on prey species.[6]

Hyenas are the chief predator in the Salient. Although the Salient does not resemble the optimal habitat for hyenas as described in the literature, it harbours a density of 1.34 hyenas per km^2, second only to that of Ngorongoro. This may be a result of the high concentration of herbivores which itself is probably a consequence of a 'funnel effect' exerted by the physical boundary and the creation of secondary forest by elephants. Hyenas were found to feed mostly on medium-sized ungulates. They forage alone or in small groups more often than in packs. However, hunting packs of up to 17 hyenas were observed, which was unexpected in a forest habitat. Lions, *Panthera leo*, were rare in the ANP forest until 1983 when the lodges' records show a sharp increase in their presence, probably due to range expansion from other parts of the ANP. At least 12 different lions utilized the Salient during our study. Regular use of the area by lions would almost certainly lead to a decrease in the hyena population through interference and exploitation competition.

Predation on Rhino Calves

Rhinos can be killed by lions even when adult.[7] They also appear to be vulnerable to predation by spotted hyena up to the age of four months.[8] Four attempts by hyenas to pull down rhino calves were observed at the Ark salt-lick during this study, all of them unsuccessful (Table). Three attacks were made on male calf A12 when he was approximately one year old. In August 1986, two hyenas grabbed the calf by the flank, inflicting wounds. A12 was attacked twice again in 1986, and on both occasions the mother, who herself is missing half her tail, charged the hyenas after the calf emitted a distress squeal. In April 1987, a very young calf of unknown sex was harassed by two hyenas and presumably wounded. Again, the mother defended the calf by repeatedly charging the hyenas, and then mother and calf fled for cover. Both calves were seen again after the attacks in seemingly good condition .

Four out of nine individually recognizable calves observed in the Salient had scars on flanks or hind legs and one had neither ears nor tail (Table). Earlessness (i.e. lack of pinnae) in the black rhino has been reported from a number of populations in southern and eastern Africa.[9,10] Although

Goddard first suggested that a genetic character could be responsible for a congenital deformity, Hitchins reviewed the subject and attributed the conditions to predation on rhino calves by spotted hyenas.[11]

Table. Known rhino calves in the Salient and evidence of predation attempts. Age estimation follows Hitchins (1970)[12]

Calf	Age	Sex	Evidence of predation
A4	2.5 yr	F	none
A7	2 yr	F	none
A12	1 yr	M	attacked by hyenas 3 times in 1986
A14	2.5 yr	F	no ears, no tail
A17	1 yr	F	wound right shoulder
A?	<1 yr	?	attacked by hyena in April 1987
A19	3.5 yr	F	none
TT	3 yr	F	none
MM	2 yr	M	none

Rhino calf survival

Attacks by hyenas on rhino calves in the Salient have been observed at the lodges' salt-licks for many years, although no successful attack has ever been reported. The high percentage of calves showing scars presumably inflicted by hyenas point to predation as a potential factor of infant mortality in the ANP. However, six out of eight known rhino cows regularly visiting the Ark salt-lick were accompanied by their calves. This gives a cow-calf ratio of 1:0.75 which is comparatively high; cow-calf ratios at Ngorongoro and Olduvai are 1:0.72 and 1:0.79 respectively.[13]

Poaching

Poaching has been the main and probably the sole cause for the depletion of the ANP rhino population. In 1982, 20 fresh carcasses were seen within one month in the Salient by S. Weller.[14] The last outbreak of organized poaching occurred in 1984.[15] During our study, six rhino skulls were collected and their age estimated using Hitchins' method.[14] Five were from animals less than 15 years old and were likely killed by poachers: the nasal region of three skulls bore signs of cutting by a sharp instrument, presumably utili[illegible] remove the horns. The sixth, approximately a 29 year-old, was killed within 400 metres of one of the guard outposts, revealing the limited influence the Rhino Surveillance Unit was having in preventing poaching in the Salient. At least one elephant was killed in 1987 by poisoned arrow heads planted on the ground.[16]

Conclusions

Our study concluded that, in their present numbers, there is no reason to suppose that predators are detrimental to the rhinos and other herbivore populations in the Salient. Despite the high percentage of calves showing scars, no successful attack by hyenas on a newly-born rhino has ever been reported. Furthermore, since the end of the study there has been a remarkable decrease in hyena sightings throughout the Salient.[17] The increase in the number of lions frequenting the Salient has been checked by limited control of trouble animals. It is uncertain whether culling of predators would enhance the survival rate of infant rhinos, a variable reasonably high in the Salient as proved by the cow-calf ratio recorded. The maintenance of the rhino population is most strongly related to poaching activity and its fate therefore lies with improving conservation. Resources allocated for the conservation of the species would be best directed towards anti-poaching and security activities.

The implementation of a Rhino Sanctuary in the A[illegible] Salient has been long recommended as a high priorit[illegible] Fortunately funds have been secured and fencing of the Aberdare Rhino Sanctuary is well advanced. Combined with an improved regime of foot patrols carried out from Headquarters and existing and planned outposts, the Sanctuary will provide appropriate protection for the black rhino and other wildlife.

Acknowledgements

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the forest type with premature tusk development, although this phenomenon would certainly seem to account for some reports.

From his observations, Offerman concluded that large height variations exist in the *cyclotis* race of elephants and that the existence of a distinct pygmy race is not proven.

It is perhaps of interest that we have a similar situation among buffaloes in the Park. Individuals of distinctly forest characteristics (*Synceros caffer nanus*), with red coats and small thin upward-pointing horns are found mixed in herds with the normal black savanna type of buffaloes, though the horns of the latter are not usually quite as large as those of East African buffaloes, possibly due to inter-breeding.

Kes Hillman Smith

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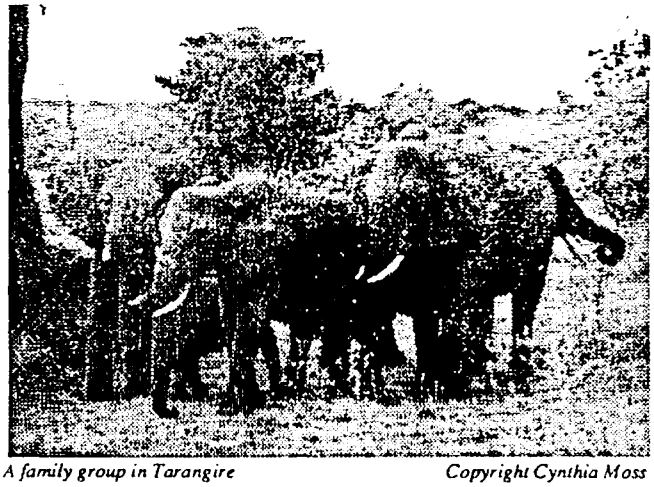

A family group in Tarangire *Copyright Cynthia Moss*

Black Rhinos in Lake Nakuru National Park

Before the translocation exercise of rhinos to Lake Nakuru National Park (LNNP) started, two rhinos, a male and a female, were already in the Park. The history of these two goes back to the late 1950s when three black rhinos used to be sighted by herdsmen on the former cattle ranch which today is a part of the Park. In 1987, when monitoring studies started, only two rhinos were located, the third was assumed dead. It is something of a mystery that the two have not bred in all this time.

By October 1987, when the exercise ended, a total of 17 black rhinos had been translocated to LNNP, 15 of which came from Solio Game Reserve, one male from Nairobi Park and another from Lewa Downs. This increased the population to 8 females and 11 males, a total of 19 rhinos. All the rhinos have settled with the exception of one female which was taken to Lewa Downs Rhino Sanctuary after having been attacked and seriously wounded.

One of the rhinos, which was pregnant when captured, gave birth in late 1989. Although there is a lot of browse in LNNP, monitoring indicates that most of it is unavailable to the rhinos due to plant heights of over 2.5 m. Dietary composition results indicate that some plants are not eaten at all, while others are heavily selected. All the animals are in the southern part of the Park. This distribution can be attributed to water scarcity in the northern as compared to the southern part of the Park where several bore-holes and shallow dams have been developed. The lake water is highly alkaline. The home ranges during the dry season are significantly larger than in the wet season.

F.K. Waweru

Unita Involved in Ivory Trafficking

Unita is involved in ivory trafficking, the South African newspaper, the *Sunday Times* reported in November last year.

The newspaper published an interview with a former officer of the South African Army, Col. Jan Breytenzach, who confirmed that Unita is still involved in trafficking ivory and rhino horns to finance its military activities against the Angolan government.

According to the officer, all ivory and rhino horns obtained from indiscriminate killing of animals in southern Angola were transported via Namibia to South Africa, which has become an important exporter of these products.

Breytenzach, who commanded battalion 22 of the South African Army in the invasion of Angola's Cuando-Cubango province, said he observed Unita killing elephants in that area with the use of AK-47's and other machine guns.

Agencies: *Kenya Times* 24 November 1989

Kenya's Rhino Man Wins the Goldman Environmental Prize

Michael Werikhe, Kenya's rhino man, was one of six recipients of the First Annual Goldman Environmental Prize. Mr Werikhe received the prize for Africa in recognition of his walks to raise funds for rhino projects in East and Central Africa, and awareness of the plight of the rhino and the state of the environment in general.

Mr Werikhe and Janet Gibson of Belize who won the prize for South/Central America for her role in helping to preserve a coral reef were two of the Wildlife Conservation Internationals' nominees for the awards. Other prize-winners included, for North America, Lois Gibson of the United States, who first warned that toxic waste was seeping into a residential area called Love Canal: for Asia, Harrison Ngau who suffered imprisonment and house arrest for his efforts to help Borneo's indigenous people to save their rainforests; for Australia and Oceania, Bob Brown of Tasmania, who left his medical practice to campaign for environmental causes; and for Europe, Janos Vargha of Hungary, who lost his job during his fight against construction of a dam on the Danube River.

In one of his speeches Mr Werikhe said, ". . . What we need most is public education, and for the governments of the world to exert influence on Arabia and the Far East, where people must be made to understand that the rhino is better alive than made into dagger handles, medicines and aphrodisiacs. Just as rhino horn has become a symbol of wealth and health for many cultures, it has long been a symbol of wildlife conservation in Africa. A metallic rhino greets you at the gates of our national parks. But if we can't take care of our symbol, what hope is there for the rest of the natural habitat, and ultimately for man himself?"

Michael Werikhe now plans to walk in the United States next year to raise further funds and support for the rhino. He will once again have the support of East African Wild Life Society and Wildlife Conservation International.

Helen Gichohi Wildlife Conservation International, Nairobi