KENYA RHINO RESCUE PROJECT

CARRYING CAPACITIES OF RHINO SANCTUARIES AND FUTURE BREEDING OF BLACK RHINO IN KENYA

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Introduction

Among the objectives of a visit to the rhino conservation areas by P.R. Jenkins and R.A. Brett between 31-1-89 and 20-2-89 were the following:

(a) to assess the carrying capacities of each area for black rhino, or maximum/target population sizes.
(b) to estimate an optimum number of rhino at which to manage breeding rhino populations in order to obtain maximum reproductive output, and surpluses over management levels with which to stock other sanctuaries (and re-stock parks and reserves in the future).
(c) to recommend any translocations on the basis of (a) and (b).
(d) to advise on and set up a system of monitoring (see Appendix I) necessary to obtain correct determinations of (a), (b), and (c) in the future as rhino numbers, habitats and security conditions change in the rhino conservation areas.

Estimates for carrying capacities, optimum numbers for management, future breeding potential and surpluses for translocation are made and discussed below, followed by detailed discussion of the breeding performance, prospects and management options for the individual rhino conservation areas. Although no target for the number for black rhino to be bred up within protected areas or sanctuaries and conserved has yet to be stated as policy, the estimates of holding capacity and potential breeding given may provide a guide as to the numbers of animals in secure breeding populations which may be conserved and managed for maximum breeding output, from which surpluses may be used to stock or re-stock other areas with adequate security.

Carrying capacities and optimum numbers for breeding

As rhino numbers build up and densities rise in rhino areas though breeding, carrying capacities will be approached when:

(i) available browse and cover are depleted;
(ii) breeding performance (and health) is adversely affected;
(iii) competition and aggression between rhinos increase, so that they disperse from areas of high density, and may wander outside of a protected area (if not enclosed).

These factors will clearly be related to the quality of the habitat, how this is influenced by numbers of other browsing herbivores, and whether a rhino area is enclosed by fencing/barriers or not. In order to obtain maximum reproductive output from breeding populations, and ideally a maximum number

of adult females breeding, it is necessary to hold numbers below carrying capacity (CC) at an optimum level for management (ca. 75% of CC) so that (i)-(iii) (above) do not occur or are minimised, and thus a sustainable yield of rhinos can be removed from rhino populations which exceed the management level, for stocking or re-stocking other areas.

In order to estimate carrying capacities, the rhino areas were divided up into ring-fenced, partially fenced and unfenced categories. In the absence of determinations of the availability of browse in each area, capacities were estimated at 1 rhino per 1 km^2 in areas with good vegetation/bush cover. In areas with a high proportion of open grassland, a CC was estimated at 1 rhino per km^2 with vegetation cover. CC's or potential numbers were reduced/modified in the light of: (a), instances of animals regularly wandering from partially or un-fenced areas; (b), former numbers and densities of rhino populations before depletion by poaching; (c), changes in habitats; and (d), discussions with wardens/managers with detailed knowledge of individual areas.

The estimated carrying capacities and levels for management for 11 rhino conservation areas are given in Tables 1 and 2, including the potential capacities for planned new sanctuaries or extensions at Ol Pejeta and Tsavo West/Ngulia. Areas omitted are Tsavo NP (outside Ngulia sanctuary), Meru NP sanctuary, Ngeng Valley, Loita Hills and Mt Kenya, where either the status or security of the rhino in these areas is not clear, or the total population is fragmented into smaller sub-populations which may or may not be breeding, and may not be considered for management.

Tables 1 and 2 indicate that the total future carrying capacity for ring-fenced sanctuaries in Kenya including the planned Ol Pejeta GR and a 65 km^2 Ngulia sanctuary is 352 rhino, preferably held at 264 to maintain maximum breeding output. The present total number of rhino in ring-fenced sanctuaries is 133 (49, excluding Solio). A total of 345 rhino could be attained in the partially fenced and unfenced rhino areas considered here, bred up from a present population of ca. 165 rhino. Thus a target for management in all areas considered is 609 rhino.

It should be stressed that the figures are initial estimates only which should be modified in the light of (a), results of future monitoring of the breeding performance and movements of rhino in these areas, (b), changes in habitat quality, and (c), the opinions of wardens/mangers with local knowledge. The figures given and any revisions recommended by informed parties should be considered by the management committee.

Availability of rhino for translocation

Although highly speculative at present (and carrying the very large assumption of complete security for present and future stocks of rhino in these areas), some idea of the potential increase in rhino populations in reserves/sanctuaries over the next ten years is given in Table 3. For each area the population increase is estimated for different rates of increase, and when numbers exceed management levels by 5-10 animals (ecomomic for translocation operations), these surpluses are removed to other areas. In three sanctuaries which will require initial or further stocking (Ngulia, Nakuru, Ol

Pejeta), population increases are shown assuming numbers of animals (+T) are translocated in.

It is clear that for rhino in sanctuaries at low density, or at reduced density in unfenced areas following substantial depletion, rates of increase can exceed a conservative 4% net annual rate of increase, and thus for 'understocked' populations a long way short of capacity, projected population sizes at higher rates (6 or 8%) of increase are also given. Given the management levels estimated, there are two populations which have a surplus of rhino for translocation at present, Solio GR and Nairobi NP. Although the size of the Solio population is not clear, it is certainly somewhere between 60 and 84 animals, thus yielding an immediate 18-42 animals for stocking of other areas. Ten animals should be available for translocation from Nairobi NP. The potential availility for surplus rhino from individual rhino areas are discussed below (see Rhino areas).

Breeding performance

In order to correctly set management levels for rhino areas, monitoring of breeding is essential, in particular to determine: (i), net rates of increase, (ii), any surpluses above management levels of rhino which can be moved to stock other areas, and (iii), to (at least) judge the effectiveness of expenditure on conservation measures to increase rhino numbers.

Even if accurate total counts of populations cannot be obtained, indicators of the breeding health of populations can easily be gained from ground and aerial census through calculation of the percentage of immature animals in a sample of, or the total population. Even in 'unseen' populations inhabiting dense bushland, young rhino can be accurately aged (up to ca. 3 years) from footprint measurements, animals which in most cases will still be accompanying, and be distinguishable from, their mothers, and thus classed as immatures in aerial counts. The percentage of immatures in a population drops as rhino populations reach carrying capacity, a healthy population having over 20% immatures.

The ratio of adult cows to calves in a population is an alternative indicator of breeding performance, a maximum output indicated by a 1:1 cow:calf ratio. This indicator may be obtained from ground (footprint) or aerial census, or from individual recognition counts. Sex ratios indicate the number of females available to breed, which will have a strong influence on potential breeding for a given population. Daily monitoring of matings and births to rhino populations is required to obtain information on gestation and calving intervals: futher indicators of breeding performance.

Based on available information to date these parameters were calculated for the rhino areas listed in Tables 1 and 2, and are shown in Table 4. Omitting the newly-stocked Nakuru and Ngulia sanctuaries (only one calf has yet been born in each), only Solio GR and Laikipia R have populations where breeding appears to be poor, relative the the very healthy breeding seen in all other rhino populations considered here. The possible reasons for this, and details of the breeding performance in all areas, including available data on calving intervals, are considered below.

Rhino Areas: breeding and management

(a) NAKURU NP

Rhino
Two adult indigenous animals (1 ♂, 1 ♀: which appear never to have bred), one adult male from the Kitengela, one adult male originally from the Nyeri forest (Amboni, ex Solio and Lewa) and 14 from Solio. A young population from a wide genetic base with excellent breeding potential (only 4 of the Solio animals were over 10 y.o. at translocation), with one calf born so far.

Carrying capacity
Estimated as 71 rhinos (1 for every km² of vegetation cover (determined from a LANDSAT image)), with population to be managed at 53. A final report by Fred Waweru on the browse availability in Nakuru may help adjust this figure. Future monitoring of rhino breeding and habitat is vital.

Potential breeding and surplus
If a further 10 animals are moved to Nakuru from Solio in 1989, management level will not be reached until 2000-2005. This should be adequate initial stocking for Nakuru, although introduction of a further 10 in 1990 will yield a total of ca. 50 rhinos in 6-8 years. If managed at 53, population would provide 7 surplus animals every 2 years (at 6% growth) or 7 every 4 years (at 4%).

General
Although the woodland/bushland in parts of the park are exceedingly dense, monitoring of all rhino through individual recognition is essential, at least to regularly establish the presence of all 19. Some matings have been observed, including one between the Kitengela male and the indigenous female. If a calf results from this, it will at least confirm the fertility of this female. Immobilisation of both indigenous rhino, and collection of blood and tissue samples from them, should be considered in order to find the reason for their collective infertility, and to determine if the mineral deficiencies at Nakuru may be or have been a cause. Sightings of rhino by visitors to Nakuru appear to be few, and introduction of more black (and white) rhino into this 'showcase' rhino sanctuary from Solio must be a priority in 1989.

(b) TSAVO WEST NP: NGULIA SANCTUARY

Rhino

Three adult cows were introduced to the former 3 km² sanctuary in April 1986. Reported adult male broke into same area on 13th June 1986. Two adult cows and one large female calf were introduced in October 1986. One of the cows broke out soon after release but was probably enclosed within the extension of the sanctuary to 20 km². Tracks of a new calf were first noticed 13th February 1988 (bringing total to 8). Census of tracks from 2-6 November 1988 detected 7 of these 8 rhino, including many tracks of the calf. The calf was aged at 15-17 months from track measurements, and hence was born June-July 1987 and conceived (@ 15 mo. gestation) March-April 1986. This confirms that this calf was born to one of the Taita cows, and conceived before their capture. This means that the male inside the sanctuary has not yet shown evidence of his potency. Introduction of a 7 year old male from Ol Jogi GR (son of a female captured at Kibwezi, and a male from the Ol Jogi area) in March 1989 may improve breeding dramatically in the future.

Carrying capacity

Although the sanctuary area formerly carried a very high density of rhino (Goddard: >1.5/km²), in view of the enclosure of rhino and the number of elephants in the area, capacity is estimated at 1 rhino/1 km², with population best managed at 15 animals for the present 20 km² area, and 49 for the planned extension to 65 km².

Potential breeding and surplus

With the high number of adult females, the breeding potential is excellent. If ten animals are introduced to the 65 km² sanctuary from the Tsavo area 1989-90, there will be surplus rhino (above 49) in 2005 (@ 6% net growth). A further ten introduced 1991-2 would result in a surplus by 1999. One of the best features of the Ngulia sanctuary is that surplus animals can simply be let out of the sanctuary to re-colonise surrounding areas, and breed with the rhinos resident outside the sanctuary.

General

Monitoring of this population can only be achieved through sightings of animals at waterholes (and from the air), and through regular footprint counts at waterholes and along the road network. The road network enclosed within the 65 km² extended area should be adequate to find tracks of all animals within the sanctuary, especially during dry seasons. The elephant situation should improve after extension, with less pressure on habitat around the present piped water hole.

(c) SOLIO RANCH GR

Rhino

The breeding success of the Solio rhino has shown how quickly numbers of rhino can increase in ring-fenced sanctuaries. However the debate about the total numbers will probably not be resolved until a full individual recognition census over several months is undertaken.

Carrying capacity

Overbrowsing by rhino on whistling thorn is still very marked. Giraffe may have contributed to depletion of rhino browse in general. Two ground counts by Major Elliot before the removal of 16 rhino for Nakuru in 1987 and aerial counts by Ian Craig in early November 1988 show that breeding success was probably adversely affected (Table 4: low % immatures) by the overpopulation. In absence of assessments of browse availability, and in order to allow the rhino vegetation to recover and continue to support a high breeding output, it is suggested that surpluses over 42 rhino should be relocated. The alternative is to increase the size of the reserve.

Potential breeding and surplus

If numbers are reduced, and/or the reserve enlarged, there is no doubt that breeding prospects are excellent. Irrespective of whether the present total is 60 or 80, 20 rhino should be immediately available for stocking other rhino areas. Recommended is: 10 animals to Nakuru in 1989, 10 animals to Ol Pejeta 1989-90, and enlargement of the reserve. If the population is managed at 42, the Solio population could provide 5 rhino every 3 years (at 4% growth) and 8 rhino every three years (@ 6%).

General

In the absence of monitoring or ground census, frequent aerial census should be continued, especially including counts of cows with calves, and future aerial counts may provide further useful information after future translocations (e.g. 10 animals to Nakuru in 1989).

(d) LEWA DOWNS RANCH: NGARE SERGOI SANCTUARY

Rhino

Animals originally from many areas and a wide genetic base. An exceptionally healthy and promising population (30% immatures; 10 females out of 13 animals; calving intervals short (e.g. 26, 27, 21, 36 months)). A young male (Kelele: ca. 7 y.o.) should start breeding this year (previous calves fathered by Godot, moved to Meru sanctuary April 1988).

Carrying capacity

With the present size of sanctuary, surplus animals over a population of 20 should be removed. With the present population this total will be reached by 1995-6. It is strongly recommended that this sanctuary be further enlarged if feasible.

Potential breeding and surplus

Managing the population at 20 rhino would yield 5 surplus animals every 4 years (@ 6% growth).

General

Possible inbreeding could result from Kelele mating his mother (Rongai). Depending on his performance, introduction of another adult male should be considered, two males likely to cohabit and breed in this 40 km² sanctuary. From the extensive records and information accumulated in this sanctuary, a great deal has already been learnt about rhino sanctuary management.

(e) OL JOGI RANCH GR

Rhino

It was established that the three founder rhino of this populations were: 1 male captured in the Ol Jogi area (1979) (and dehorned while held in a small enclosure prior to release); and 2 adult females captured at Kibwezi (Carr Hartley). Since release into the reserve in 1980, these animals have bred exceptionally fast, with six calves (five ♂♂, one ♀♀) born between February 1980 and July 1987. Calving intervals have been very short (31, 32, 18, 25 months). The first calf born (John ♂: now 7 y.o.) killed two white rhino introduced to the reserve in 1988, and was subsequently captured, dehorned, and moved to Ngulia sanctuary in early March 1989.

Carrying capacity

Due to intense overbrowsing by giraffe and general overstocking of the reserve the rhino browse has been badly depleted. Any surplus rhino over 15 should be removed, a total which, at present breeding rates, may be reached by 1997.

General

Because the breeding male (Ol Jogi) has fathered all calves (and of the 5 that remain, 4 are males), and will certainly have the two cows in calf again, an inbreeding problem looms. The single female calf (now 4½ y.o.), if not mated by her father (courtship already recorded), will be mated by her eldest ½-brother (now 5½ y.o.) in the future. Mother-son matings are also possible. It is strongly recommended that either, (a), the breeding male is replaced with another (the proposed swop with Godot from Lewa was a badly missed opportunity), or (b), offspring are removed when they show signs of sexual maturity, and the present (highly fecund) trio continue to breed.

(f) NAIROBI NATIONAL PARK

Rhino

30±3 rhino were counted by Hamilton & King in August 1968. Of these at least 6 were indigenous, 9 (out of 12) had been introduced between June 1963 and December 1964, and 18 (out of 22) were introduced between October 1966 and March 1968. The rhino put in up to the end of 1968 came from a variety of areas (Kitengela: >5, Kapiti: 7, Nyeri Forest: 4, Kiboko: 2 and Darajani: 8). From 1978-80 a further 10-14 rhino were introduced from Aberdares/Mt Kenya. A very wide genetic base for this population would be further increased when Sheldrick orphans Sam (from Mara) and Amboseli start to breed in the park.

Ground counts by Wanjohi and Waweru (1985-) estimated 30 rhinos in the park. The recent Goss/WWF individual recognition count in October 1988 photographed 47 animals, with seven identified from tracks, and a further 2 'uncertain' rhino wandering into the Kitengela. Given insufficient information on possible uncounted animals in the forest, a minumum of 55 can be stated with confidence. The count was larger than expected and showed that the population is breeding healthily (Table 4: 22% immatures). In March 1989 a new calf (born in January to a young female) was detected in the forest.

From the ca. 30 animals present in 1968, if the population bred normally in the last 20 years, there should be many more animals than the 55 there are now, and there has probably been substantial loss from this population. Whether most of this loss has been through poaching or through animals wandering out of the park into the Kitengela is not clear.

Carrying capacity

The breeding performance of the population does not appear to be affected yet by the rhino density, which in the south east corner of the park (e.g. Athi basin) appears very high in poor rhino habitat. The carrying capacity of Nairobi park will be better defined by the numbers of animals moving out of the park, and setting a population where breeding output is maximised for minumum emigration. Without assessment of browse availability it is estimated that capacity for the park is 60 animals (perhaps present numbers), and it is recommended that numbers be managed at 45 animals. Close monitoring of the breeding performance, rhino movements and rhino habitat is required in order to establish an appropriate management level.

Potential breeding and surplus

If the population is reduced to 45 animals, 10 animals are available for translocation in 1989, and would be most profitably moved to Ol Pejeta GR when complete (with Nakuru or an enlarged Ngulia sanctuary as alternative recipients). Continued management at 45 would yield 5 surplus animals (@ 4% growth) or 8 animals (@ 6%) every three years.

General

The WWF photofile and census requires further refinement, particularly in establishing the exact number of rhino in the forest. Animals from present counts may have been individually recognised in previous counts, and it is likely that some young animals introduced in 1968 are still alive; this should be investigated. The movements of rhino into the Kitengela need to be examined in detail, and consideration given to areas from which rhino should be translocated in order to minimise excursions into vulnerable areas. Nairobi park is probably the best/easiest place to see black rhino in the parks: the present density is 0.5 rhinos/km^2.

(8) ABERDARE NP: SALIENT

Rhino

26 animals have been recorded in a well-maintained individual recognition file by Ian Hardy and Mary Aggett at the Ark. 4-8 animals visit Treetops, though it is not certain whether these are different from the Ark rhino. An estimate of 37 was provided by WCMD patrols, and a week-long Goss/WWF census counted 31 rhino (from tracks). The details of this last count must be substantiated and then be the basis for long-term monitoring of the rhino in the whole Salient, together with the photographic records from the Ark and Treetops. Using the Ark 26 as a sample of the Salient rhino, breeding performance is excellent (Table 4: 28% immatures).

Carrying capacity

A very approximate management figure of 50 rhino is provided from which to work, which will have to be modified in the light of the results of accurate long-term census, and in particular, monitoring of movements. As with Nairobi Park, capacity will be determined by the extent of movements of animals out of the Salient towards the moorlands. The security of the rhino if they leave the Salient, and the extent of these movements at present need to be determined.

Potential breeding and surplus

Surplus rhino over a capacity for the area would probably move out of the Salient to the west, and if security for rhino outside the Salient is good, this may be a good dispersal area. If a attainment of a total of 50 is approximately when rhinos do start moving out as a capacity is reached, as a rough guide, 6 rhino would be 'surplus' above this number every 2 years (at 6% growth) or 4 years (@ 4%).

General

Monitoring of rhino away from popular waterholes and salt licks will be very difficult in this dense habitat. Identifying the Ark and Treetops rhino from their footprints, determining the limits of ranges of these rhino, and then finding the ratio of 'known' to 'unknown' footprints should provide another estimate of the number of rhino and the limits of their movements. Until more information about the numbers and movements of the Salient rhino are forthcoming, no translocations of rhino into this area should be contemplated. Fencing and increased security of the Salient (particularly in the north west corner) will aid conservation of the present healthily breeding population, and introduction of further rhino may only result in an exodus of animals out of the Salient into more vulnerable areas.

(b) LAIKIPIA RANCHING/OL ARI NYIRO RANCH

Rhino

The 44 indigenous rhino resident on the ranch have had a poor breeding performance in recent years (14% immatures), which may be due to the loss of many cows and calves through poaching in 1979-80, the effects of the 1984-5 drought on fertility, and a marked bias in sex ratio towards males (24:15) seen in the present population. Most loss of rhino in the last 10-15 years has been through peripheral rhino wandering off the ranch and being poached. Three animals (all males) continue to move outside the ranch. Although ring-fencing is impossible due to terrain, and the requirement to allow elephant to move in and out, further fencing and enclosure of the ranch would prevent most rhino excursions, and increase the holding capacity for rhino on the ranch.

Carrying capacity

The population could increase to over 100 animals, but this figure would depend on the security of the rhino inhabiting the margins of the ranch.

Potential breeding

At present breeding levels (ca. 4%), the population would increase to 65 in the next 10 years.

General

Although the present number of rhino (most inhabiting the central area of the ranch) are well-protected by anti-poaching alone, and their security could be maintained without fencing, increase in numbers through breeding would mean that enclosure of the ranch will be necessary for the security of larger populations up to ca. 100 animals.

(i) MASAI MARA GR

Rhino

A very healthy indigenous population of 21 (24% immatures; 11 adult females; recent calving intervals: 26, 27 mo.), with great potential for re-stocking the whole Mara reserve if security can be maintained. Well-kept birth and mating records provide the best 'family tree' information available for any rhino area. There are 4 breeding males, 3 of whom have fathered recent calves; hence a recent (possible) father-daughter mating may not be problematic.

Carrying capacity

Sheldrick and Fraser-Darling counted over 150 rhino in 1958. Mukinya individually recognised 108 rhino in 1971-2. Although the habitat has become much more open in the last 30 years, it is thought that the Mara reserve could still support 100 rhino, the initial limiting factor being the security of rhino that wander from the reserve, particularly into Tanzania. Further work through the ecological monitoring program in the Mara may provide a better estimate of the ecological carrying capacity for rhino in the area.

Potential breeding

Given continued good breeding (6-8% growth), the population would not reach 100 until 2012-2018.

General

Protection of rhino wandering into Tanzania may be increased through improved cross-border security/liason with Serengeti NP staff and/or radio-tagging of rhino.

(j) AMBOSELI NP

Rhino
A recent birth to one of the remaining two adult females brings the total to 9, hugely depleted from former population sizes (well documented by David Western). Recruitment must be limited by the male-biased sex ratio, and recovery of this population may be very slow even if they are protected.

Carrying capacity
Amboseli formerly carried very high densities of rhino. Given the depletion of rhino habitat in the park, a figure of 50 is given as a potential target population.

Potential breeding
From the present population, the total may only rise to 12-14 animals in the next 10 years.

General
Although this population has been so reduced, the few Amboseli rhino remain hugely valuable as they are so visible to tourists. Any rhino resident in Amboseli, of whatever sex, carries this value. Some re-stocking of this population should be considered, particularly if a female becomes available, but only if surveillance is good, and protection, at least from Masai spearings, is complete.

Table 1: Estimated Carrying Capacities (CC) of existing and planned ring-fenced rhino reserves/sanctuaries, estimated numbers for management at maximum breeding levels (75% CC) and present numbers of rhino.

Sanctuary or Reserve	Area (km^2)	Carrying Capacity	75% CC (manage)	Population size (3/89)
Existing:				
Nakuru NP	142	71	53	19
Tsavo West NP: Ngulia	20	20	15	9
Solio GR	56	56	42	84 (?:>58)
Ngare Sergoi	40	26	20	13
Ol Jogi GR	73	20	15	8
Totals	335	194	145	133
((excluding Solio	279	138	103	49)
Planned (1989):				
Ngulia:	65 (150	65 150	49 113)	(9)
Ol Pejeta	93	93	70	-
Totals	158	158	119	-
TOTAL (existing & planned)	493	352	264	133

Table 2: Estimated Carrying Capacities (CC) of existing partially fenced or unfenced rhino reserves/sanctuaries, estimated numbers for management (75% CC) or potential numbers, and present numbers of rhino.

Sanctuary or Reserve	Area (km^2)	Carrying Capacity	Manage/ target no.	Population size (3/89)
(i) Partially Fenced				
Nairobi NP	117 *	60	45 (75% CC)	55
Aberdare NP: Salient	70	50	50	37 (?:>30)
Laikipia R	397	100	100	44
Totals	581	210	195	**136**
(ii) Unfenced:				
Masai Mara GR	1690	(100)	100	21
Amboseli NP	390	(50)	50	8
Totals	2097	150	150	**29**
TOTAL (part- & unfenced)	2768	360	345	**165**
TOTAL (all areas including ring-fenced sanctuaries)	3171	712	609	**298**

Table 3; Potential increase in numbers of black rhino in Kenya reserves/sanctuaries over 10 years from 1989 at different rates of net annual increase (r), given surplus animals (above management levels (Tables 1-2) available and translocated (-T) out of sanctuaries, and stocking of sanctuaries with surplus animals if available from other areas (+T),

Area	r(%)	'89 T	'90 T	'91 T	'92 T	'93 T	'94 T	'95 T	'96 T	'97 T	'98 T	'99
Nakuru NP	4	19	20 +10	31	32	34	35	36	38	39	41	42
		19	20 +10	31 +10	43	44	46	48	50	52	54	56
	6	19	20 +10	32	34	36	38	40	43	45	48	51
		19	20 +10	32 +10	45	47	50	53	56	60 -7	56	60
avo West;	6	9	10	10	11	11	12	13	14	14	15	16
gulia		9	10 +10	21	22	23	25	26	28	29	31	33
		9	10 +10	21 +10	33	35	37	39	41	44	46	49
		9	10 +10	21	22 +10	34	36	38	40	43	45	48
Solio GR	4	84 -42	44	45	47 -5	44	45	47 -5	44	45	47 -5	44
		84 -10	77 -10	70 -10	62 -10	54 -10	46	48 -6	44	45	47 -5	44
	6	84 -42	45	47	50 -8	45	47	50 -8	45	47	50 -8	45
		84 -10	78 -10	73 -10	66 -10	60 -10	53 -10	45	48 -6	45	47	50
Ngare Sergoi	6	13	14	15	16	16	17	18	20	21	22	23
	8	13	14	15	16	18	19	21	22	24	26 -6	22
Ol Jogi GR	6	8	9	9	10	10	11	11	12	13	14	14
	8	8	9	9	10	11	12	13	14	15	16	17
Ol Pejeta	6		+10	11 +10	22	23	25	26	28	29	29	31
	8		+10	11 +10	23	24	26	28	31	33	36	39
irobi NP	4	55 -10	47	49	51 -6	47	49	50 -5	47	49	51 -6	47
		55	57 -10	49	51 -6	47	49	50 -5	47	49	51 -6	47
	6	55	58 -10	51	54 -9	48	51	54 -8	48	51	54 -8	48
Aberdares;	4	37	39	40	42	43	45	47	49	51	53	55
Salient	6	37	39	42	44	47	50	53	56 -6	53	56 -6	53
Laikipia R	4	44	46	48	50	52	54	56	58	60	63	65
Masai Mara	6	21	22	24	25	27	28	30	32	34	36	38
Amboseli NP	4	8	8	9	9	9	10	10	11	11	11	12
	6	8	9	9	10	10	11	11	12	13	14	14

Table 4: Rhino breeding performance indicators in Kenya reserves/sanctuaries: known sex ratios (S.R.), % immatures (< 3.5 y.o.) and cow:calf ratios.

Reserve Sanctuary	Pop.size (3/89)	S.R. (♂:♀)	% imms.	cow:calf ratio	Source/count
Nakuru NP	19	11:7	5.3	7:1	
Tsavo West NP: Ngulia	9	1:6	11.1	6(7?):1	
Solio GR	87	46:41	18.7	2.2:1	Elliot (5/87)
	94	51:43	11.7	2.8:1	Elliot (7/87)
	>56		17.9		Craig (11/88)
Lewa Downs R: Ngare Sergoi	13	3:10	30.8	1.3:1	
Ol Jogi GR	8	5:3	25.0	1:1	
Nairobi NP	55	20:23	21.8	1.4:1	Goss (11/88-)
Aberdares: Salient	>26	8:10	28.0	1.1:1	Hardy/Ark (2/88-)
	31-37				Goss (2/89-)
Laikipia R	44	24:15	13.6	3.3:1	Brett (88)
Masai Mara GR	21	8:13	23.8	2.2:1	
Amboseli NP	9	6:2	22.2	2:1	

FEEDING PREFERENCES OF ELEPHANTS:
QUANTIFICATION OF BROWSE DAMAGE

INTRODUCTION

Elephants are known to cause considerable alteration of habitats especially in the Tsavo Ecosystem, (Eltringham, 1979) and elsewhere as in the Aberdare National Park (Gichohi, 1993). Contrary to the assertion by some authorities, this may not be vegetation destruction per se as it (a) opens up thick forests thereby creating microhabitats for smaller mammals and (b) facilitates mineral cycles through decomposition of the fallen trees (c) may actually speed up vegetation on the other hand, the browse damage by elephants is instrumental in preventing the regeneration of woodland and enhances effects of fire on such trees due to reduced fire resistance.

BROWSING PRESSURE AT SWEETWATERS GAME RESERVE

Sweetwaters Game Reserve is not exceptional to habitat alteration by elephants. These are about 74 elephants in the reserve. These concentrate their activity in a few areas notably the marsh area and along the Ewaso Nyiro River.

The elephants push down trees commonly Acacia xanthophloea, A.Drepanolobium, Balanites glabra, Euclea divinorum and Albizia gumnifera. Consequently, it is common to find many dead fever trees at the marshes where the activity is concentrated.

Not all of the affected trees are debarked. Ecacia drepanalobium for example, is usually pulled down but very rarely eaten or debarked. In contrast, the elephants seem to have a strong liking to the bark of A. Xepathophloea, and have therefore broken into S.WT.C to fulfil that need. Those areas whose physiology has not been seriously impaired bear some dead branches but show continued growth.

The growth and regeneration of some trees like Balanite, glabra has seriously been retarded. It is uncommon to find tall and leafy desert dates in the reserve. Their height average about 2.5m with most of the branches broken. The browsing pressure on this tree as well as on others is compounded by utilization by other browsers notably rhinos and giraffes.

It was interesting to note how elephants immediately roughed up some trees when part of a previously enclosed area at Ol Pejeta Ranch House was opened up. They broke up, ate the leaves and heavily debarked all the Schinus Molle trees available. In a bush of Rhus natalensis and Euclea divinorium, the former was heavily browsed while the latter was left untouched. A young Maerua triphylla was not eaten but had signs of debarking. There was an indication of the debarking of felled Acacia drepanolobiun at the site.

There are not many Albizia gumnifera trees in the reserve, the few available being along the riverine habitat. The base of the trunks of these trees are also debarked. The effects of browsing and debarking on these trees depends on the intensity of use. Thus Standing dead and growing trees can be found.

This activity seem to take place mainly in the late evening hours and during the night. The trees may sometimes be left for some time before being debarked. The affected trees are mostly mature ones, perhaps because of higher mineral concentration. It is also probable that the tree felling activity which has been noted to be commonly effected by bulls (Smith pers, comm) is triggered by excitment if not on impunity towards tall trees.

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The activity has been happening for a long time(some trees already rotting). The following table shows how some trees have been affected by elephants.

Table 1

Species	Height	Utilization	Response/
Acacia xanthophloea	20m	-debarked at base	-dead (standing)
" "	24m	-tip of branches debarked	-dead (fallen)
" "	25m	- Most branches cut off. some debarked	-alive, some branches dead.
" "	15m	- debarked & browsed;	-dead & fallen
Banites glabra	2.25m	-broken up & browsed many alive.	-The tops and branch little regeneration
A drepanolobium	20m	- not browsed at all; fallen	-dead
A drepanolobium	15m	not browsed/debarked	-slowly regeneratin not completely uprooted.
Albizia gumnifera	15m	-debarked at base (standing)	- dead
Albizia gumnifera	15m	- debarked at base (standing)	- growing
Rhus natalensis	2m	-browsed and broken up	-still growing

IMPACT AREAS

High use	Medium use	Low use
Marshes	-Mrera Ndonga	-Euclea dominated area
	-Along Ewaso Ngiro river	-A. drepalolobium area
	-Nanyuki corner	

The Chimpanzee sanctuary can serve as an experimental control area as elephants have been excluded from the site for about 2 years. Even though they do break into the chimpanzee sanctuary occasionally, it is a good area to monitor the response of the woody vegetation which had previously been affected. Similarly, the Morani enclosure gives valuable comparative information on the level of browsing by these herbivores. One of the desert dates for example, is about 8m tall, with a huge leafy canopy. Sometimes giraffes do get into the enclosure but do not seem to have heavily browsed these trees.

The browsers have especially modified the woody vegetation in other areas in the reserve. Both apical and lateral growth of trees have been affected. Thus apical growth could be cut off to bear small cone-shaped apices with ~~however~~ lower lateral shoots removed.

Food averlop between giraffes, elephants and rhinos in the reserve remain to be investigated as well as the impact of each one of these on the woody vegetation. This would explain the present and expected level of environmental response induced by the big mammals.