Minimizing competition by removing elephants from a degraded Ngulia rhino sanctuary, Kenya

Benson Okita-Ouma[1], Dominic Mijele[1], Rajan Amin[2], Francis Gakuya[1], David Ndeereh[1], Isaac Lekolool[1], Patrick Omondi[1], Daniel Woodley[1], Moses Litoroh[1], Juma Bakari[1], Richard Kock[2]*

[1] Kenya Wildlife Service, PO Box 40241 00100 Nairobi, Kenya; email: Bokita@kws.org or Rhino@kws.org
[2] Zoological Society of London, Regents Park, London NW1 4RY, UK

Introduction

The Ngulia rhino sanctuary located in the central part of Tsavo West National Park (NP) is completely fenced within an area of 88 km^2 following its expansion from 62 km^2 in May 2007. It has been one of the more successful areas for the protection and breeding of black rhinos in Kenya since its creation in 1986, and has succeeded in re-establishing a productive breeding nucleus of rhinos within a larger protected area with very considerable potential for further expansion to a large, genetically viable population. The sanctuary therefore plays a key role in the conservation of the eastern black rhinoceros (*Diceros bicornis michaeli*).

Following concerns about the deteriorating vegetation condition in the sanctuary (fig. 1), detailed analysis of population data and assessment of habitat showed a 59% decline in the available rhino browse between 1991 and 2005 (rhino food plants i.e. below 2 m high) and 100% decline of browse material above 2 m height (fig. 2). The analysis also showed that the rhino population performance had been significantly declining over several years due to high densities of rhinos (fig. 3a) and competing browsers particularly elephants (table 1). The annual growth rate had fallen to below the minimum national target of 5% (Okita-Ouma and Wandera 2006) and the situation warranted intervention (fig. 3b). The 2005 black rhino population size estimate of 65 animals in an area of 62 km^2 far exceeded the management level originally set for this sanctuary (KWS 1993), which was also no longer applicable due to the significant degradation of habitat by competing browsers, notably elephants and giraffes. The carrying capacity of the sanctuary had been reduced from an estimated 1-1.5 rhino/km^2 (Goddard 1969; 1970) to approximately 0.6 rhino/km^2 (Brett and Adcock 2002; Okita-Ouma 2004). The average body condition of both rhinos and elephants had also deteriorated from an average 'good' to 'fair' - 'poor' (Okita-Ouma and Wandera 2006).

The overstocking was threatening the sanctuary's productive potential for rhino, as well as their nutrition, condition and health. The browser impact had caused ever-accelerating rates of decline in browse and predictions showed very low levels of browse resources by 2007. In such a situation, adverse or drought conditions could potentially irreversibly damage the future productivity of the area and cause a cessation of breeding by the rhino population as well as a population crash. In similar situations, other black rhino populations have crashed (Hitchins 1968; Emslie 1999; Emslie 2001).

The high number of large herbivores also imposed a major burden on the sanctuary's infrastructure, especially the piped water supply. The piped water resources (and security) within the fenced area have been a major attraction for elephants in particular, and presumably encouraged animals to remain resident and breed within the sanctuary area. The 15 km of reticulation and three waterholes provides the only source of water in the sanctuary during the dry season (July – October). With the increasing densities of herbivores came dangerous water access conflicts that developed between the rhinos and elephants. There were significant maintenance problems and costs associated with elephants digging up and breaking water pipes and fittings. Monitoring rhino also become a hazardous exercise.

Résumé

Le Sanctuaire de rhinocéros de Ngulia (clôturé) qui se trouve au Parc National de Tsavo West, au Kenya, était parmi les sanctuaires de rhinocéros qui réussissait le mieux à élever des rhinocéros noirs depuis sa création en 1986 jusqu'en 2001 quand le taux de croissance du rhinocéros noir a commencé à décliner. Ce déclin était principalement imputable à la dégradation de l'habitat et à la réduction des plantes à brouter qui constituent la nourriture des rhinocéros noirs. Cette dégradation de l'habitat était causée par une forte densité d'éléphants et d'autres herbivores concurrents dans le sanctuaire. Les plantes constituant la nourriture des rhinocéros noirs se sont réduites de 59% ce qui a réduit considérablement la capacité de charge pouvant assurer la productivité maximale des rhinocéros noirs dans le sanctuaire. Pour renverser la situation, le Service de la Faune du Kenya a élargi le sanctuaire de 62km^2 à 88km^2 et entre 2005 et 2006, il a fait la translocation de 255 éléphants hors du sanctuaire jusqu'à environ 15km de la ligne de clôture du sanctuaire en laissant au moins deux éléphants. La translocation a été faite en trois phases en utilisant trois stratégies différentes. La première phase a consisté à chasser les familles d'éléphants du sanctuaire par l'usage des hélicoptères. Dans la deuxième phase, les éléphants mâles adultes matures étaient chimiquement immobilisés et transférés, alors que la troisième phase consistait à l'immobilisation chimique et à la translocation de familles d'éléphants. Cette troisième phase (et technique) était la plus réussie avec une moyenne de 15 éléphants transférés par jour. Il y a eu deux cas d'éléphants qui ont pu revenir au cours de l'exercice de translocation. On s'attend à ce que la végétation et le brout disponible pour les rhinocéros s'améliorent et par conséquent contribuent à restaurer la croissance optimale de la population du rhinocéros noir.

Crisis Management

A number of approaches were considered for improving the breeding performance of the rhino population and the productivity of the sanctuary (Brett and Adcock 2002; Okita-Ouma, Amin et al. 2005). The approaches included: a) expansion of the sanctuary; b) destocking of rhinos from the sanctuary by establishing a population outside the fenced area within an Intensive Protection Zone (IPZ) (Leader-Williams et al. 1997) in Ngulia and Rhino valleys (fig. 4), Tsavo West; c) reduction and control of numbers of competing browsers in the sanctuary particularly elephants but also giraffes and buffaloes (which can take over 25% of their diet as browse).

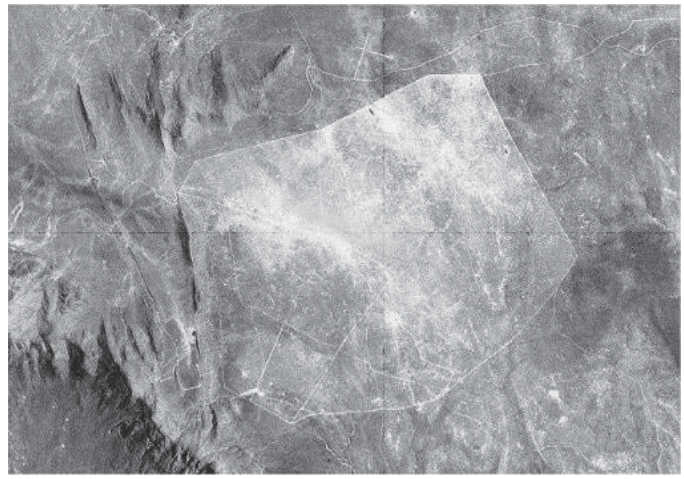

Figure 1. A LANDSAT TM satellite image (2001) of Ngulia rhino sanctuary showing the extent of vegetation degradation due to high density of browser species (Brett and Adcock 2002).

The expansion of the sanctuary by an extra 26 km^2 started in June 2006 and was completed in May 2007. This increased the total area of the sanctuary to 88 km^2 (fig. 4). Translocation of rhinos into the IPZ was planned to take place in October 2007 but was deferred. The 2008 post election violence and political instability resulted in a plunge in revenues. Reduction and control of numbers of competing browsers in the sanctuary, particularly elephants, forms the basis of this article. Numbers of giraffes and buffaloes are yet to be reduced.

Elephant removal from Ngulia sanctuary

Removal of 255 elephants from the sanctuary began in October 2005 and was completed in October 2006. Three approaches to remove the elephants were used. The first attempt was driving away elephants using a helicopter, the second attempt was darting, capturing and removing adult bulls, and the final attempt was chemically immobilising and removing family herds.

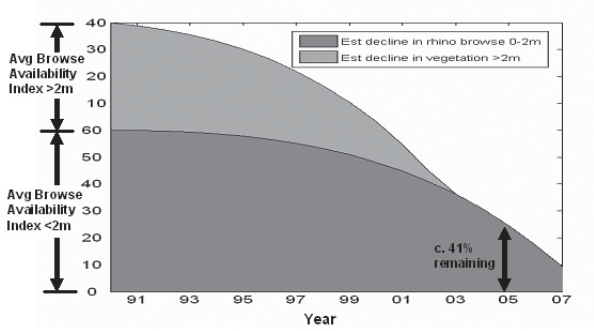

Figure 2. Estimated patterns of elephant impact on browse in the >2 m and of 0-2 m height ranges (updated from Brett and Adcock 2002).

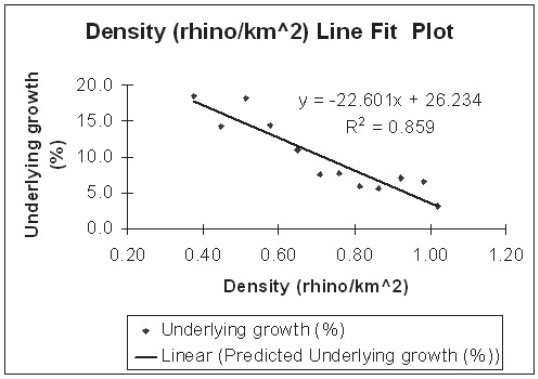

Figure 3A. Linear relationship between density and underlying growth rate in Ngulia from 1992-2006. The graph shows that -22.60 x density +26.23 significantly explained 85.9% of the variations in the underlying growth rate ($F_{1,10}$ = 61.11; P = 0.000) (updated from Okita-Ouma 2004).

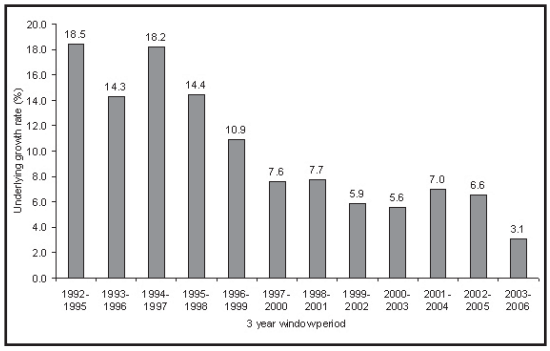

Figure 3B. A 3-year moving average underlying growth rate of Ngulia black rhino population 1992-2006.

Driving elephants out of the sanctuary using helicopter and a ground team

In order to increase the likelihood of evicted elephants staying outside the fence, and to reduce the incentive for more elephants to cross into the fenced sanctuary and its extension, the existing water system was first extended to provide water to two waterholes outside the sanctuary. The existing fence was also upgraded and made elephant proof by putting a live wire at 2m high on the exterior of the fence posts.

Driving away elephants using a helicopter was carried out between 23 and 27 October 2005. This first option was assumed as the most efficient in removing many elephants within a short time. An operational plan was put together with agreed conditions for cut-off times for the length and duration of drives once they were either successful or ceased to be effective. Efficient control of movements of helicopters, fixed wing aircraft and vehicles was essential. The water supply to artificial waterhole No. 2 (WH2) was shut off leaving waterholes No. 1 and No. 3 (WH1 and WH3) as the only water drinking points (fig. 4). WH1 and WH3 are close to the fence line and thus minimized the pushing distances and associated stress to the rhinos. Helicopter operations are discouraged in rhino habitats due to their potential adverse effects on the rhinos. All wires along a 200 m length of fencing were taken down and rolled up in preparation for careful driving of individual cohesive groups with a helicopter supported by a ground team with vehicles and a fixed-wing aircraft to monitor movements. The area was checked in advance by the fixed-wing aircraft to ensure that no rhinos were present or could be flushed out prior to the drive. The initial effort was to try to move a small number of elephants (e.g. one or two family groups of 10-20 animals) and subsequent operations were then to be planned based on experience. The elephants were to be driven 2 to 5 km away from the sanctuary. Following removal of the target group of animals, fence wires would be put up quickly and power restored. Numerous brightly coloured plastic streamers would also be placed on the wires as a visual guide and deterrent to animals wishing to make an immediate return. An initial attempt to move a target group of elephants was unsuccessful. The driven group of elephants stopped as they approached the pulled-down fence-line boundary and further attempts to drive them forward towards the boundary failed. The animals became too stressed

so the operation was stopped. It was then decided to remove the fence posts as well and place vegetation on the fence-line's service road to conceal it and then make a further attempt (fig. 5). This helped and a total of 17 elephants were eventually removed during a total of 10 helicopter hours. Two lone bull elephants broke back into the sanctuary two days after they were removed.

Lessons learnt

It was easier to move the elephants once all signs of the fence and the service road were removed or concealed. It was challenging to keep an elephant group intact when driving them away using a helicopter. The driving by helicopter strategy was stressful to the weak elephants. Two elephants collapsed and had to be given time to recover while a few others stopped walking despite pressure by a thunder flash and noise from the ground crew. The method was thus stopped proving its anticipated efficiency wrong in that scenario. An alternative approach was needed.

Ground darting and translocation of lone elephant bulls

Ground tranquilizer darting and translocation of lone bulls was attempted to further reduce the number of elephants as funds were being sought for translocation of family groups. This operation was undertaken between 26 May and 11 June 2006. Lone elephant bull elephants were located, and using a Dan-Inject rifle were darted on foot or from a vehicle depending on approachability and vegetation cover. Once immobilized by the remote injection of etorphine hydrochloride (M99® , Norvartis South Africa (Pty) Ltd), the elephant was prepared for recovery while the veterinary doctors and technicians monitored its state of immobilization under neuroleptanalgesia and collected biological samples. The immobilized elephant was then placed on a truck using a lifting crane (fig. 6) and transported in lateral recumbency to a distance of about 5 km to the release site (fig. 7) where the immobilizing agent's effect was reversed by the intravenous injection of a narcotic antagonist (diprenorphine hydrochloride (Norvatis South Africa (Pty) Ltd/(Edms) Bpk), (the details of the immobilization process are provided in a later section). The elephants were up on their feet within two to three minutes post administration of the revival drug. Some larger bulls had problems standing up from a position of lateral recumbency. They were mechanically aided by using a strap hooked on the top tusk and then manually pulled into sternal recumbency. From this position they were able to stand up and

Table 1. Estimated number of large herbivores in Ngulia rhino sanctuary (2005) (Source: KWS, *Tsavo West Research Department)*

Large Herbivore	Number
Elephant	250
Giraffe	40
Buffalo	250
Zebra	30
Lesser kudu	40
Black rhino	65

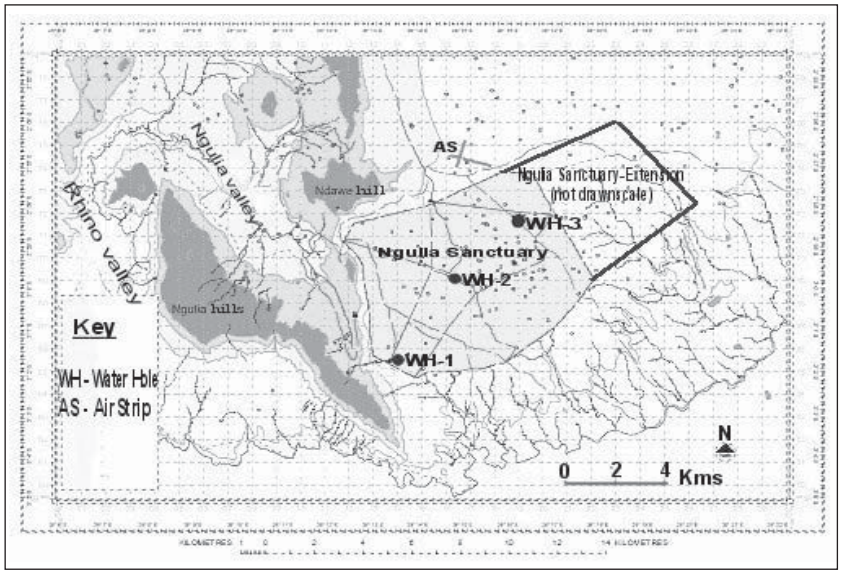

Figure 4. Map of Ngulia rhino sanctuary, showing the existing 3 artificial waterholes, Ngulia and Rhino valleys (updated from Brett and Adcock 2002).

move away. The translocated elephants were marked by sequential numbering using a white oil-based paint (Crown™ Paints) on their backs to allow post release monitoring (fig. 9).

A total of 38 elephants (35 lone bulls and a family of 3) were translocated during this phase. Two bulls managed to break back into the sanctuary but one was recaptured and removed again.

Lessons learnt

For about 20 days after the operation, 10-12 bulls were still seen on the outside of the fence line and they made attempts to break back into the sanctuary. The fence monitoring team was on standby at all times supported by a plumber to repair damaged water pipes by the elephants outside the sanctuary. This strategy was eventually successful for these lone bulls. Even though a family of 3 was successfully moved, it was found to be problematic and it is not advisable to attempt this operation on a family group unless there is a fixed-wing aircraft, a helicopter and sufficient number of men on the ground.

Darting from the helicopter and translocation of families of elephant

This operation was aimed at removing all the remaining elephants in the sanctuary. The exercise which saw a total of 200 elephants translocated out of the sanctuary was conducted in two phases between 10 and 22 September and between 25 and 30 October 2006 due to logistical reasons. In the first phase, a total of 132 elephants was removed from the sanctuary while in the second phase 68 elephants were moved. The actual interventions took place over 13 days (table 2). On average 15 elephants per day were immobilized and moved some 15 km from the sanctuary into Rhino valley within Tsavo National Park (fig 4). One adult male elephant died due to capture stress.

All the elephants were immobilized using etorphine hydrochloride (M99® , Norvartis South Africa (Pty) Ltd) (Table 3). This drug was combined with hyaluronidase (Kyron Laboratories (Pty) Ltd) after reconstitution of 100 mg powder (5000 iu), in 5 mls of water for injection The combined drug was put in a 3 cc Palmer Capchur dart (Harrington & Richardson Inc.). A Dan-Inject dartgun (Dan-Inject APS) was used to dart lone bull elephants on the ground while a Palmer Capchur dart gun (Harrington & Richardson Inc.) was used to dart elephant families from the helicopter.

C. Khayale

Figure 5. Elephants pushed by a helicopter crossing the concealed fence line.

Darting was done systematically starting with the oldest then the sub-adults then the young ones. Induction time for adults and sub-adults took an average 7-10 minutes. Elephant calves that were less than one year old were physically captured using strong sisal ropes and then hand-injected using 1-5 mgs of etorphine hydrochloride.

Antony Wandera

Figure 6. An elephant being loaded on to a Volvo truck by an Iveco lorry's crane.

Monitoring of neuroleptanalgaesia was done following standard veterinary procedures (Kock et al, 1993). As soon as an elephant went recumbent and was well immobilized, veterinarians, laboratory technicians and security rangers attended to it and ensured that the animal was breathing, that the trunk was patent and that the animal was lying in lateral recumbency with eyes covered by the ear flap. Physiological parameters measured were recorded every five minutes. At the end of the procedure the dart was removed and dart wound treated locally using antibiotic cream and prophylactically using a long acting antibiotic injected intramuscularly.

During the neuroleptanalgaesia the animals usually maintained a respiratory rate of between 4-6 per minute for adults and between 8-12 for juveniles or young ones. If the respiratory rate went lower than these expected values, doxapram hydrochloride 20 mg/ml (Dopram, Bodene (Pty) Ltd) was administered slowly intravenously at a dose rate of 400 mgs (20 mls) for adults, 200 mgs (10 mls) for sub-adults and 100 mgs (5 mls) for juveniles. This resulted usually in the respiration returning to within the acceptable parameters noted above.

In case of a decreased pulse rate i.e. <61, <65 and <74 beats/min for adults, sub-adults and juveniles respectively (Kock et al. 1993; Gakuya et al. 2003) and collapse of the superficial veins, adrenaline 1:1000 (Kyron Laboratories (Pty) Ltd) was administered intramuscularly at a dose rate of 20 mls for adults, 10 mls for sub-adults and 5 mls for juveniles.

If an elephant developed a 'pink foam syndrome' that is exhibited by pink frothy discharges from the trunk due to pulmonary oedema, or in cases where the animal had run for more than 15 minutes before immobilization, dexamethasone sodium (Glucortin-20 (Interchemie, Holland) was administered intramuscularly at a dose rate of 60-80 mgs (30-40 cc) for adults, 30 mgs (15 cc) for sub-adults and 10 mgs (5 cc) for juveniles. High body temperatures above 39.5^{o}C were controlled by pouring large amounts of cold water on the ear flaps and the whole body. Whole blood preserved in ethylenediaminetetra-acetic acid (EDTA) and dung samples from the rectum were collected for laboratory analysis.

The animals were recovered using different types of vehicles including a modified Volvo truck, two Iveco lorries fitted with lifting cranes, and a tractor fitted with a carrier. The elephant was tied on the two front limbs and two hind limbs using a strap at the level of tarsus and carpus respectively (Fig. 6). After the limbs were tightly secured using the straps, the lifting crane lorry moved closer and the elephant was hooked up by the crane and then either loaded onto the crane itself or onto another vehicle such as a tractor, Volvo truck or a Canter. For the very young

Table 2. Dates and number of elephants moved

Date	Number of elephants moved
Phase 1	
10/09/2006	3*
11/09/2006	18
12/09/2006	21
13/09/2006	21
14/09/2006	8
18/09/2006	9
19/09/2006	19
20/09/2006	25
21/09/2006	8
Phase 2†	
26/10/2006	19
27/10.2006	19
28/10/2006	22
29/10/2006	8
Total	200

* Elephants that were darted on foot

† Age and sex composition of the translocated elephants (phase 1 data not available): 9 adult males; 23 adult females; 7 sub-adult males; 9 sub-adult females; 6 juvenile males; 14 juvenile females

Juma Bakari

Figure 7. An immobilized elephant being transported to the release site.

Table 3. Dosage of immobilization drugs for different elephant age-classes

Approximate age	Etorphine Hcl	Hyaluronidase
Male adults (bulls)	18 mgs	5000 iu
Female adults	16 mgs	3500 iu
Sub-adults	10 mgs	2500 iu
Juveniles	1-5 mgs	1500 iu

elephants, a Landcruiser pick-up was used to recover them from the field.

After recovery from the field, the elephants were driven to the loading site from where they were put into the recovery container. Elephants were revived from neuroleptanalgaesia after being loaded into the recovery container or transportation truck and all the doors confirmed locked. The sub-adult and young elephants were loaded directly into the transportation truck and revived. Narcosis was reversed by intravenous administration of diprenorphine hydrochloride (M5050, 12 mg/ml, Novartis South Africa (Pty) Ltd) The dosage varied according to the age and size of the animal and amounted to approximately two to three times the mg dose of etorphine used for immobilization. That is 60 mgs for adult bulls and females, 36 mgs for sub-adult males and females, 12-24 mgs for young males and females. After revival, the elephants took about two to three minutes to stand.

The animals were transported to the release site, escorted by a smaller vehicle. A veterinarian and trained rangers accompanied the animals. At the release site, a ramp was constructed to enable the animals to walk directly out of the truck. The truck was reversed up to the ramp, the sliding doors of the truck opened and elephants walked out freely (fig. 8). Reluctant animals were encouraged by a low voltage electric cattle prodder as required.

Lessons learnt

There were no reports of elephants coming back to break into the sanctuary. The reason for this might be attributed to the fact that families were moved close to a water source and were not separated at the time of capture. This method proved to be the most efficient way of removing the elephants.

Juma Bakari

Figure 8. Release of the elephants at the Rhino valley in Tsavo West National Park.

Conclusion

Removal of the elephants from the sanctuary was a considerable success and a technical achievement for the Kenya Wildlife Service. It prioritized rhino conservation in a ring fenced sanctuary. A total of 255 elephants were removed from the sanctuary. Only two translocated bull elephants broke back into the sanctuary and these were subsequently removed. Only two elephants (a sub-adult and an adult) now remain in the sanctuary. It is the most important step towards improving conditions in the sanctuary, allowing vegetation recovery and ensuring a return to an optimal growth rate of black rhinos. The next phase is to reduce the rhino densities inside the sanctuary to below the Maximum Productivity Carrying Capacity (MPCC) level by translocating surplus rhinos into the larger Tsavo West National Park to form an IPZ.

Acknowlegements

Financial and technical support from Kenya's Ministry of Tourism and Wildlife, Kenya Wildlife Service, African Wildlife Foundation (AWF), Eden Wildlife Trust, US Fish and Wildlife Service, World Wide Fund for Nature (WWF), Zoo D'Amneville, Zoological Society of London (ZSL) and Zurich Zoo towards analysis of the rhino population, habitat assessment, translocation of the elephants and expansion of the sanctuary is highly appreciated. Dr Peter Morkel's initial contribution to the elephant translocation is also acknowledged.

References

Brett R, Adcock K. 2002. Assessment of options and areas for the expansion of the black rhino population at Ngulia rhino sanctuary, Tsavo West Nat. Park, Kenya. Nairobi: AWF and KWS. vi + 68 p.

Emslie R. 1999. Uses of VORTEX PVA modeling to examine some of the other causes of Hluhluwe decline in feeding ecology of the black rhinoceros (*Diceros bicornis minor*) in Hluhluwe-Umfolozi Park with special reference to the probable causes of the Hluhluwe population crash. In: Emslie R. The feeding ecology of the black rhinoceros, *Diceros bicornis minor*, in Hluhluwe-Umfolozi Park with special reference to the probable causes of the Hluhluwe population crash. PhD Thesis. p. 448-497. University of Stellenbosch, South Africa.

Emslie R. 2001. Strategic achievement of meta-population goals - why rapid population growth is so important. In: Emslie R. ed., Proceedings of a SADC Rhino Management Group (RMG) Workshop on Biological Management to Meet Continental and National Black Rhino Conservation Goals. p. 14-24. Giants Castle, South Africa.

Gakuya F, Wambwa E, Ndeereh D, Manyibe T. 2003. Physiological and haematological findings in immobilized free-ranging African Elephants. *Pachyderm* 35:77–81.

Goddard J. 1969. Aerial census of black rhinoceros using stratified random sampling. *East African Wildlife Journal* 7:105–114.

Goddard J. 1970. Age criteria and vital statistics of a black rhinoceros population. *East African Wildlife Journal* 8:105–121.

Hitchins PM. 1968. Some preliminary findings on the population structure and status of the black rhinoceros (*Diceros bicornis*) in the Hluhluwe Game Reserve, Zululand. *Lammergeyer* 9: 26–28.

Kock RA, Morkel P, Kock MD. 1993. Current immobilization procedures used in elephants. In: Fowler, ME, ed., *Zoo and Wild Animal Medicine, 3rd Edition*. California USA.

Leader-Williams N, Brett RA, Brooks PM, Craig I, du Toit RF, Emslie RH, Knight MH, Stanley-Price M, Stockhil C. 1997. A scheme for differentiating and defining the different situations under which live rhinos are conserved. *Pachyderm* 23:24–28.

Okita-Ouma B. 2004. Population Performance of Black Rhinoceros (*Diceros bicornis michaeli*) in Six Kenyan Rhino Sanctuaries. [MSc] pp. xix + 112. Canterbury: University of Kent.

Okita-Ouma B, Amin R, Mwazia R, Munyambo O, Kilonzo D, Mulama M. 2006. De-stocking of Ngulia sanctuary and re-establishment of rhino population in Ngulia and Rhino valleys, KWS Report. Kenya.

Okita-Ouma B, Wandera AB. 2006. Status and management of black rhino in Kenya, 1 January to 31 December 2005. Kenya Wildlife Service; Nairobi. 47 p.