ANNEX 6: A POSITIVE TURNING POINT IN BLACK RHINO CONSERVATION IN KENYA

Background and Review of the Strategic Plan and Actions (2001-2006)

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Black rhinoceros population in Kenya is now growing positively. This is the result of nearly forty years of effort and from applying science in conservation. The population is now distributed across 15 protected areas in community, state and private land and growing on average by at least 5% with a range of growth from negative to 13% in different sites.

Rhinoceros conservation policy is now well established in Kenya and future strategy should be modified to improve growth and management rather than seeking any radical shift, the status of rhino is now improving year on year. The long term vision remains 2000 rhinos through growth of metapopulations and through re-establishment of free-ranging populations. The latter in historically key sites like Tsavo and Meru National Parks.

Management science continues to focus on standardized ecological and population monitoring systems and status reporting. Conservation effort is adjusted according to performance to ensure maximum growth to just below ecological carrying capacity. The concept of harvesting populations is now well understood and is being practiced but needs to be more commonly applied. This will ensure sustained reproductive performance and optimal habitat condition for rhino and other browsing species. Competitors are also managed to reduce impacts including browsers and invasive unpalatable plant species are now seen for the threat they are and control strategies now need to be urgently developed and implemented.

More attention is now being given to cross border populations and to the need to expand metapopulations as current sites quickly saturate. Recent years have also shown the need to have target setting according to each population management model. Context is all important to conservation and breeding potential. More work on disease dynamics and the relationship of nutrition and health of rhino is needed in improving diagnostics, management and monitoring in this area, especially when reintroducing populations.

Security remained a core element in the programme and the minimal poaching over recent years is a remarkable achievement. However, the rhino remains vulnerable with continuing demand for horn both regionally and increasingly from the Far East. Rhino security has also been beneficial to other species, minimising other illegal extraction activities. The value of good community relations and their input into anti-poaching activities has also been recognized and will drive new strategic directions in the future.

The success of the rhino programme has been dependent on capacity and there is evidence that without continued investment and management of capacity, the situation could easily deteriorate. This is true across all the sectors and not just within the KWS. Fund raising for this will remain a priority, as well as seeking greater efficiencies through community engagement in rhino conservation and spreading of responsibilities across the sectors. The success, in no small way, is a result of cooperation and coordination and this is critical to ensure sustained commitment. Improvements in the overall management and integration of the various actors will improve sustainability of the systems and viability of populations. Greater emphasis is needed in helping the weakest links in the rhino community and improving technologies in the most difficult areas, especially where management is constrained by size and difficult terrain.

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There are five extant species of rhinoceros (hereafter referred to as rhino): three occur in Asia, i.e. the greater one-horned rhino (*Rhinoceros unicornis*), Javan rhino (*Rhinoceros sondaicus*) and Sumatran rhino (*Dicerorhinus sumatrensis*), and two in Africa, i.e. the black rhino (*Diceros bicornis*) and white rhino (*Ceratotherium simum*). Description of the habitat, biology and behaviour of the two African species can be found in Estes (1991) and Mills & Hes (1997). Black rhino once existed wherever herb and woody browse occurred in sufficient amounts to support a population. This spanned a wide range of habitats, including deserts, semi-deserts, wooded savannahs, woodlands, forests and even sub-alpine heath lands. However, the densities at which black rhino can exist in these habitats vary 100-fold, from one rhino per 100 km^2 in the desert plains of Western Kunene, Namibia, to more than one rhino per 1 km^2 in thicket vegetation.

There are four recognized subspecies of black rhino occupying different regions in Africa (Figure 1); one, However due to the failure of survey teams to find any signs of *Diceros bicornis longipes,* or much of its possible range in Cameroon, and evidence that general wildlife poaching was widespread in areas surveyed the IUCN SSC AfRSG now fears that the western black rhino may be extinct (Emslie 2006).

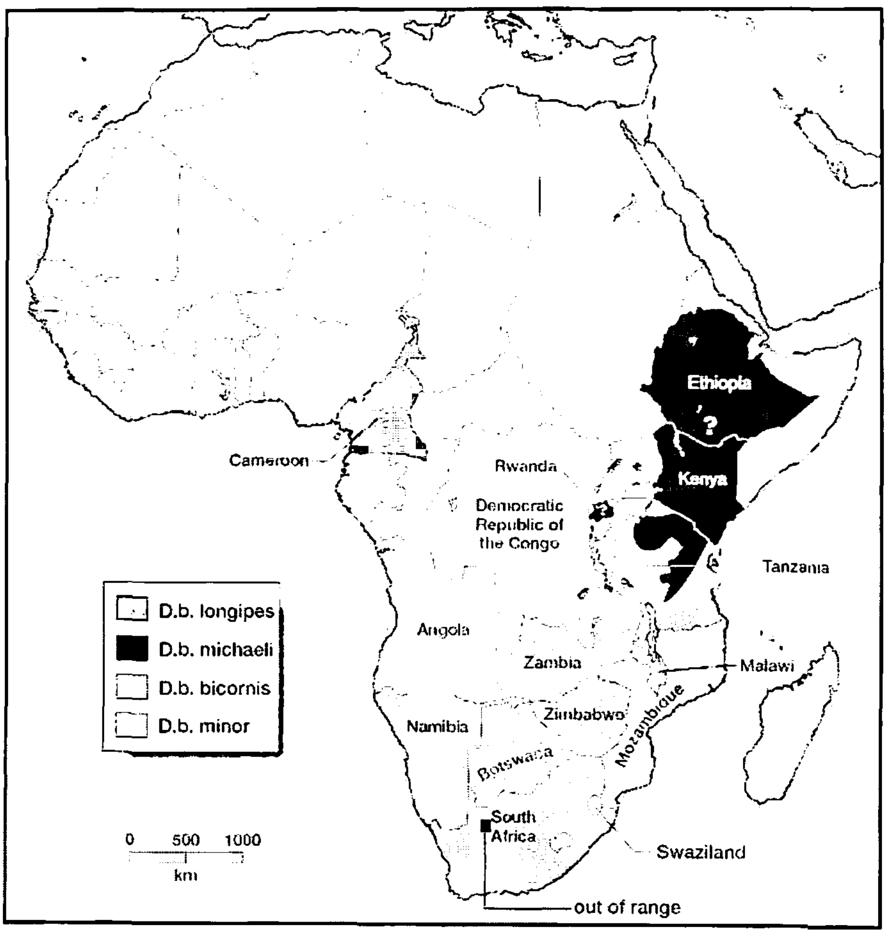


Figure 1: Distribution of black rhino *Diceros bicornis* (as at 31 December 2005, Amin, Thomas *et al.* 2006); The "?" for *D. b. longipes* in Cameroon refers to possible "extinction" of this subspecies. The "?" in Ethiopia and Rwanda refers to possible existence of *D. b. michaeli* from unconfirmed reports. In the case of Rwanda only one animal may still remain but the species could have gone extinct in this country.

All four subspecies of black rhino are listed in Appendix I of the Convention on International Trade in Endangered Species and Wild Fauna and Flora (CITES)[1]. At a species level the black rhino is listed as *Critically Endangered* on the *IUCN Red List of Threatened Species* (IUCN 2006). Kenya holds the only substantial IUCN SSC AfRSG-rated *Key* wild populations of the eastern race or subspecies of the black rhino (*Diceros bicornis michaeli*) (Figure 2). Outside Kenya; the only other significant numbers of this subspecies are found in northern Tanzania, and in an out of range introduced population in South Africa. Kenya at the end of 2005 remains the stronghold for the subspecies conserving an estimated 85% of the eastern black rhino population in the wild. Kenya is also one of the "big four" major black rhino range states along with South Africa, Namibia and Zimbabwe which together conserve all 15 Key rated black rhino populations and 88% of the 26 Important black rhino populations. As of the end of December 2005 these countries conserved 96.3% of Africa's remaining black rhino in the wild. At a continental level, in December 2005 Kenya conserved 14.5% of Africa's wild black rhino. (Emslie 2006)

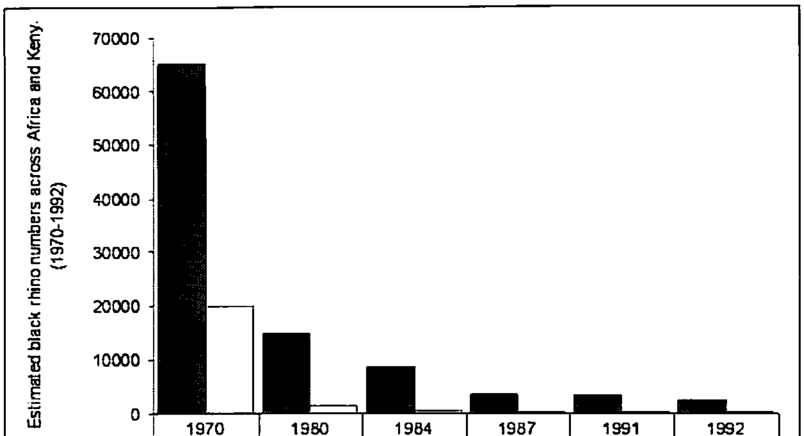
Figure 2: Eastern black rhinoceros *Diceros bicornis michaeli* showing the slender curved horn and distinctive skin ridges.

Rhinos, like other charismatic megaherbivores, require large areas to support viable populations. They act as umbrella species for the ecosystems they inhabit because their conservation requirements, by default, encompass those of other smaller species. If rhinos can be successfully conserved and protected within an area, then the other species in the area will also benefit.

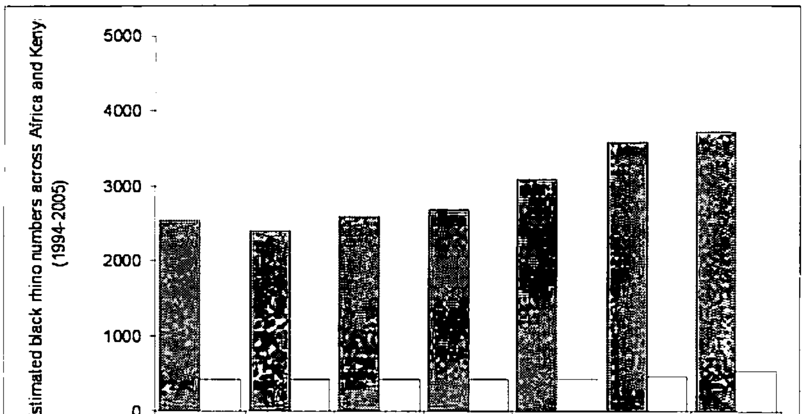
[1] CITES prohibits international commercial trade in endangered species.

1.2 Distribution and status of eastern black rhino

The black rhino suffered a catastrophic decline across Africa in the 1970s and 1980s, both in numbers and the extent of its range. Numbers plummeted from an estimated 65,000 in 1970 to fewer than 2,500 by 1992. Over the last 20 years in particular, considerable amounts of money and resources have been expended in several African countries aimed at saving the black rhino from extinction. The decline was reversed as a result with numbers slowly increasing (Figure 3). Poaching for the horn has been and continues to be the major threat.



	1970	1980	1984	1987	1991	1992
■ Africa	65000	14785	8800	3665	3450	2475
□ Kenya	20000	1500	550	381	398	414



	1994	1995	1997	1999	2001	2003	2005
■ Africa	2550	2410	2600	2700	3100	3606	3725
□ Kenya	417	420	424	423	430	459	539

Figure 3: Black rhino trend across Africa and in Kenya 1970–1992 showing the sharp decline (top) and slow recovery from 1994 to 2005 (bottom). The latest continental estimates for elephants compared to that of black rhino is over 150 African elephants for every black rhino (approx 569,000 elephants vs only 3,725 black rhinos). Data courtesy of IUCN-SSC-AfRSG and KWS.

The decline in the eastern black rhino in East Africa was particularly severe (Western 1982, Western & Sindiyo 1972; Gakahu 1993), where the very large National Parks and Reserves such as Tsavo National Park (NP) and the Selous Game Reserve (GR) each used to hold perhaps twice as many black rhino as currently exist in the world. Tanzania's eastern black rhino now number less than 60 animals, and the species is extinct in Uganda and Somalia. The status of the rhino in Ethiopia is thought to possibly comprise one minor population in the south although the status of this possible population has to be confirmed.

Rhino numbers in Kenya started to be steadily reduced from the beginning of the century, as large areas of range were cleared for settlement, and rhino were considered vermin or a nuisance. For example, approximately 1,000 animals were shot during the Makueni settlement scheme in 1946–1948 by the game control officer J. A. Hunter and his colleagues. The scientific and popular literature is full of accounts of the decline of the species, and expressions of alarm, crisis and regret at the ever-worsening situation (e.g. Ritchie 1963; Hillman & Martin 1979).

Throughout the 1970s and early 1980s, Kenya's black rhino were poached in all areas, inside and outside of National Parks and Reserves, with few controls and little law enforcement. In addition to the removal of most of the animals in lowland areas (e.g. Tsavo NP, Meru NP) by well-organised poachers from the east of Kenya, many of the black rhino from Montane forest population and lowland rhino populations were slaughtered by poachers from local areas. By 1990, the Kenyan population had declined to fewer than 400 from an estimated 20,000 in 1970.

The rhino are targeted for their horn for which, there are two main uses. It is carved to make ornate handles for Jambiyas (ceremonial daggers worn in Yemen). Rhino horn is also used in traditional Chinese medicine (Martin & Martin 1982; Emslie & Brooks 1999). Since the early 1970s Yemen has imported the largest quantity of African rhino horn, which is preferred to Asian rhino horn owing to its larger size, thus allowing more Jambiya dagger handles to be made per horn. Most illegal horn from eastern Africa has been smuggled by traders into Yemen. It is only in recent years that Yemen became a party to CITES and has outlawed imports of rhino horn and exports of horn shavings to the East. Internal trade in rhino horn was also prohibited and the making of new rhino-horn Jambiya handles was banned. Attempts have been made to lower demand by encouraging high-value substitutes (e.g. agate: a hard, fine-grained semi-precious stone) (Vigne and Martin 2006). For a time the amount of rhino horn entering Yemen declined (Martin *et al.* 1997; Martin & Vigne 2005). However, recent information indicates that Yemen remains the main recipient of rhino horn from Africa. Jambiya with new rhino-horn handles have been found on sale openly suggesting that craftsmen have little reason to hide them because government inspectors are not doing enough to curb the trade (Vigne & Martin 2006).

1.3 [illegible] Conservation policies in Kenya

It was eventually recognised that the only hope for protecting the remaining black rhino in Kenya lay in concentrating security within smaller areas of intensive protection. Resources and manpower had previously been spread too thinly over large areas to yield any benefit (see also Leader-Williams & Albon 1988; Leader-Williams 1989, 1990). From 1984 onwards, an active conservation programme devoted to the recovery of the species was pursued. The conservation policy was centred on the development of specially protected and fenced areas, or sanctuaries. Within these relatively small areas, many of which are completely enclosed by specially designed and monitored electric fences, a large proportion of the country's black rhinos have been protected from poaching and have slowly increased in numbers. Sanctuaries were initially stocked mostly with unprotected rhino, typically isolated and vulnerable animals living in areas outside of National Parks or Reserves. After 1984, surplus animals from overstocked areas were used.

Several ring-fenced sanctuaries were started under the Kenya Rhino Project in the 1980s, including Lake Nakuru NP, Ngulia Rhino Sanctuary (RS) in Tsavo West NP, Ngare Sergoi RS in Lewa Ranch [now a wildlife conservancy with the fenced RS removed], and Sweetwaters rhino reserve in Ol Pejeta Wildlife Conservancy (WC). The latter two sanctuaries were developed through fruitful cooperation between firstly WCMD and then the newly constituted KWS, private land owners and various conservation NGOs. In addition, other areas were upgraded to sanctuary status with the construction of some fencing and improved anti-poaching and surveillance (e.g. Nairobi NP, Aberdares NP - Salient). In 2004, fully fenced Mugie RS was created with a founder population of 20 rhinos from Lake Nakuru NP and Nairobi NP. Rhinos were finally re-introduced into a fenced enclosure within Meru NP; the park had lost all its rhinos in the 1980s. The sanctuary policy has been relatively successful as an emergency measure to protect and breed black rhinos (Anon. 1993; Anon 2003).

While sanctuaries have been developed and stocked, other important unconfined black rhino populations [e.g Masai Mara National Reserve (NR)] were provided with improved surveillance *in situ* (Anon. 1993; Anon 2003). Forty-eight animals were also re-introduced into Tsavo East NP during the 1990s. However, there has been some poaching of rhinos and their protection has been a challenge especially in the larger protected areas owing to the large distribution areas and limited manpower and resources. A map of the present distribution of the species in Kenya is shown in Figure 4.

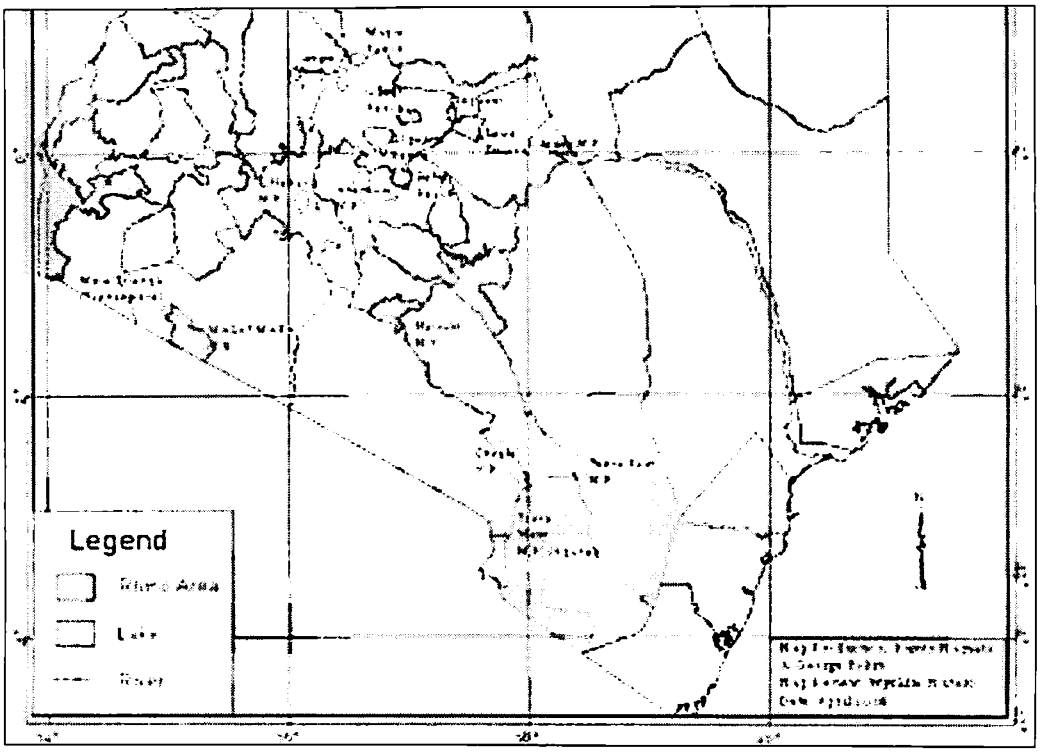


Figure 4: Distribution of black rhino in Kenya (Southern part of Kenya only shown).

Kenya has four IUCN categorised *Key-2* populations (Lake Nakuru NP, Nairobi NP, Tsavo West NP – Ngulia RS, Solio Game Ranch) and seven *Important-1* populations (Lewa WC, Masai Mara NR, Ol Jogi GR, Ol Pejeta WC, Tsavo East NP, Mugie RS, Chyulu Hills NP) (Emslie 2006). Tanzania has one *Important-1* population and two *Important-4* populations while South African has a single out of range *Important-1* population of eastern black rhino.

All black rhinos in Kenya are State owned. However, the efforts and foresight of private landowners have also played a large part in the success achieved so far. Since 1984, there has been an exceptional coalition between the WCMD/KWS, the private sector, and NGOs and donor organisations which realised the conservation potential of rhino sanctuaries. Changes in wildlife administrations and in the status of rhino populations (Figure 5) have resulted in the creation of different policies and structures to oversee rhino conservation. The latest policy guidelines for conserving the species were formulated in 2000, revised in March 2003, when they were officially ratified by the government. The current guidelines are based on the plans of 1979, 1983, 1985 and 1993 that saw numbers stabilise and slowly increase (Figure 6). However to improve and maintain metapopulation growth rates of 5% or more per annum, the 2001-2005 Kenyan Black Rhino Conservation Strategy had given the highest priority to biological management as it was recognised that some populations may have been underperforming due to overstocking. This would allow black recovery targets to be met and would safeguard the long-term demographic and genetic viability of the Kenyan black rhino herd.

Year	Policies and milestones	Rhino numbers
before 1960	Control, protection in parks and reserves and legal hunting	Decline
1960s	Translocations	Decline
1977	Hunting banned for rhinos in general	Decline
1979	Presidential decree on special protection; Coherent conservation strategy developed by stakeholders and experts; Translocation of non-viable groups and retention of viable groups; increase anti-poaching effort; Sanctuary feasibility; Control of illegal horn trade; Public awareness campaigns; Potential Donors identified	Decline
1980 & 1981	Sanctuary development refined	Decline
1983	Black rhino management plan officially ratified	Decline
1984	Save the Rhino Committee (SRC) chaired by Director established with representation from conservation NGOs	Stable
1985	Further refinement of the 1983 management plan; Fund raising document produced; Donor support invited	Stable
1988	SRC replaced by National management Committee on technical maters, and National Forum Committee on information and funding requirements both chaired by Director KWS; Association of Private land Rhino Sanctuaries (APLRS) formed	Stable
1989	National rhino coordinator appointed; Rhino programme placed under Management and Research departments; Policy decisions approved by the Director	Increase
1993	Revised Conservation Policy and Management Plan built around the 1979, 1983, and 1985 plans; Five objectives formulated – Protection, Translocation, Research; Free release, and control of illegal trade	Increase
1995	2nd national rhino co-ordinator appointed; Rhino management placed under Wildlife Service department	Increase
1998	Rhino management placed under Research and Planning department	Increase
1999	Rhino management placed both under Research and Planning and Wildlife Service Departments	Increase
2000	3rd and 4th national rhino coordinators appointed; Placement of rhino programme under KWS organization structure reviewed; 2001-2005 Conservation and management Strategy developed. Like 1979 stakeholders and experts invited and 6 strategic objectives formulated; Rhino Technical Committee formed	Increase
2001	5th national rhino co-ordinator appointed; Rhino numbers assessed by independent consultant to pave way for official ratification of the 2000-2005 Conservation strategy.	Increase
2003	The 2000-2005 Conservation Strategy revised; The strategy officially ratified	Increase
2005	Site-specific plans for specific respective sanctuaries proposed.	Increase

Figure 5: Summary of the policies and milestones in rhino management in Kenya (1960 onwards).

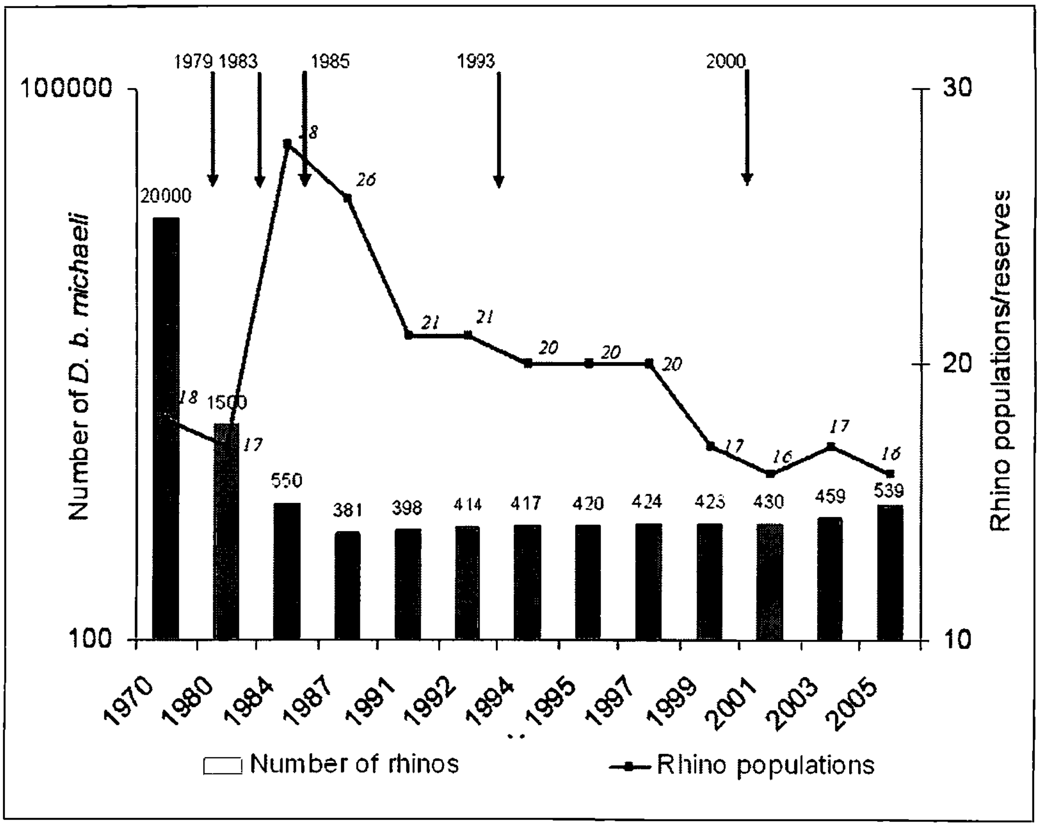


Figure 6: Trends in rhino numbers and populations from 1970 to 2005. The solid line represents the number of populations. Arrows indicate the date that management strategies were formulated. The increase in the number of populations in the early 1980s is the result of increased fragmentation into smaller populations. The decrease in the number of rhino between 1984 and 1991 resulted from the loss of outlier populations. The effect of the policies is shown by the steady increase in rhino numbers from 1993. Annual increases above the target 5% have occurred since 2003.

2 Conservation Strategy Objectives

2.1 Vision (long term)

"A metapopulation in Kenya of 2000 of the eastern African race/subspecies of the black rhino (Diceros bicornis michaeli) managed in natural habitat in the long-term" (Anon. 2003).

At the time of the revision of the strategy in 2001 'Two thousand' was recognised as being the minimum number, or metapopulation, necessary to ensure the long-term survival of this species in Kenya (du Toit *et al.* 1987). The faster growth to this target can be achieved, the more the loss of overall genetic diversity will be reduced.

2.2 Five-year goal

"Black rhino numbers to increase by at least 5% per annum, and reach a confirmed total 650 rhino by 2010 and 1000 rhino by 2020, using conservation management approaches that are biologically, socially, economically and politically sustainable" (Anon 2003).

The value of 5% was chosen as the minimum acceptable annual growth rate as it is only just over half of r_{max}[2] (9%) and should be attainable. In practice, one would hope to achieve higher rates of increase. Given an expanding population with a young age structure in good habitat, one can temporarily achieve even higher rates of growth (10%+). At the 5% growth rate it would take 30 years to achieve the target population level of 2000 animals; a level that could be achieved in 15 years if annual metapopulation growth rate could increase to 9% (i.e. near the biological maximum growth rate for non-sex-biased black rhino populations; Figure 7). Large, rapidly breeding healthy populations not only provide the best possible insurance against future poaching losses but also preserve genetic diversity, or at least minimize loss of heterozygosity, by ensuring maximum rate of gene transfer to future generations (Gilpin & Soulé 1986).

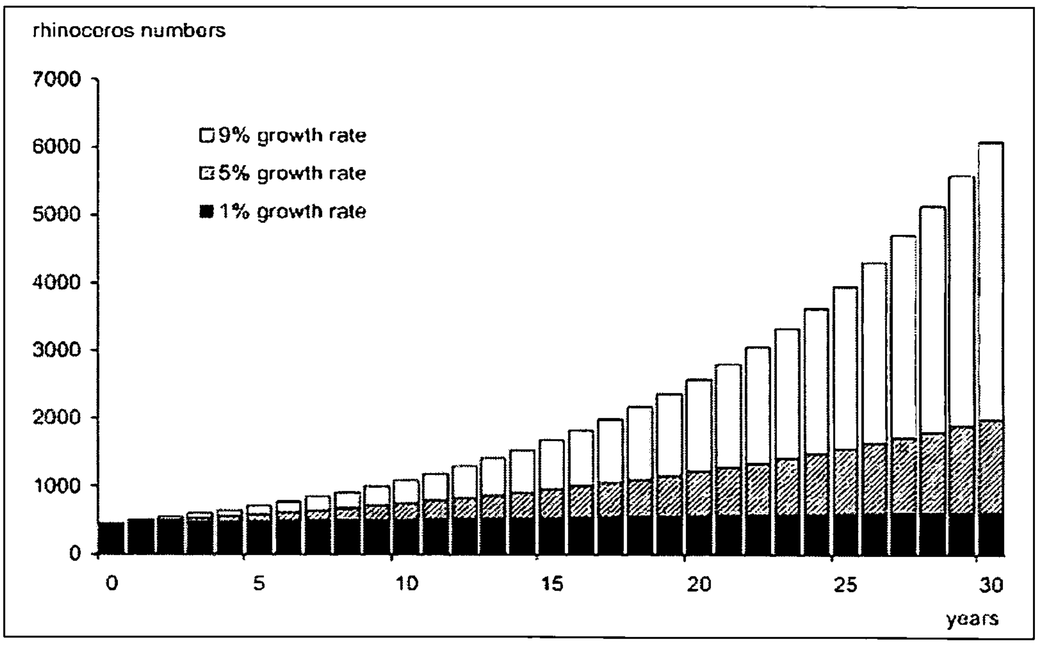


Figure 7: Estimates of eastern black rhino populations at 1%, 5% and 9% growth rates. If the population numbers increased at an annual rate of 1% and, without biological management to improve population growth, it will take 170 years to reach the target population of 2000 rhino. However, with the improved population growth rates of at least 5% per annum, this target population will be achieved in 30 years and at a rate of 9% the target population could be achieved in 15 years.

[2] Population growth rate describes the per capita rate of growth of a population, either as the factor by which population size increases per year, conventionally given the symbol λ ($=N_{t+1}/N_t$), or a $r=\log_e\lambda$

1.3 Strategic objectives

In 2001 six strategic objectives were developed in order to achieve the overall goal. Each objective has measurable targets against which success can be evaluated. By achieving short-term goals, progress towards achieving the long-term vision for rhino conservation in Kenya can be made.

Strategic Objective 1: Monitoring for management
An integrated, standardised monitoring system for rhino numbers and status, and for habitat change and community dynamics, will be developed which through continuous and annual status reporting and feedback will provide the necessary information for protection, metapopulation management and programme implementation.

Strategic Objective 2: Biological management
An overall population growth rate of at least 5% per annum with a total population of 500 in 2005 will be maintained in the full range of habitats (forest lowland/savannah; tsetse/non-tsetse) through informed, adaptive metapopulation management.

Strategic Objective 3: Protection
Poaching losses will be minimised through appropriate management action, improved laws and sentences, effective prosecution, co-operative intelligence, detection, law enforcement and community support.

Strategic Objective 4: Capacity
The resources necessary for the effective and efficient management of designated rhino areas will, through collaborative efforts, be sustainably secured and strategically allocated.

Strategic Objective 5: Support
The sustainable mutual support and shared responsibility of all rhino conservation stakeholders for effective implementation of this strategy will be achieved.

Strategic Objective 6: Coordination
An effective coordination framework for decision-making and action will be implemented, encompassing management, research and security considerations, and involving all stakeholders.

3 Monitoring for Management

3.1 Background

In order to monitor rhino populations, the Kenya Rhino Programme has implemented a standardised patrol system to obtain information on sightings and mortalities. Rhino surveillance personnel collect information from daily vehicle and foot patrols (Figure 8 and Figure 9). Rhino are where possible identified individually, information recorded and registers of the features of individual animals are maintained (Figure 10 and Figure 11). Where needed, recordings are also made of quality sightings of 'clean' rhino (those that are not individually recognisable). Monitoring data are used to provide estimates of population size, age and sex structures, calving rates (breeding performance), mortality rates (by age and sex) and the distribution and movement of rhino. This information is used to gauge the performance of each population and guide biological management decision-making processes, such as introductions and removals, in order to achieve the national target of increasing the total rhino population as rapidly as possible. The individual identification of rhino requires properly skilled and motivated observers, a system of strict control on data quality at observer and data-recording levels and the support of the wider conservation-management structure. A key to the success of this approach has been a better understanding of the biology and behaviour of the rhino amongst the ranger and warden cadres, which has reduced the misconceptions and fear about the animals. A better knowledge of rhino behaviour also means that fewer risks are taken during close contact procedures. The result of this is that professional, proud and confident staff provide the necessary information for research and management.

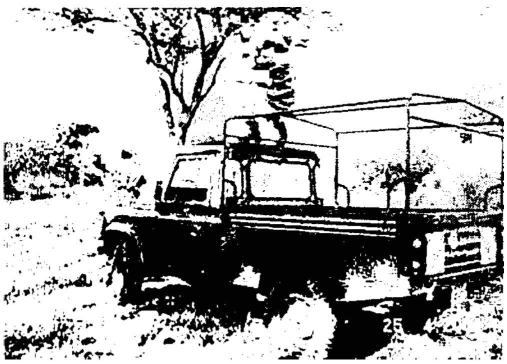


Figure 8: Rangers carrying out daily monitoring and anti-poaching patrols.

Figure 9: A field ranger carefully observing a rhino using a pair of binoculars from a safe distance.

Figure 10: An ear-notched and easily recognizable eastern black rhino on the plain in Lake Nakuru NP, Kenya.

Figure 11: A field ranger completing a rhino sighting form.

3.2 Population monitoring

Successful management of all black rhino populations for rapid population growth (and prevention of overstocking and resultant sub-optimal performance) will depend on uninterrupted and detailed population monitoring. The objective of rhino monitoring is to obtain accurate and precise black rhino population estimates and derive the necessary additional demographic information to assess population performance and behaviour in each population primarily as an aid to guide biological management decision making as well as providing quantitative measures against which progress towards meeting plan goals can be assessed.

This work includes obtaining:

1. Confirmation of the presence and health of individual rhino.
2. Personal-history records of all rhino.
3. Details of births and mortalities, and, where possible, matings.
4. Identities of breeding animals.
5. Provenance of calves.
6. Information on the size of home ranges.
7. Analyses of these data to provide measures of population size and performance of each population within the metapopulation.

In addition, monitoring of law enforcement can be very useful in guiding patrol deployment and increasing protection, as well as providing measures to assess performance.

Individuals are recognised by a combination of features (ear notches, distinctive body marks, horn shape, age and sex). Animals that cannot be recognised by a combination of these features are considered "clean". Rhino are sexed and aged using the standardised AfRSG A–F age categories (Figure 12). Body-condition scoring using the standardised AfRSG scoring system is also extremely useful but needs well-trained personnel (Figure 13). The use of standardised continental age and body-condition assessment scores also allows results to be compared between parks, including those in other range countries.

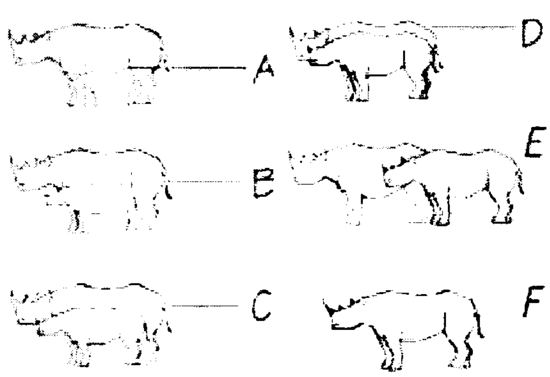


Figure 12: Standardised AfRSG A–F age classes used to monitor individual rhino (Adcock & Emslie 2000)

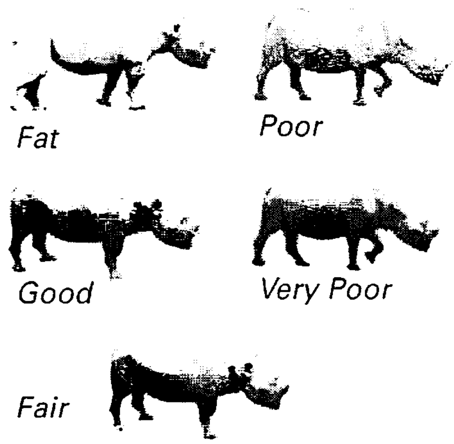


Figure 13: Standardised AfRSG body condition scores (Adcock & Emslie 2000)

The present system of collection, storage and analysis of information is as follows.

1. Standardised record books for rhino surveillance teams for patrol records, sightings records and mortalities.
2. Record books used by Kenyan Wildlife Service (KWS) vets for all mortalities/ autopsies. Horns are marked, catalogued and stored in a secure place.
3. Record books and capture data forms used by KWS vets for recording details of all captures and translocations. All immobilised rhino have body measurements, blood and tissue samples taken.
4. Rhino "ID" master files used for data quality control.
5. A computer Geographic Information System (GIS) database containing (a) records of all individually known rhino, including history and breeding records, (b) sightings of ID and clean rhino, and (c) patrol movements and the tools to analyse population breeding performance, (population size and age structure, growth rates, percentage of calves in the population, cow/calf ratios, sex ratios, calving intervals), carrying capacities, individual-rhino sighting frequencies and patrol effort (Amin, Okita-Ouma *et al.* 2006).

Measures have been put in place to promote a high-standard of data collection in order that the best possible data are available for comprehensive analyses of each rhino population and the national herd.

3.2.1 Rhino monitoring training

A formalised training programme for personnel can greatly accelerate the process of acquiring high standards of observational and data-collection skills. The Kenya Rhino Programme with initial assistance from a Darwin initiative project has implemented a sustainable field-staff training programme and so far 28 officers from all rhino conservation areas have been trained as accredited rhino-monitoring instructors using the continent-wide modular African Rhino Specialist Group (AfRSG) course (Figure 14; Adcock & Emslie 2000). The process of testing and accrediting both trainers and trainees should help institutionalize the process and provide formal recognition to those who gain accreditation. A significant advantage of this approach is that staff can be trained where they are located, thus saving time and financial resources and minimizing daily operational impact on the field teams. In addition, with continuous teaching of the modules it is possible to maintain consistency as well as deal with staff turnover.

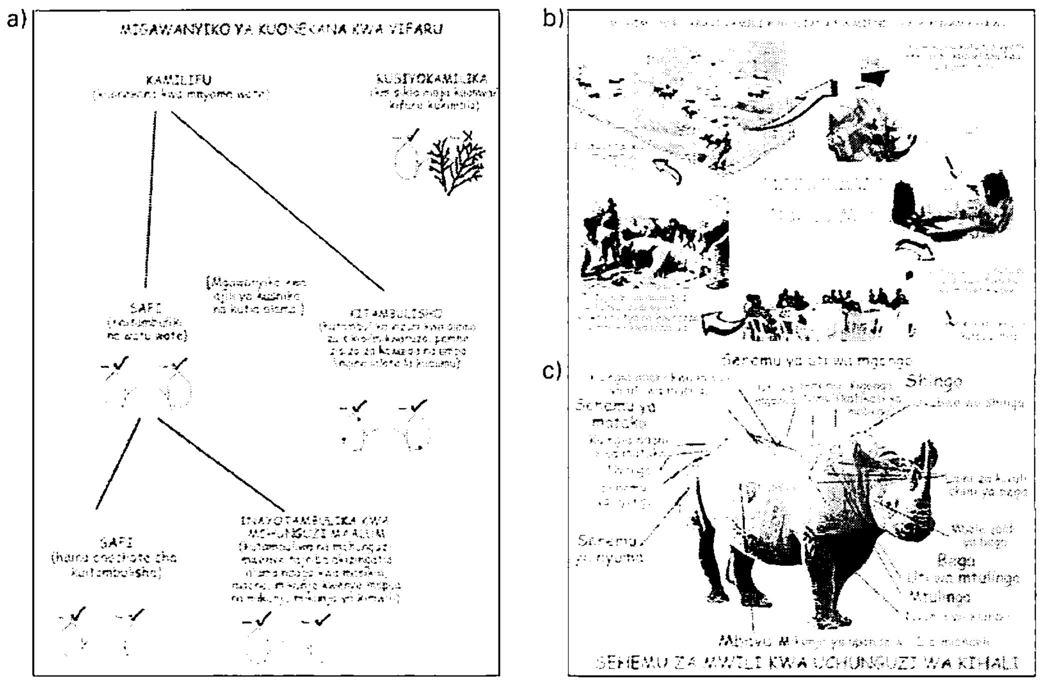


Figure 14: An example of Swahili training posters from the AfRSG training course trainees guide: (a) classification of rhino sightings; (b) importance of good monitoring data; (c) regions for the assessment of body condition.

Figure 15: One of the 28 project-trained site-level instructors imparting monitoring skills.

The field instructors are, in turn, training around 200 rangers in the field (Figure 15). The instructors are responsible for training and testing new staff in monitoring rhino and keeping an up-to-date training chart; conveniently displayed so that staff can review their progress. The training needs to be undertaken on a regular basis to ensure that standards are maintained. Review of monthly progress reports and regular auditing of the data collected will ensure that staff continue collecting data adequately. The instructors are supported and mentored by Rhino Programme KWS Headquarter staff.

3.2.2 Quality of rhino monitoring data

The Kenya Rhino Programme has with initial assistance from a Darwin initiative project implemented data quality-control procedures in its reserves to ensure that data are collected on an on-going basis and are of the best possible quality. Field rangers have been trained to approach and observe rhino, and accurately complete the standardized sighting forms (Figure 16 and Figure 17). This information is then checked by experienced accredited observers and the sightings are classified in accordance with the 'ID' master files (Figure 18 and Figure 19) into: (1) first class ID sighting with ID number assigned; (2) first-class clean sighting; (3) incomplete sighting. The 'ID' master files are also used to capture and transfer the knowledge/skills of the highly experienced key observers which otherwise would be lost during staff transfers or retirements. The use of high-resolution digital cameras would help this process. The photographic sequences kept in the files should also allow changes in the animals to be tracked over time and also allow Kenya to develop guidelines on horn and body-size appearance with rhino age at sanctuary level, thus improving the accuracy of estimations of ages of rhino in future. The information in the files should be accurate and kept up-to-date by the data controllers. All rhino *sightings should be classified and filed according to the following categories:* (1) identifiable always by all rangers using obvious easy to record features (ear notches mainly); (2) identifiable based on more subtle or harder to record features (but defendable features, not location or behaviour) by some key observers but which would not be recognised or recorded by all observers always (e.g. accurate horn configuration drawings, scars, photographs of nose wrinkles etc.); (3) possibly identifiable but insufficient evidence on file to justify ID; (4) Definite clean animals.

Figure 16: A ranger being trained to complete rhino sighting forms correctly.

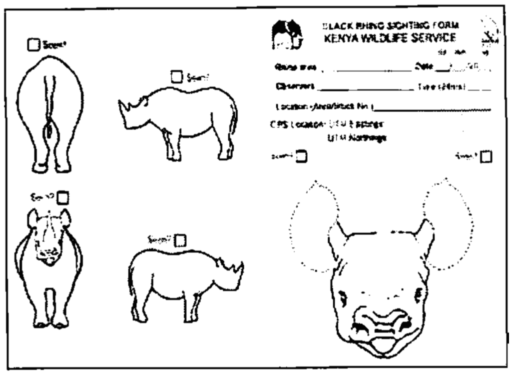


Figure 17: One side of the standardized form used to record details of rhino sightings.

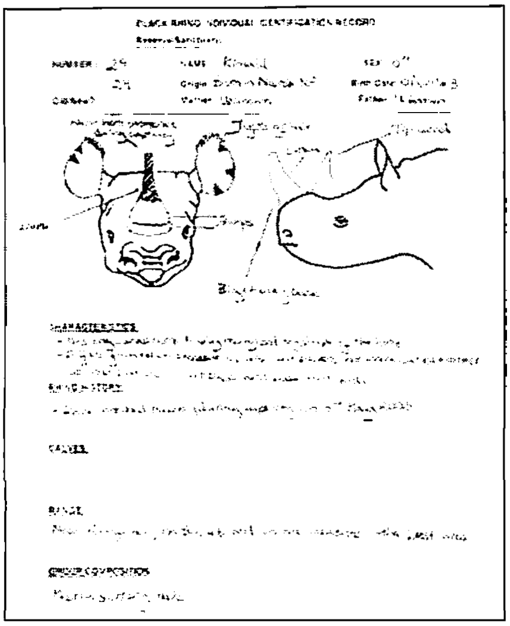


Figure 18a: (above): A completed record in rhino ID Master file "ID" master file.

Figure 19 (above): An accredited observer carefully checking a completed sighting form.

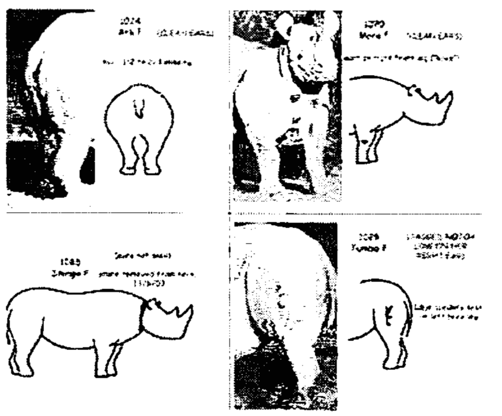
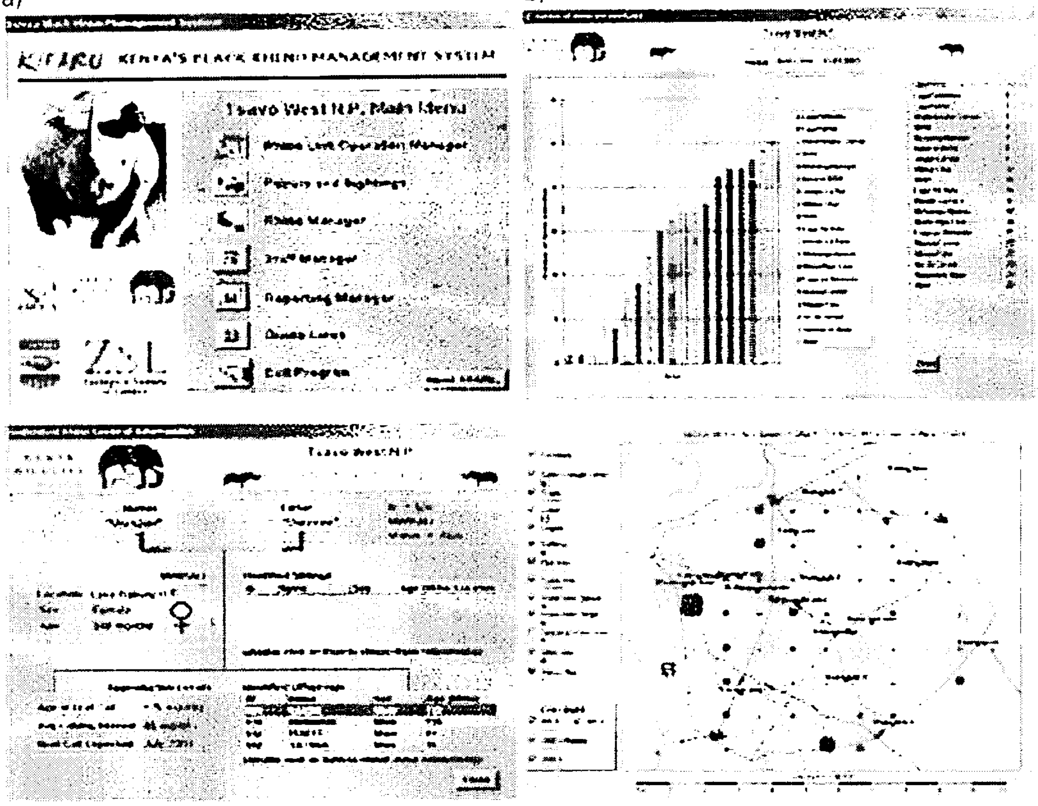


Figure 18b: (right): some summary records from rhino "ID" master file.

3.2.3 Kenya Black Rhino Information Management System (KIFARU©)

KIFARU© has been implemented and is operational in the majority of reserves. It is a comprehensive geographic information database management system which allows data to be stored and analysed to produce a range of reports, such as monthly sighting reports of individual rhino, patrol movements and the availability of manpower resources, which can be used to optimise deployment of patrols and analyse population performance (Amin *et al.* 2001) (Figure 20). In each reserve field staff have been trained to use KIFARU© and have the responsibility to ensure data are entered on a regular basis and reports are generated to assist park/rhino management. Training new staff to use monitoring equipment, regular upgrading of computer hardware and software and safe archiving of information are mandatory.

a) b)



c) d)

Figure 20: Various pages from the Kenya Black Rhino Information Management System (KIFARU©, Amin *et. al.* 2001): a. main tools in KIFARU©; b. patrol effort and movement along with information on poaching threats and animal distributions helps in more effective deployment of patrols; c. rhino reporting element provides information on demography, population structures and performance indicators; d. GIS element of the system provides information such as home ranges and patrol intensities.

3.2.4 Monitoring and surveillance effectiveness

Field rangers on patrols should regularly log their position using a Global Positioning System (GPS) receiver. These should then be entered into the KIFARU© database system and plotted on the Park GIS map. This information, along with positions of individual-rhino sightings, illegal activities (such as snares) and indirect rhino sightings is useful for planning daily patrols. The monitoring database should also be linked with any existing security databases in order to strengthen general security surveillance in vulnerable reserves.

The ability of monitoring and surveillance teams to sight and confirm rhino will vary between different areas owing to differences in the terrain to be covered, the density of rhino, the vegetation cover/habitat and the temperament of rhino. Management should ensure that average sighting levels per rhino does not decline below the threshold levels. Once the absence of an individual exceeds a critical period, intensive searching should be carried out within, and then outside its known home-range. Maximum Interval between Sightings (MIS) (or Critical Sighting Intervals) was established in 1993 (Table 1) to ensure patrols were effective and to detect evidence, such as carcasses, early. A number of MIS guidelines were updated in 1999 but these need to be reviewed and benchmarks established that are appropriate to current conditions. The sighting data in KIFARU© can be used to analyse the sighting patterns and frequencies for individual areas and individual rhino. RHINO 2.1 © software can also be used to analyse sighting data to objectively identify critical sightings levels on an individual animal basis.

Table 1: Maximum Interval between Sightings (MIS) guidelines for State conservation areas as defined in the 1993 management plan and current average sighting intervals.

State Rhino Areas	Maximum Interval Between Sightings	Current Avg. Sighting Interval
Nairobi NP	14 days (plains/gorges habitat) 30 days (forest habitat)	29 days
Lake Nakuru NP	30 days month (all areas of NP)	56 days
Aberdares NP	60 days (monitoring at Arks, Treetops, salt licks)	23 days
Tsavo East NP	-	70 days
Ngulia RS	60 days (monitoring at piped waterholes)	50 days
Meru NP	-	1.5 days
Masai Mara NR	60 days (all areas of NP)	99 days
Chyulu Hills NP	-	-

3.3 Estimating population size

There is a growing problem in several reserves of an increasing number of animals that are not individually recognisable (i.e. clean). Young clean rhino become unrecognisable once they leave their mothers. In the past, population estimates have only been based on identifiable animals, which provide a minimum index rather than an estimate of the true population size. Reliable population-size estimates (within 90% of the true total) are required every year (or at least every 3 years) in order to assess how well a population is performing and to manage populations at the metapopulation level. This information, along with the ecological carrying capacity estimate of each park, can assist managers in making decisions that are necessary for achieving and sustaining high population growth rates.

The individual-identification-based monitoring method undertaken in Kenyan reserves enables the use of mark–recapture methods for estimating population size. Field staff are being trained on a continual basis to ensure accurate recording of sightings of both identifiable and clean rhino, with equal emphasis on each sighting. Rhino Programme scientists have also been trained to use the RHINO© Bayesian Mark–Recapture software tool (Emslie & Amin 2003), which estimates population size and confidence levels using ongoing sighting data (Figure 21). This should be used to provide better population estimates (with confidence intervals) despite the number of clean rhino and when known individuals are not all seen within a year. RHINO© is already being used by trained staff in several areas in Kenya and in a number of rhino reserves in South Africa and has proved to be effective.

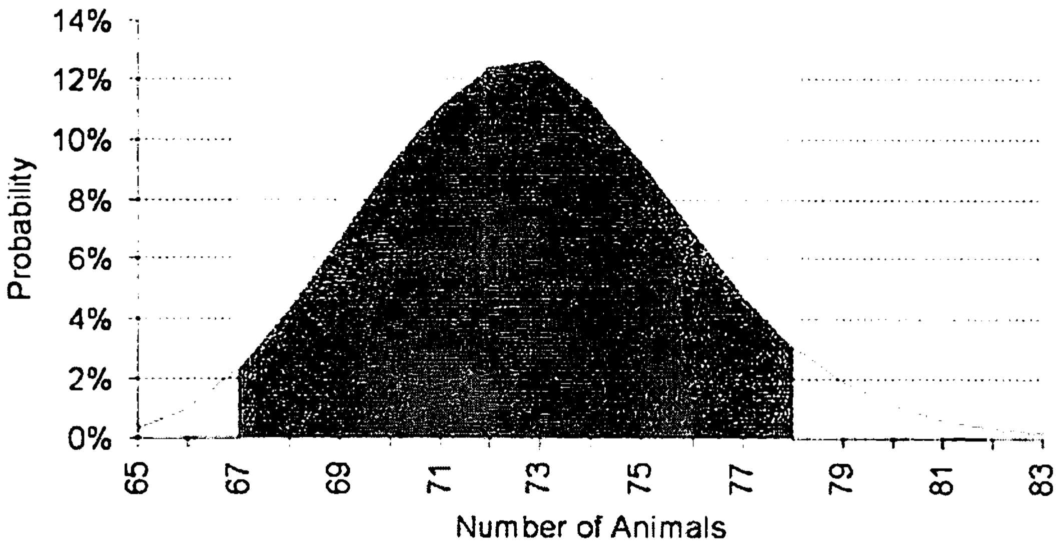


Figure 21: Population estimate of Nairobi NP black rhino population in 2005 using RHINO © Bayesian mark-recapture software tool (Emslie & Amin 2003).

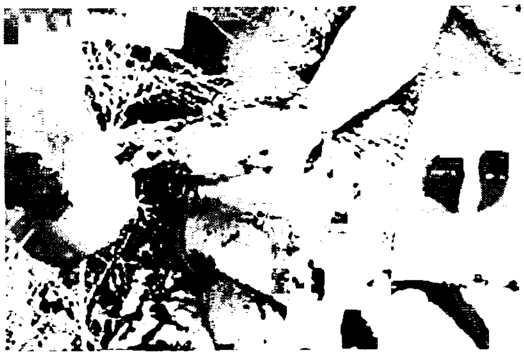


Figure 22: A rhino being ear-notched with a unique 4-digit code during a translocation.

To improve population estimates and increase the sample size of rhinos that can be easily identified by all observers all rhino immobilized for translocation or veterinary treatment are ear-notched and fitted with transponders under the skin for identification purposes as standard practice (Figure 22). When resources are available, specific ear-notching exercises are undertaken in areas with a high proportion of clean animals. Notching programmes boost interest and motivate monitoring staff. Cost is an issue - in 2007 ear-notching costs in the region of 200,000 Kshs (*c.* UK£1450 or US$3000) per animal using a helicopter, but could perhaps be reduced if veterinary capacity was increased to enable ground darting of rhino. A training programme would need to be established in order to ensure veterinary personnel are able to carry out the procedures. In addition, a fixed-wing aircraft would be required: costs, though reduced, would still be significant at *c.* 50,000 Kshs (*c.* UK£365 or US$750) per animal. In the absence of routine ear-notching programmes as a population grows the proportion of notched animals in the population will decrease (Table 2). Management can always decide to increase the ID notched percentage even for big populations.

Table 2: Proportion of ear-notched rhinos in rhino conservation areas (end of 2006).

Rhinoceros Reserve	Confirmed	Probable	Ear- notched	% Ear-notched
Lake Nakuru NP	59	2	30	49%
Ngulia RS	58	6	26	41%
Solio GR	92	2	10	11%
Lewa WC	53	0	29	55%
Ol Jogi GR	26	0	8	31%
Nairobi NP	62	2	10	16%
Masai Mara NR	25	10	15	43%
Tsavo East NP	6	20	15	58%
Ol Pejeta WC	49	0	36	73%
Aberdares NP (Salient)	7	3	3	30%
Chyulu Hills NP	15	6	0	0%
Mugie RS	24	0	20	83%
Laikipia Nature Conservancy	9	4	5	38%
Meru NP	20	0	20	100%
Il Ngwesi	1	0	1	100%
Mara Triangle	2	0	0	0%
TOTAL	**508**	**55**	**228**	**40%**

In some areas such as Tsavo East NP and Aberdares NP where routine daily monitoring of the rhino population is not as effective, and population size can only be estimated on the basis of additions (births, translocation, known immigration) or removals (mortalities, translocation, known emigration) of rhino since the last time the total rhino numbers were known, a total census of the population will be required. In these cases no longer than 3 years should elapse before a full census is repeated.

3.4 Monitoring practicalities in difficult terrains

In Tsavo East NP it has proven to be difficult to monitor rhino through direct sightings with the small monitoring team as the range area for the rhino is estimated to be greater than 4000 km^2. This, coupled with Tsavo's close location to the Somali border, limited resources (human/equipment) and difficult terrain has proven difficult to effectively secure the population. Rhino are also rarely sighted during the day in the difficult terrain of the Chyulu Hills NP, and in the dense vegetation of Aberdares NP and Tsavo West NP Ngulia RS. The practical issues of achieving effective monitoring in these areas need to be addressed and require the development of specific, targeted and sustainable programmes.

In Ngulia RS, the dry season full-moon night census is being improved using better planning and equipment to obtain more comprehensive population information. A complete (from data capture to analysis) intensive 4-night water-hole photographic survey programme undertaken in 2006 included the use of third-generation night-vision equipment and high-resolution digital cameras (Figure 23). This provided much improved data on rhino numbers and structures and these photographic surveys should be continued (Table 3).

Figure 23: Rhino images obtained using night-monitoring equipment clearly showing the ear notches.

Table 3: Summary results of the 2006 Ngulia RS night water-hole surveys.

Total number of rhino sightings	303
Total number of sightings of ID animals	144
Total number of sightings of animals with subtle features (clean)	159
Total number of ear-notched animals seen (ID by all always)	20 (six ID animals were not sighted during the entire 3-month night survey: one since confirmed dead, two were last sighted in August 2006 during the day, two in September 2004 and one in August 2003
Total number of distinguishable rhino from subtle features	36 (inc. four newly sighted rhinos) five dependent calves (between classes C–E) seen in the previous year were not seen with their mothers — they may have become independent however carcasses of two unknown rhino between the age classes of D and E were later found during patrols
Total number of different rhino sighted	56 + 2 ID rhinos sighted during day patrols only = 58 confirmed rhinos by end of 2006

In Tsavo East, Aberdares and Chyulu Hills NPs, a combination of direct and indirect methods for deriving indices of rhino abundance, and relating these to indices of patrol effort and poaching activities, should be considered to track population distributions and densities, and allocate law-enforcement efforts appropriately in order to protect these populations (Figure 24). In Tsavo East NP, the area has been mapped for efficient patrol blocks and all security staff should now be trained to routinely log their 'patrol movements' and sightings of rhinos (direct and indirect) and illegal activities.

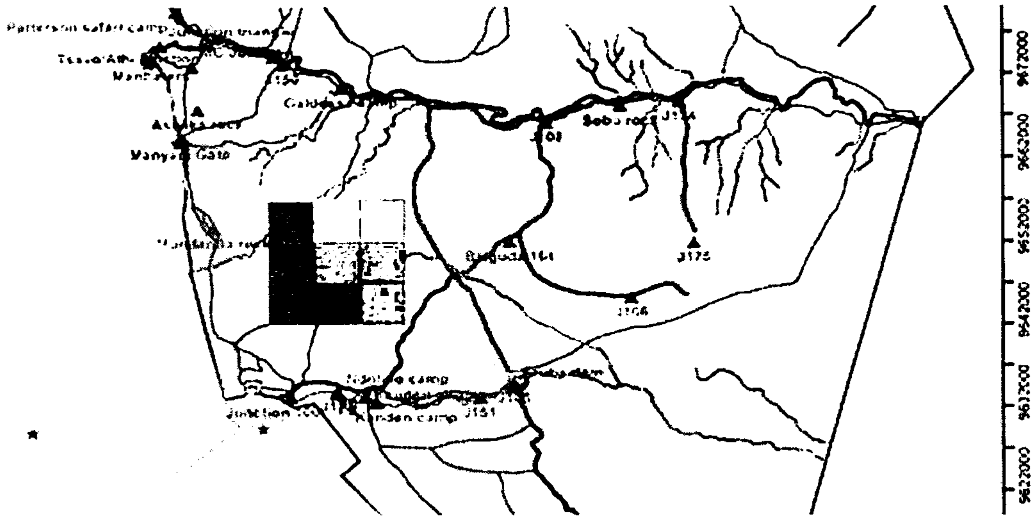


Figure 24: Example of patrol Index map for Tsavo East NP (note that only a few of the intensity map grid cells are shown for clarity).

In Aberdares NP, there is a need to kick-start viable intensive forest surveys by expert rhino monitors and enhance the knowledge and experience of selected park monitoring personnel so it can continue into the future. The movements and seasonal distribution of rhino are poorly known and experience has shown that limited radio-tracking can provide useful information which can be used to guide future deployment of monitoring staff. A pilot transect survey was undertaken in the Salient Section of the park in 2006. Rangers have now also been trained to look for and collect indirect signs during their daily patrols. The low number of signs observed so far along with the much fewer sightings of rhinos during night monitoring at the Ark and Treetops lodge waterholes indicate that the population has declined to as low as ten individuals. The recovery of this population needs to be a key component of the 2007-2011 Black Rhino Conservation Strategy. Staff have also been trained in Chyulu Hills NP to collect indirect signs including fresh samples of dung for DNA analysis.

A majority of enclosed areas will or have already reached their carrying capacity and there will soon be the need to translocate rhino on a regular basis from these reserves in order to maintain maximum productivity. The two largest Protected Areas (PAs) in the country, the Tsavo NPs and Reserves (*c.* 22,000 km^2) and the Greater Meru Conservation Area (*c.* 4,000 km^2), are the only areas with the capacity to assimilate large numbers of rhino from the smaller, overstocked sanctuaries and parks. These areas used to have over 6,000 black rhino before the poaching onslaught in the 1970s and 1980s. However, the practical issues of achieving effective monitoring in these areas need to be addressed before such moves can take place.

… border animals

Initial discussions have taken place between relevant Tanzanian and Kenyan staff regarding increase cooperation and sharing of information in view of the fact that many rhino in the northern Serengeti-Mara area are cross-border animals. There is a need for a workshop to bring together staff from both countries to standardise monitoring protocols and to ensure information on all rhino in the north of the Serengeti-Mara ecosystem is being shared and is captured on the identification master files of all parties. Specific training and capacity-building in coordinated cross-border monitoring should be facilitated, from organised periodic joint or parallel surveys to field data collection, record keeping and mutual reporting.

3.6 Ecological monitoring in sanctuaries

The successful management of sanctuaries will depend on detailed ecological monitoring. Particular attention should be paid to assessment of vegetation status, and the numbers and population dynamics of several species of grazing and browsing herbivores, as well as predator species. In rhino sanctuaries, priority should be given to the requirements of the black rhino. This should entail complete protection for this species, and maintenance of the habitat conditions and population structure to promote maximum sustainable breeding output.

Events that have occurred in fenced rhino sanctuaries in the last 20 years suggest that enclosed systems are susceptible to major fluctuations in the numbers of different species. Some of the changes that have already been observed include: die-offs of eland (*Tragelaphus (Taurotragus) oryx*, greater kudu (*Tragelaphus strepsiceros*), oryx (*Oryx gazella*) and warthog (*Phacochoerus aethiopicus*) in dry years (Lewa WC); overpopulation of waterbuck (*Kobus ellipsiprymnus*) and impala (*Aepyceros melampus*) at low predator numbers (Lake Nakuru NP); increase in predator numbers (spotted hyaena *Crocuta crocuta* in Aberdares NP); large increases in numbers of giraffe (*Giraffa camelopardalis*), zebra (*Equus burchelli*) and buffalo (*Syncerus caffer*) in several areas (Ol Jogi GR, Lewa WC, Lake Nakuru NP); overbrowsing of favoured browse species by black rhino (made more acute by giraffe grazing at lower browse levels after depleting reserves at higher levels) (Ol Jogi GR). In addition, confinement of elephant (*Loxodonta africana*) has caused significant habitat change (e.g. Ngulia RS, Ol Pejeta WC, Laikipia Nature Conservancy [NC]), problems with water and fence maintenance, and possible disturbance to rhino. There is a need for a monitoring system appropriate to the enclosed ecosystem. This is important as over time changes in densities of competing browsers and/or habitat can result in carrying capacities for black rhino changing quite considerably.

3.6.1 Monitoring of vegetation and ecological carrying capacities

Standardised assessment of ecological carrying capacities (ECC) should also be carried out once every few years in order to monitor medium- to long-term vegetation changes. This is important as ECC will change over time in response to habitat changes, which for black rhino may be positive (increased browse availability of suitable plant species) or negative [favoured food plants declining or growing out of reach, unpalatable species increasing at the expense of more palatable species, increases in alien plants (e.g. *Lantana camara*), frequent fire, increased grass interference and/or an increase in browsing pressure following a build-up in numbers of competitive browsers (e.g. elephant, giraffe, buffalo and impala). To be able to update ECC estimates of existing areas and obtain estimates of new areas, therefore, requires a team of trained staff with an understanding of browser/browse dynamics, the nature of vegetation changes and their likely impact on ECC (Figure 25 and Figure 26). Habitat-monitoring procedures have been developed specifically for black rhino and as part of a Darwin Initiative project eight park personnel have been trained in their use. The trained team has already assessed one new area and this should continue on a regular basis. A vegetation database has also been developed to store and analyse data and produce standardised reports.

Figure 25: Training of Kenyan rhino personnel in browse assessment and plant identification.

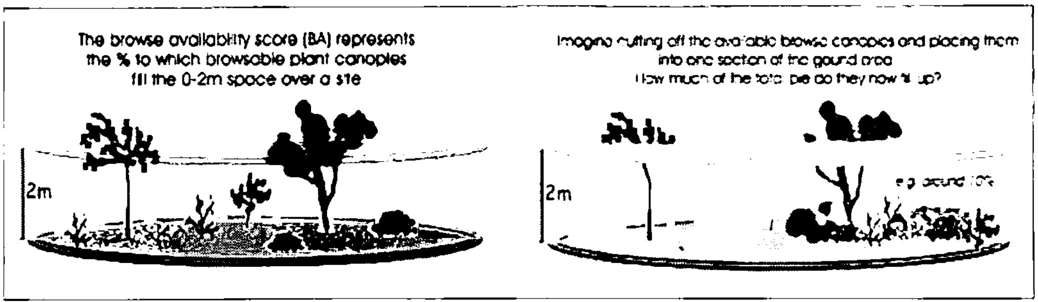


Figure 26: Training posters for rhino browse assessment training (Adcock 2005).

3.6.2 Monitoring of competitor large herbivore species

Monitoring of key species that are likely to have an impact on the reproductive performance of the black rhino should be undertaken. Estimating the numbers of giraffe, elephant and buffalo on an annual or bi-annual basis would provide detailed information on the impact of intense browsing by competitor species on essential rhino browse species (Figure 27 and Figure 28). Vegetation monitoring to establish browse pressure and distribution of invasive plant species should also be carried out using key indicator species. Certain invasive plant species can smother and replace indigenous species and can significantly lower carrying capacities for rhinos and other species impacting negatively on conservation of biodiversity.

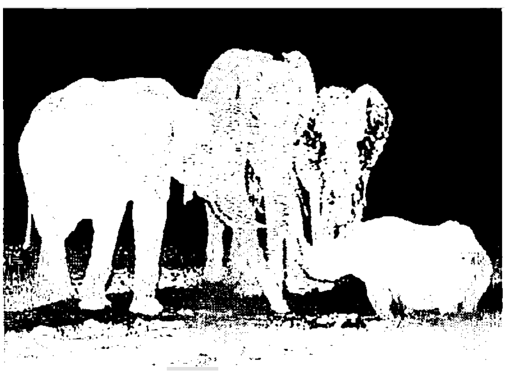


Figure 27: Elephant competing with rhino for water and vegetation (Ngulia RS).

Figure 28: Buffalo numbers have built up in some rhino reserves (Lake Nakuru NP, Ngulia RS).

3.6.3 Monitoring of rhino predators

With so few rhinos apparently remaining Predators are alleged to be a threat to rhino in the Aberdares NP where hyenas or lions could kill the odd calf. Evidence of past attacks includes missing ears and tails in adult and sub-adult rhino. There have been isolated cases in other areas, for example, one sub-adult and one old adult rhino were killed by lions (*Panthera leo*) in 2006 in Nairobi NP and Ol Pejeta WC respectively, while a rhino death in 2005 was suspected to have been caused by lions in Laikipia NC. Careful and continuous monitoring of both the predators and rhinos is therefore required to ascertain this.

3.6.4 Monitoring of water quality and wetlands

Agricultural chemicals such as fertilisers, pesticides, herbicides as well as industrial and domestic effluent from the heavily populated Nakuru town and the city of Nairobi enter the Lake Nakuru and Nairobi NPs through surface inflows. Pollution of the wetland poses a severe threat to the aquatic ecosystems inside the parks. It is thus important to monitor the water quality of the parks wetlands and at the catchments. This will provide information necessary to initiate remedial measures within the catchments and pollution sources adjoining the parks.

3.6.5 Monitoring of land use and fragmentation in wildlife dispersal areas

Communal grazing lands and wildlife dispersal areas are experiencing sustained fragmentation and alteration around a number of rhino conservation areas. For example, the Tsavo and Meru PAs are under enormous pressures from the growing fringe communities driven by necessity to exploit resources, such as bushmeat and timber from within the parks. Over 60% of people living in rural communities live below the poverty line, earning less than 1 US dollar per day. Apart from ecotourism these communities currently have no way of economically benefiting from any wildlife on their land and the wildlife may compete with them and their livestock for food. In addition, livestock population within buffer zones has increased by nearly 100% in the last 20 years, putting considerable pressure on water and forage resources. As a result these PAs and buffer zones are suffering significant biodiversity decline and land degradation.

Similarly, in Nairobi, sub-division of land within the Kajiado area begun in 1984 following a change in government policy on group ranches, encouraged subdivision. Proximity of the area to Nairobi City has accelerated land sales and fragmentation. The area is very attractive to those seeking residential plots. The price of land bordering the park has increased because of the ambience provided by the park environment and currently the price of 1 acre (0.4 ha) ranges between US$10,000 and $15,000. It is a matter of time before the entire area bordering the park to the south is converted for residential use. The maintenance of the park's ecological integrity depends on wildlife access to the ever-dwindling Kitengela-Athi Kapiti dispersal area. It is quite clear that the park cannot support the variety and numbers of wild animals normally seen within it, and unless the park has permanent access to this adjunct area to allow for seasonal migrations and as a source of forage, other management approaches that focuses on maintaining the park as a rhino sanctuary will be required (Figure 29).

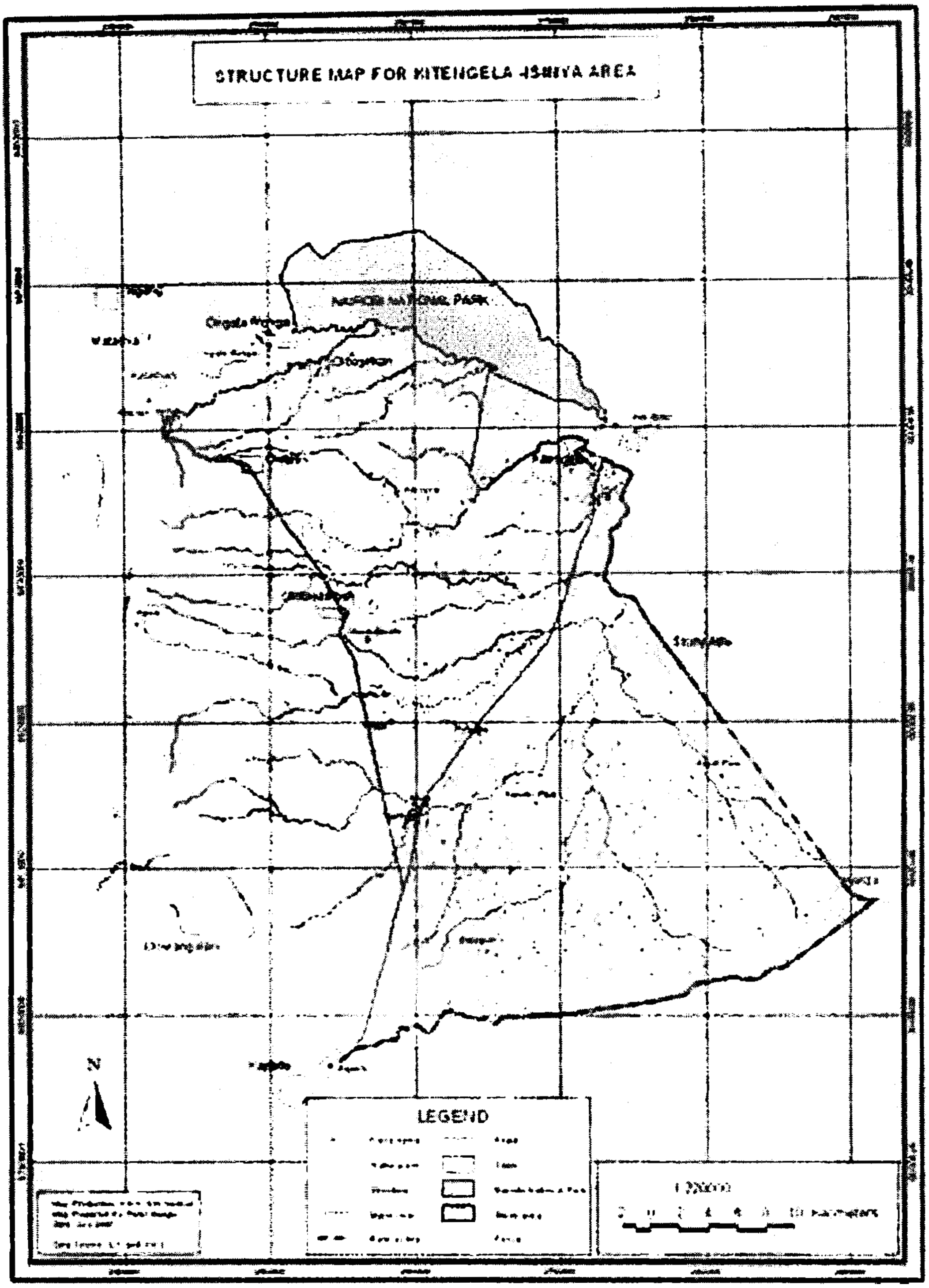


Figure 29: Map showing land fragmentation in the Kitengela-Kajiado area south of Nairobi NP

4 BIOLOGICAL MANAGEMENT

4.1 Background

The primary goal of biological management is to breed rhino as rapidly as possible in order to benefit from compounded growth rates and preserve genetic diversity in the long term. Rapid growth also enhances a population's ability to withstand limited poaching incidents. To achieve this, biological management must ensure maximum growth rates are attained through proper rhino stocking rates and minimisation of competition from other browsing species. Overstocking of parks or sanctuaries beyond maximum productivity carrying capacity and/or social (especially male) carrying capacity can impact negatively on rhino reproductive performance, and have major impacts on: (1) overall rhino numbers, (2) the potential to withstand poaching incidents, and / or (3) the habitat's ability to sustain sound, productive rhino populations in the long tem.

To contribute to achieving the metapopulation growth target of at least 5% per annum, in addition to effective security, specific capacity and procedural mechanisms are needed in:

1) field monitoring of rhino, data collection, analysis and reporting,
2) production of standardized annual status reports that assess the numbers, performance and population dynamics of rhino populations and estimated numbers of major competing large herbivores in order to aid biological-management decision making,
3) assessment of habitat conditions (including browser impacts and threats posed by alien plant infestations), and
4) updating estimates of rhino ecological carrying capacities in fenced sanctuaries.

The knowledge obtained allows for improved management of rhino and their habitats by adjusting rhino and where needed other browser population densities and fire regimes; and also to assist in development of new viable populations. Some Kenyan sanctuaries have in the past or are currently experiencing high densities of rhino and competing browsers, or very high or low fire frequencies given their rainfall, leading to reduced performance and negative habitat changes for rhinos. In certain cases there is a risk of the long-term productivity of the habitat being negatively affected.

Table 4 shows that Kenya, for the first time since the 1970s, achieved a net overall annual growth rate of >5% over the period 2003 and 2005. Many of the established sanctuaries are breeding well and some of them are being harvested. Thus the increased focus on biological management in the 2001-2005 seems to have had a positive impact. It is suspected that the free-ranging populations (Tsavo East NP and Masai Mara NR) have remained stable. However improved estimates of the Tsavo East NP population are required. There is strong evidence that the Aberdares NP-Salient population has declined significantly and needs urgent attention (see Section 3.4 for more detailed discussions). The Ngulia RS growth rate has been declining due to a high density of browsers impacting the vegetation. Improved dry season full-moon night census has been setup (2006). In order to give the habitat a chance to recover and increase ECC for rhinos, density reduction of the competing species in the sanctuary is now under way. 255 elephants have been translocated out with only two animals remaining inside. The sanctuary extension is now completed and some rhino will be translocated into this new area from 2007. An Intensive Protection Zone (IPZ) in the neighbouring valleys is also being planned with considerable potential for moving surplus rhino from the sanctuary on a regular basis (see Section 8.1 for more details).

Table 4: Rhino status in Kenyan rhino conservation areas (2000–2005). The figures represent confirmed and probable estimates. Where there has been, or is uncertainty over numbers this is indicated in the right hand column of the table.

Area	2000	2001	2002	2003	2004	2005	Status
STATE AREAS							
Aberdares NP (Northern)	3	0	0	0	0	0	Locally "extinct"
Aberdares NP (Salient)	43	34	31	18	22	18	Uncertainty in population estimates; strong evidence of declining population
Chyulu Hills NP	6	9	9	7	10	21	Monitoring improving; population recovering slowly
Meru NP	0	0	0	0	1	1	A population of 21 black rhinos was established in February 2006
Mt. Kenya NP	5	0	0	0	0	0	Locally "extinct"
Nairobi NP	59	64	70	75	78	74	Breeding well, being harvested
Lake Nakuru NP	58	60	63	69	59	69	Breeding well, being harvested
Ngulia RS	48	53	55	50	64	54	Uncertainty in past estimates; but recent improved night census (2006); evidence of declining growth (over the last few years) following excellent initial growth
Tsavo East NP	51	49	49	51	52	47	Difficult area to monitor on account of its size and there is uncertainty in these population estimates; new census techniques required for this extensive area
Tsavo West NP	0	0	0	0	0	0	
Subtotals	**273**	**269**	**277**	**270**	**286**	**284**	
PRIVATE AREAS							
Laikipia NC	9	7	7	7	7	13	Newly re-established, developing population
Lewa WC	29	30	33	37	41	45	Breeding well, will need harvesting soon
Mugie RS	0	0	0	0	21	21	Newly re-established developing population
Ol Jogi GR	16	18	20	22	25	25	Small, soundly breeding population
Ol Pejeta WC	28	32	36	37	39	45	Breeding well
Solio GR	53	52	49	49	45	72	Monitoring improved, breeding well, needs further removals
Subtotals	**135**	**139**	**145**	**152**	**178**	**221**	
COUNTY COUNCIL							
Mara Triangle	0	0	0	0	2	2	
Masai Mara NR	38	22	22	36	30	31	
Subtotals	38	22	22	36	32	33	
COMMUNITY							
Il Ngwesi Group Ranch	0	0	0	0	1	1	Indigenous population with static net increase (possibly through immigration), monitoring improving
TOTAL	**446**	**430**	**444**	**458**	**497**	**539**	

4.2 Metapopulation status reporting

National status reporting is a key component of implementing the conservation strategy. In the past metapopulation performance has been 'averaged out' at a metapopulation level, thus performance issues within individual populations may have been overlooked. To promote optimal metapopulation performance it is necessary to look at the age and sex composition, calving rates, causes and rates of rhino mortality, and habitat status and rhino body condition within each population as well as densities of potentially competing large herbivores. Reasons for suboptimal performance can then be better determined and solutions put in place to avoid demographic and genetic problems and maintain rapid growth rates.

A formal national-status reporting programme has been implemented. As part of the KWS-AfRSG-ZSL Darwin Initiative project, 28 officers from all the rhino reserves have been trained in population data analysis and preparation of annual park-status reports. KWS rhino scientists have also been trained to analyse population performance data and synthesis of the national status report. The training introduced the principles of status reporting, the concepts around metapopulation management and, in particular, the critical need to maintain rapid population growth rates (for demographic, strategic and genetic conservation reasons). Trainees were shown how to recognize the main causes of poor growth and how to interpret various performance indicators derived from their own ongoing ground-based monitoring of rhino. The practical application of these indicators was also highlighted, and trainees were shown how monitoring assists with the decision-making process on sanctuary management and translocations (Amin, Adcock *et al.* 2005).

The park-level status reports supply information on population size, age and sex structure, translocations and mortalities (including causes), as well as a number of standardised biological performance indicators (age at first calving, percentage female calving, proportion of adult females with calves, intervals between calving, mortality rates and net population growth rates) (Okita-Ouma & Wandera 2006). Future reports will contain indices of levels of competing browsers and every two years updated habitat assessment information will also be included.

The individual park reports are synthesized and analysed at a national level by KWS Rhino Programme. The resultant national report interprets and contrasts the status, performance and population dynamics of all black rhino populations in Kenya. The feedback from the national-status summary report is vital to programme managers and staff because it places the results of individual-reserve reports into a metapopulation context.

Without regular park-level status reporting and the production of interpreted national status report summaries, a problem may also remain undetected far longer. For example, the 2004 and 2005 status reports showed clear density dependence in a number of populations stocked at or near ECC. The reports indicated that a number of Kenyan rhino populations can and should become donor populations. In addition, the *c.* 5% underlying population growth in Nairobi NP following a period with an average 5% annual removal of rhino provided empirical support to the Set Percentage Harvesting approach advocated by the IUCN/SSC's AfRSG and SADC Rhino Management Group (Emslie 2001; Okita-Ouma 2004, Emslie & du Toit 2006).

The production of annual park and national status reports commenced in 2004 and management actions are now taken based on this information to optimally manage black rhino habitats and browser densities, and thus promote the increase of black rhino numbers. Examples include translocation of surplus rhino from Nairobi NP and Lake Nakuru NPs considering sex ratio and age structures to create new populations in Mugie RS and Meru NP, improved night census and removal of 255 elephants from Ngulia RS to reduce the browser impact on the vegetation, extension of the sanctuary and the creation of the IPZ in Tsavo West NP. In response to the declining Aberdares population, the park has been divided into management sectors. Baseline surveys are also being undertaken. The aim is to have very intensive management programme for the area and once this has been fully setup rhino numbers should be built up by initially translocating some animals into the area.

To achieve rapid growth of the national herd, the rhino and the habitats in which they live must be managed so that rhino breeding performances are maximised, death rates are minimised, and the rhino food resource base is not compromised. Monitoring and managing black rhino numbers and their major competitors at a level below the carrying capacity of the habitat is one important way of promoting productivity of the black rhino, and preventing density-dependent declines in breeding performances and increases in mortalities. Introductions of rhino into new areas can be planned at well below carrying capacity to minimise social stresses and losses during the settling-down period, and promote maximum opportunities for population growth.

It appears that black rhinos suffer density-dependent reductions in performance as do other large mammal species such as white rhino, moose, red deer, bovids and equids (e.g. Owen-Smith 1988, 1990; Clutton-Brock & Albon 1989; Freeland & Choquenot 1990; McCullough 1992). These density dependent effects in response to reduced quality of nutrition include delayed ages at first calving, delayed time to next conception after giving birth (longer inter-calving intervals), lowered calf and subadult survival, lowered survival of old animals, and increased fighting mortalities. These all contribute to an overall slowing or decline in population growth rates. Given the population dynamics of such large, long-lived animals, it has been estimated that rhinos have a ramp shaped production curve with a Maximum Sustained Yield [MSY: commonly called maximum productivity carrying capacity (MPCC)] at around 75% of ecological carrying capacity (Owen Smith 1988; McCullough 1992) (Figure 30). Densities therefore should not be allowed to increase to, or exceed, ecological carrying capacity (ECC) levels. Optimal stocking levels may be lower than 75% of ECC during drought years. Managing populations around 75% of ECC should minimize the risk of density-dependent effects negatively affecting populations. The situation in reality is likely to be further complicated by time lags caused by the time it takes young calves to grow up and exert their full impact on the habitat, while more calves are being born in the meantime. As a result, large long lived species like rhino numbers can potentially overshoot ECC before density dependent reductions in performance are detected. Thus it is preferable to be proactive and act early rather than wait until one has recorded density dependent reductions in performance before acting. By reducing densities of black rhino and/or other browsers to below habitat carrying capacity, there is also a reduced risk of negatively affecting the long-term rhino carrying capacities of the areas. Decisions on off-takes should also be guided by both the results of monitoring of population status and performance, as well as using improved estimates of ECC.

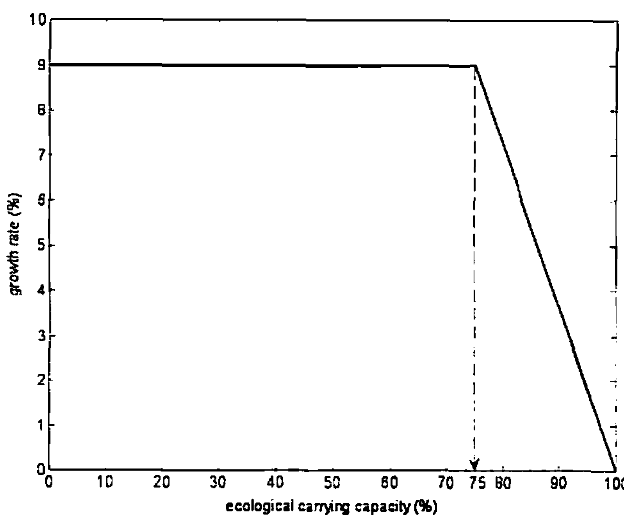


Figure 30: It is hypothesised that rhinos have a ramp shaped production curve and only start to show density dependent declines in performance above 75% of ecological carrying capacity. This threshold point is believed to represent the approximate highest density at which population productivity of K-selected species like rhino is unaffected by density-dependent feedback. Productivity curves for large mammals are skewed towards carrying capacity, and are not near ? of carrying capacity as with smaller mammals. This is owing to their typically high adult survivorship, long gestation periods and relatively old ages at first calving, which limit the range over which life-history parameters can change in response to changing density or food supply (see McCullough 1992 for a summary large-herbivore population dynamics).

4.4 Estimating ECC of sanctuaries

It is easy to conceptualise that a habitat at a given point in time must be able to sustainably support a limited number of any given herbivore species. This ECC is probably most closely defined as 'the maximum number of animals of a species (sustainably) supportable by the resources of a specified area' (Caughley 1976; McCullough 1992). Ecological carrying capacity or zero growth density estimates (averaged for a period of a few years rather than a month to month basis) are useful practical tool to guide determination of desirable stocking levels for rhino areas. It is not easy to measure/estimate ECC, and in reality it will continually fluctuate in response to climate, and vegetation changes. Never the less estimates of ECC (relevant to a period of a few years) provide a useful guide for management decision-making. Past estimates of black rhino ECC have differed widely in the reports of different observers for the same area. At times this has been due to major changes in ECC in response to habitat changes over time. However, experience throughout Africa has also shown that non rhino habitat-experts tend to substantially over-estimate ECC.

Adcock, Amin *et al.* (2007 in prep.) also show how total browser carrying capacity and competing browser densities need to be accounted for, as the resources available to black rhino are shared with a significant guild of browsers and mixed feeders.

The estimation of black rhino ECC is multi-faceted. For a given amount of standing 'browse-plant biomass' the browse productivity (growth rate) and quality are primary determinants of black rhino carrying capacity. Rainfall, soil quality and temperature influence these parameters on a broad scale and measures of these factors are also required (Adcock, Amin *et al.* 2007, Adcock, Amin *et al.* in prep.) (Figure 31).

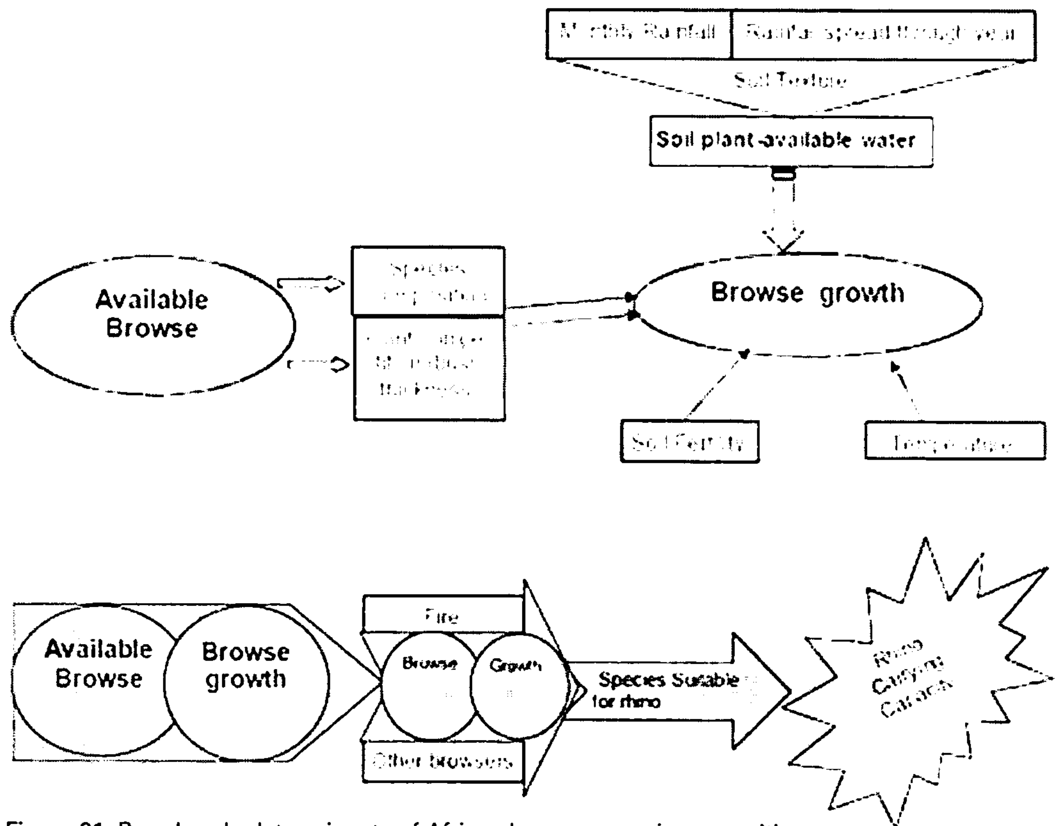


Figure 31: Broad-scale determinants of African browser carrying capacities.

At a broad level, black rhino carrying capacity is determined by: (a) the amount of browse (woody plants and dicotyledonous herbs) available in the area; (b) the amount of annual growth in this available browse. Browse growth depends on its species composition, competition between plants in thick bush areas, the amount of soil water available to the plants, the fertility of the soil and temperature conditions for nitrogen mineralization and plant growth. Water availability is determined by rainfall patterns and soil texture. The component of available browse + growth suitable for black rhino determines actual carrying capacity. Available browse can be impacted by competing browser species and fire. (Adcock, Amin *et al.* 2007, Adcock, Amin *et al.* in prep.)

All nine well-established Kenyan rhino sanctuaries/reserves have been surveyed for browse availability and species composition (details are available in Adcock, Amin *et al.* 2007 and Adcock, Amin *et al.* in prep). About 100–150 detailed vegetation plots were assessed in each conservation area. Rhino feeding data was also compiled from observations made at each site. These plots sampled all the major vegetation types in each area, and catalogued amounts and composition of black rhino browse (Figure 32). This information was combined with vegetation maps and Landsat-7 satellite imagery data to give overall browse-availability and browse suitability index maps for each vegetation type in each area (Figure 33a,b,c,d).

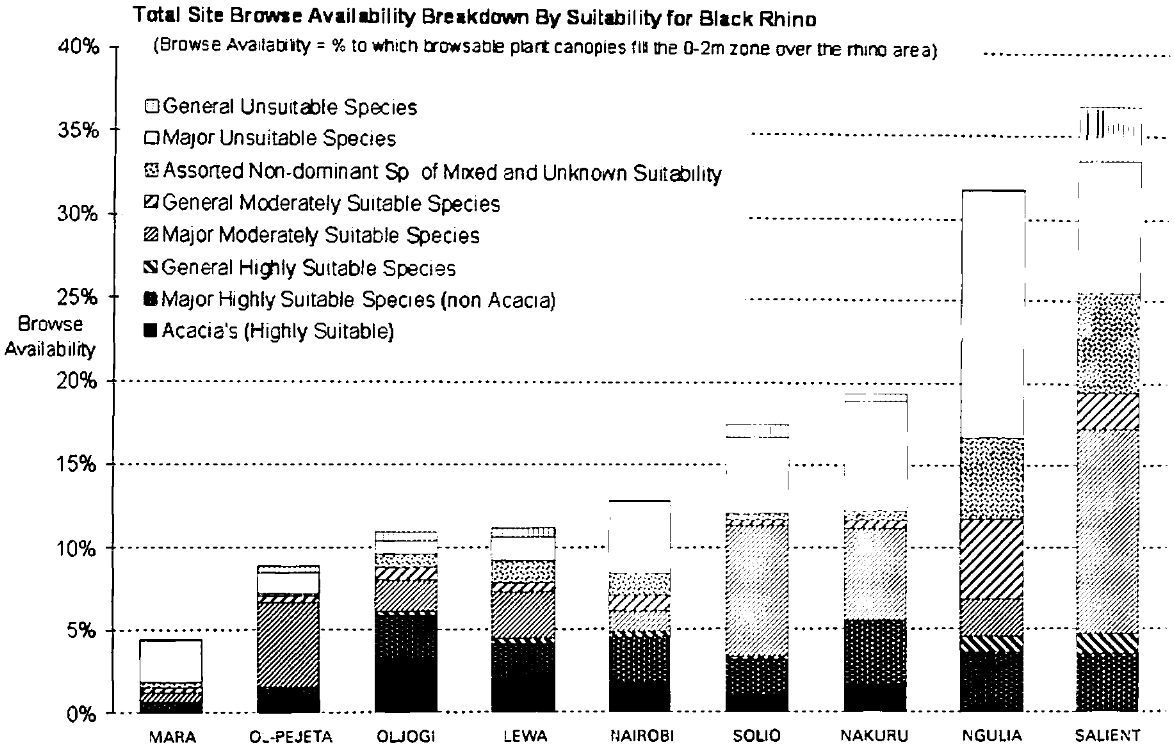


Figure 32: Amounts of available browse in each of the nine main Kenyan black rhino areas and the compositional breakdown of this browse by suitability class (i.e. the suitability of the browse component for black rhino). Each class comprises several woody or forb species. Almost all of black rhino browsing occurs within a 0–2 m height range and the browse availability (BA) measure indicates the percentage to which this 2 meter layer is filled by browsable plant canopies. BA was sampled by vegetation type and a weighted average BA was obtained accounting for the proportional area of each vegetation type within each rhino sanctuary. The Aberdares NP-Salient and Masai Mara NR have the most and least browse respectively, but most of their browse is not suitable rhino food. Ol Jogi GR and Lewa WC have the most favourable browse by proportional composition (see Adcock, Amin *et al.* 2007 for details).

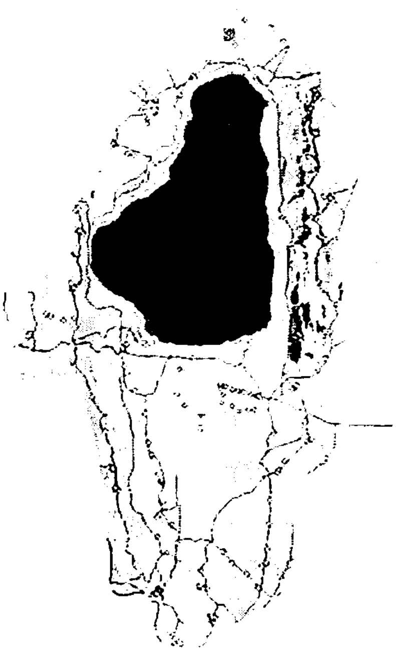


Figure 33a: Landsat image of Lake Nakuru NP showing location of browse assessment plots, drainage lines and general roads.
(Adcock, Amin *et al.* 2007)

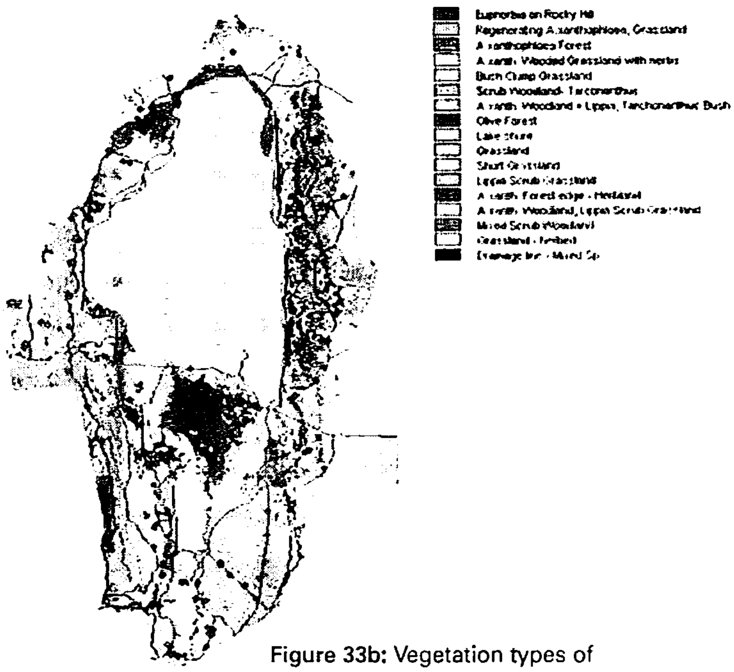


Figure 33b: Vegetation types of Lake Nakuru NP.
(Adcock, Amin *et al.* 2007)

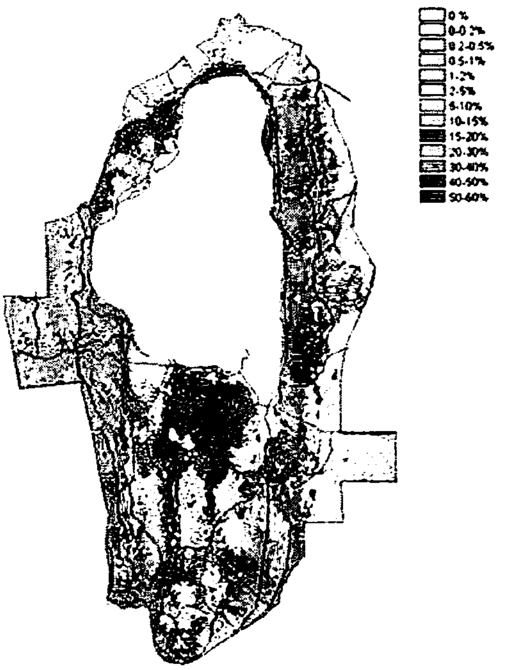


Figure 33c: Total browse availabilities (total BA) for the vegetation types of Lake Nakuru NP.
(Adcock, Amin *et al.* 2007)

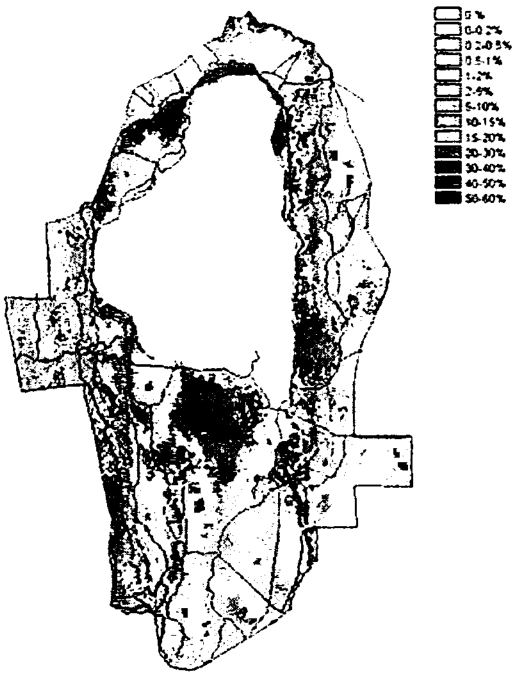


Figure 33d: Browse availability of high and medium suitability species (suitable BA) in the vegetation of Lake Nakuru NP.
(Adcock, Amin *et al.* 2007)

The suitability of many rarer species and even some dominant ones is not properly known, due to lack of comprehensive diet studies in many of the Kenyan areas. The suitability classification used was based on available east African diet surveys as well as observation of feeding intensities relative to species abundance made during the Darwin Initiative habitat surveys. The following summarises results from Adcock, Amin *et al.* 2007.

<u>Highly suitable *Acacia's*</u>
These make up around 30% of total browse in Ol Jogi GR, 14-19% of browse in Ol Pejeta WC, Lewa WC and Nairobi NP, and 6-8% in Masai Mara NR, Lake Nakuru NP and Solio GR. Ngulia RS and Aberdares NP-Salient have little or no *Acacias. Acacia* species diversity is highest in Ol Jogi GR and is also good in the Masai Mara NR, Lewa WC and Nairobi NP.

<u>Other highly suitable browse species</u>
Other highly suitable species also make up a high percentage of Ol Jogi GR's available browse, dominated by *Lycium* and *Grewia*. In Lewa WC, the leguminous herbs/woody herbs and the woody herbs of the *Achyranthes* genus make up much of the highly suitable browse. Lake Nakuru NP also has much *Achyranthes* with *Justicia* and *Tinnea aethiopica* making up most of the good browse. In Nairobi NP, *Phyllanthus, Grewia* and *Achyranthes* dominate the highly suitable browse. *Grewia, Lantana* (indigenous) and *Tinnea aethiopica* dominate other good browse in Solio GR; while *Grewia* and *Lantana* do in Ngulia RS and *Phyllanthus* does so in Ol Pejeta WC. In Masai Mara NR, *Grewia, Phyllanthus* and *Tinnea aethiopica* dominate other good browse.

<u>Main moderately suitable browse in each area</u>
Euclea divinorum is a common and often dominant feature of medium-suitability species in Masai Mara NR, Ol Pejeta WC, Ol Jogi GR, Lewa WC and Solio GR, but is uncommon or absent in Nairobi NP, Ngulia RS and the Aberdares NP-Salient. It is not a suitable browse species in southern Africa where it is highly rejected. The main species making up moderately suitable browse in each area are as follows: *Euclea divinorum, Rhus natalensis* and *Erythrococca bongensis* in the Masai Mara NR; *Euclea divinorum, Rhus natalensis and Scutia myrtina* in Ol Pejeta WC and Solio GR; *Euclea divinorum, Rhus natalensis, Scutia myrtina* and *Hibiscus* in Ol Jogi GR; *Euclea divinorum, Rhus natalensis, Scutia myrtina, Maytenus; Abutilons/ Maytenus Pavonias* and *Hibiscus* in Lewa WC; *Rhus natalensis, Scutia myrtina* and *Hibiscus* in Nairobi NP; *Rhus natalensis., Erythrococca bongensis, Abutilon/Pavonia, Solanum and Maytenus* in Lake Nakuru NP; *Abutilon/Pavonia and Hypoestes* in Ngulia RS; and *Solanum, Abutilon/Pavonia* and *Hypoestes* in the Aberdares NP-Salient.

<u>Main unsuitable browse in each area</u>
In Masai Mara NR, the unsuitable *Croton dichogomas, Lippia javanica* and *Teclea* make up around 45% of all browse, while the poor browse *Premna resinosa* and *Bauhinia taitensis* make up around 45% of all browse in Ngulia RS. The unsuitable *Toddalia asiatica* and bamboo make up over 10% of browse in the Aberdares NP-Salient. *Croton, Aspilia mossambicensis* and *Lippia javanica* dominate unsuitable browse in Nairobi NP. In other areas, main unsuitable species are as follows: *Tarconathus, Teclea, Ocimum* in Lake Nakuru NP; *Rhamnus staddo, Psiadia punctulata* and *Carissa edulis* in Solio GR and Ol Pejeta WC; *Lippia javanica, Psiadia punctulata* and *Ocimum* in Lewa WC; and *Lippia javanica* in Ol Jogi GR.

Auxiliary data on variables linked to black rhino ECC were also compiled for the areas (long-term rainfall, soil and geology data, temperature and fire records) (Figure 34 and Figure 35). Indices of the effects of these parameters were determined and applied to model Browse Growth. The levels of competing browser biomass feeding in the 0-2m rhino layer were also determined (Figure 36). Older estimates of the black rhino CC (Brett 1989 and Anon. 1993) based on the opinion of rhino experts familiar with the areas were adjusted by undertaking a more detailed review of actual population performances in the rhino areas since 1993. This was coupled with additional ecological insights accrued since then based on field rhino feeding surveys, estimated average home range sizes (Figure 37) which have been found to be correlated with (and hence an index of) carrying capacity (Adcock 2001), and other research (Okita-Ouma 2004, Birkett 2002, KWS rhino programme population estimates and black rhino performance data).

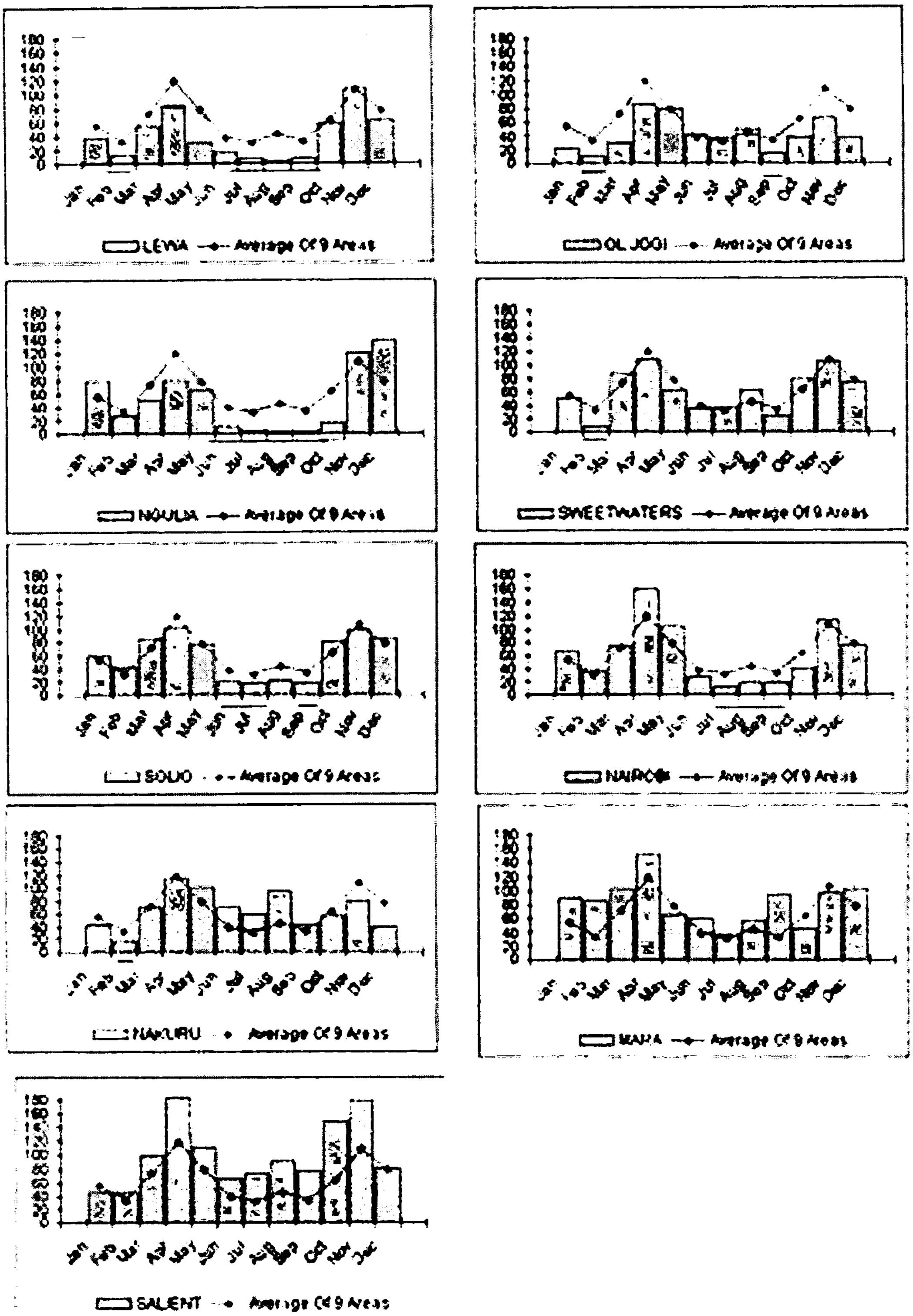
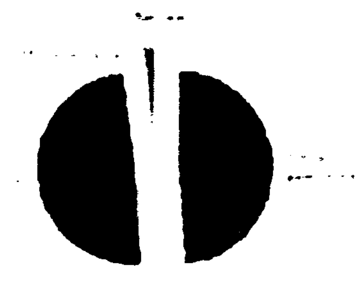
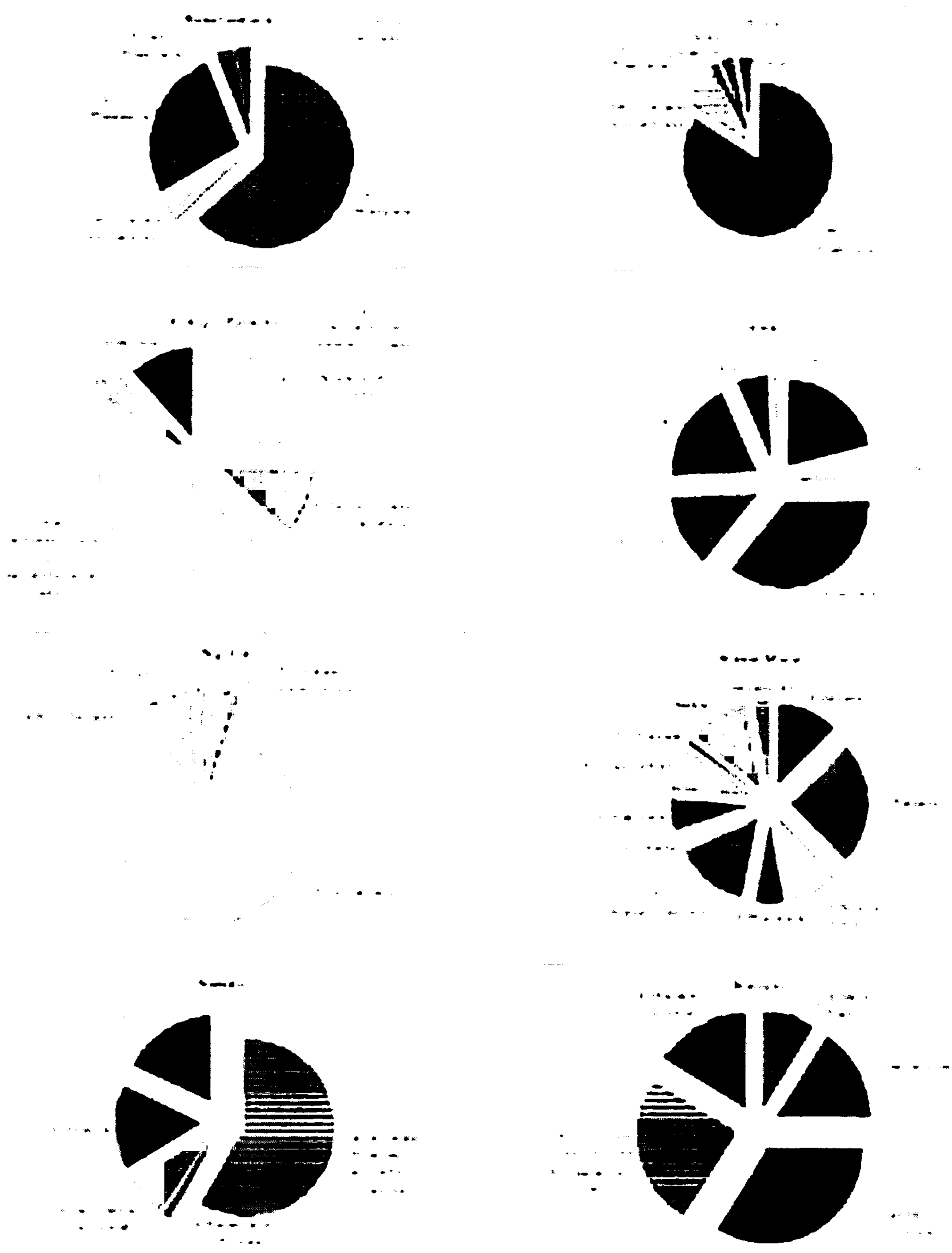


Figure 34: Monthly rainfall patterns in the nine rhino areas. Months with less than 20 mm average rainfall (where little or no plant growth will occur) are underlined. The average rainfall pattern of all nine areas is shown on each graph for comparison. Among dry areas, Lewa WC and Ngulia RS have the longest runs of dry months (<20 mm), while Ol Jogi GR has a surprisingly even spread of rainfall. Among high rainfall areas, Aberdares NP-Salient and Masai Mara NR GR have no very dry months, and Lake Nakuru NP only has one (Adcock, Amin *et al.* 2007).

Figure 35: Pie charts showing the proportion of each rhino area made up of different substrate types. The number before each substrate name is the fertility score (index) of that type. The fertility scale ranges from 1 (lowest fertility and lightest shading) to 9 (highest fertility and darkest shading). The darker the pie the higher the overall substrate fertility of the rhino area. Soil depth is not accounted for. In general, the "darker" soils have higher clay contents, while "light" soils have high sand contents. The soil texture affects plant available water (Adcock, Amin *et al.* 2007).





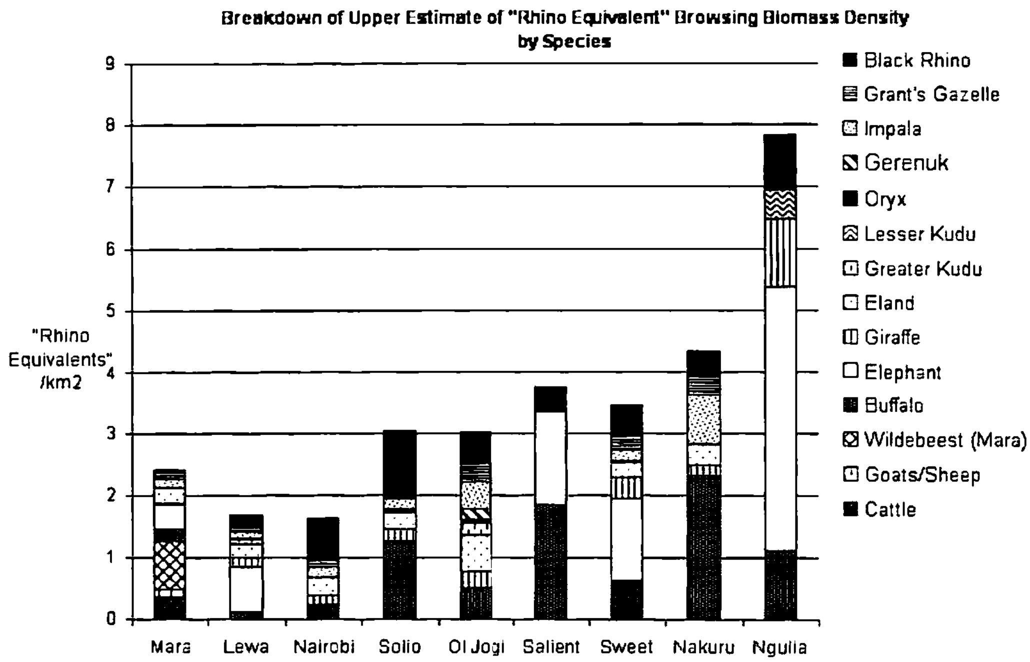


Figure 36: Breakdown of estimated browsing herbivore biomass in potential competition with black rhino in nine sanctuaries/reserves (end of 2005). Data exclude bushbuck and very small antelope due to lack of population estimates. Ngulia RS with its large overall BA has the greatest browsing biomass, owing to elephant and giraffe, while the Aberdares NP-Salient (which has even higher browse availability and much higher rainfall) has an intermediate browser biomass. Lake Nakuru NP biomass is high, probably owing to the high groundwater levels promoting browse supply. Ol Jogi GR browsing biomass is notably high given its low rainfall and poor soils. Masai Masai NR browsing biomass is the lowest of the nine areas but these levels are high given that this area also has the least available browse. (Adcock, Amin *et al.* 2007). Elephants are absent in Ol Jogi GR (except for 3 tame elephants), Lake Nakuru and Nairobi NPs, but comprised a major component of total rhino equivalents in other areas. Buffalo also feature as a major component in several areas, especially at Lake Nakuru NP. These animals feed a lot on herbs and also take woody browse in the dry season. In large numbers they therefore can compete with black rhino. In the Masai Mara NR, the trampling effects of Wildebeest, along with the impacts of small browse intakes by cattle and sheep/goats, constitute a significant level of browse impact on the vegetation (Dublin 2005). The browser CC model can be found in Adcock, Amin *et al.* (in prep.). Black rhino themselves only comprise significant proportions of the total browsing biomass in Solio GR and Nairobi NP.

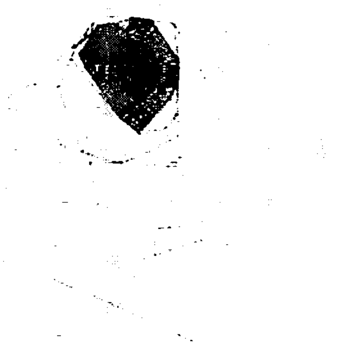


Figure 37a: Example showing Minimum Convex Polygon (95%, 90%, 80%, 75%, 50%) home ranges (Amin *et al.* 2006).
Estimates of home range are useful as they have been shown to be correlated with estimates of ECC (Amin, Adcock *et al.* 2006)

Figure 37b: Example showing Kernel (95% - 50% in steps of 5%) home ranges (Amin *et al.* 2006). Estimates of home range are useful as they have been shown to be correlated with estimates of ECC (Amin, Adcock *et al.* 2006)

Black rhino ECC was modelled using combined Kenyan and southern Africa data (existing data from Southern Africa were processed in the same way), as there were too few Kenyan sites to statistically develop a local model. The model independent variables were Suitable Browse Availability and Suitable Browse Availability Growth accounting for Soil Fertility, Temperature and Fire, with the initial (adjusted) CC estimates forming the dependent variable (all variables on log scale). The ECC estimation model is highly significant ($p<0.000001$) and has an adjusted r^2 of 0.896 (Table 5). Figure 38 shows the model graphically.

The resulting initial model estimates of black rhino carrying capacity density and number for the nine Kenyan areas is given in Table 6. Note that despite the strong relationship between expert estimated and modelled ECC, it should be remembered that a) these estimates do not account for densities of competing browsers, and b) these are ballpark figure with wide confidence intervals.

Table 5: Summary of regression statistics for the black rhino carrying capacity model (from Adcock, Amin *et al.* in prep.).

Multiple R	0.951					
R Square	0.905					
Adjusted R Square	**0.896**					
Standard Error	0.308					
Observations	24					
Analysis of Variance:	**Degrees of freedom**	**Sum of Squares**	**Mean Square**	**F-Value**	**Significance of F-Value**	
Regression	2	19.029	9.515	100.14	1.82539E-11	
Residual	21	1.995	0.0950			
Total	23	21.025				
	Coefficients	**Standard Error**	**t Statistic**	**P-value**	**Lower 95.00**	**Upper 95.00**
Intercept	1.553	0.233	6.680	0.0000008	1.070	2.037
Suitable BA	0.690	0.116	5.944	0.0000046	0.449	0.932
Suitable BAGrowth inc. fertility, temperature, fire	0.427	0.071	5.990	0.0000042	0.279	0.575

Table 6: Model predicted carrying capacity density ranges (rhino per km^2) for nine Kenyan black rhino areas, from Adcock, Amin *et al.* (2007)

	Model Predicted CC Density (Rhino per km^2)				**Model Predicted CC Number (Rhino)**		
	Lower 95% CI	**Mean**	**Upper 95% CI**	**AREA (km^2)**	**Lower 95% CI**	**Mean**	**Upper 95% CI**
Masai Mara NR	0.048	**0.069**	0.097	1526.3	73	**105**	148
Lake Nakuru NP	0.427	**0.514**	0.618	149.3	64	**77**	92
Ol Pejeta WC	0.254	**0.307**	0.371	87.2	22	**27**	32
Ol Jogi GR	0.261	**0.299**	0.342	46.7	12	**14**	16
Lewa WC	0.245	**0.28**	0.321	250.4	61	**70**	80
Aberdares NP-Salient	0.781	**1.002**	1.285	126.6	99	**127**	163
Nairobi NP	0.286	**0.339**	0.402	116.9	33	**40**	47
Solio GR	0.411	**0.491**	0.587	69.4	29	**34**	41
Ngulia RS	0.338	**0.405**	0.485	62.2	21	**25**	30

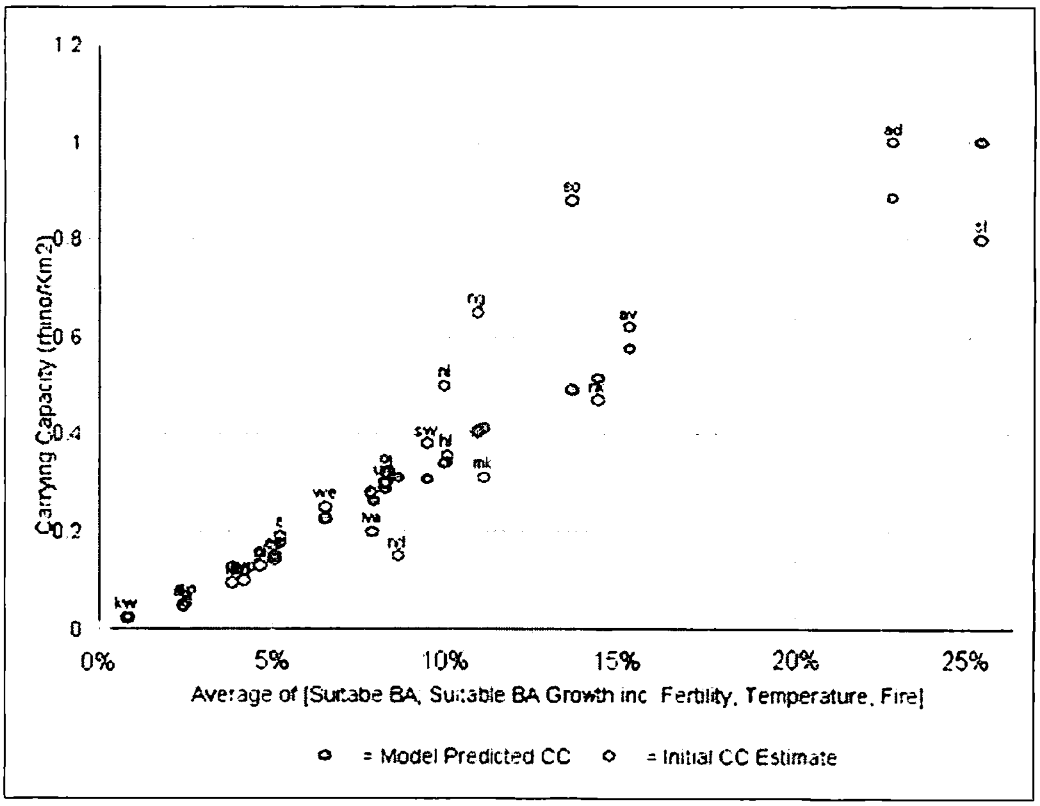


Figure 38: "Prior" and model-predicted black rhino carrying capacity density estimates (rhino per km^2) versus the average of (Suitable BA and Suitable BA Growth including fertility, temperature, fire). The actual regression model is very similar to a straight average of the two independent variables (Suitable BA and Suitable BA Growth including fertility, temperature, fire), and presenting the "prior" carrying capacity estimates and model predicted estimates against this average shows the carrying capacity relationships in an easily understandable and convenient way. The X-axis represents the average percentage of suitable [(browse & its growth index)/2] filling the 0–2 m volume over a reserve.

Lewa WC = lw; Masai Mara NR = ma; Nairobi NP = ni; Lake Nakuru NP = nk; Ngulia RS = ng; Solio GR = so; Ol Jogi GR = oj; Aberdares NP-Salient = sl; Ol Pejeta WC = sw

A total browser ECC model was also developed to assess the likely impacts of browser competition on black rhino (Figure 39). The model predicts the theoretically sustainable level of total browsing biomass (as Rhino Equivalents) taking food from the 0-2m rhino browse layer. Given the levels of browse availability and rainfall, soil, temperature and fire conditions in each areas, the model suggests that Masai Mara NR, Ol Pejeta WC, Ol Jogi GR, Lewa WC and Ngulia RS had browser biomass densities exceeding the likely CC for the rhino feeding layer. Lake Nakuru NP, Nairobi NP and Solio GR are near (or just below) browser CC, while Aberdares NP-Salient is theoretically well below CC.

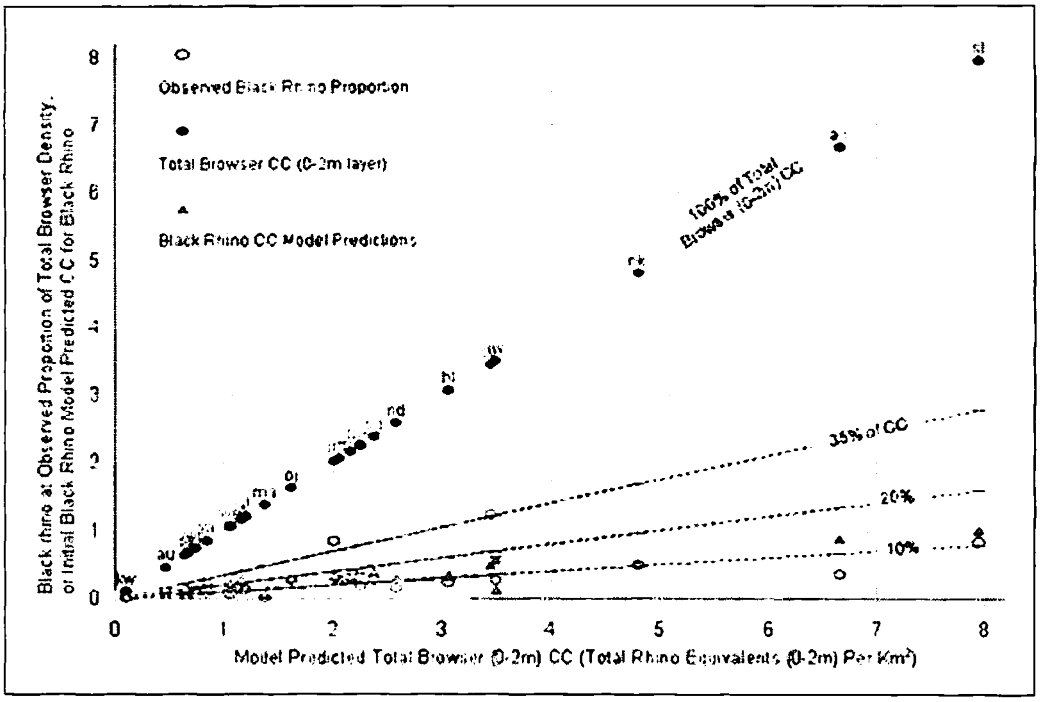


Figure 39: Model of total browser CC (from Adcock, Amin *e. al.* in prep.). The dark lines show 35%, 20%, and 10% of total browser CC. Black rhino are observed to form 10-15% of the total browser biomass feeding in the 0-2m layer across a range of rhino areas (mean 13% median 10.7%). The initial black rhino, which does not account for competing browser densities, appears to predict rhino as forming +-13% of total browser biomass on average, while also accounting for actual availabilities and growth of browse suitable for black rhino specifically. Areas like Solio GR and Nairobi NP where rhino exceed predicted rhino CC, have low densities of competing browsers and total browser densities not in excess of total browser CC. Black rhino form over 35% of total browser biomass in such areas.

The initial black rhino CC model (Figure 38) does not account directly for other browsers, but though it does account for actual availabilities of suitable rhino browse. Modeling indicated that on average black rhino make up around 13% of total browser CC. However, based on two cases in this study, there are certain circumstances where black rhino can comprise at least 30-35% of total browser biomass for their feeding layer (see Table 7). These are thought to be cases where browse conditions are good for black rhino, but where removal pressure on other browsers, or historical or habitat circumstances, have led to much lower densities of competing browsers than in most other African areas (relative to their rainfall, soil and browse availability characteristics). The implications of this are that black rhino can suffer a certain degree of competition from other browsers, and that net resource overlap with black rhino is generally in the order of +- 20% (the difference between c. 33% potential proportion black rhino can comprise of total browser CC, and the average observed proportion of c.13% generally made up by black rhino).

Table 7: The observed proportion that black rhino make up of total browser biomass density, and initial Black Rhino Carrying Capacity Model-predicted CC for black rhino of each Kenyan area. Also shown are the predicted rhino densities that could result if this species achieved 10, 15 and 35% of total estimated browser CC in each area, along with the observed recent upper black rhino density (up to 2005), and the degree to which recent total browser stocking densities exceeded estimated total browser carrying capacity.

	Observed Black Rhino Density as % of Observed Total Rhino Equivalent biomass	Black Rhino density if they were 35% of Browser CC	Black Rhino density if they were 15% of Browser CC	Black Rhino density if they were 10% of Browser CC	Black Rhino Model Predicted Rhino CC density	Observed Recent Upper Black Rhino /km²	Browsers Exceed Total Browser CC by (x times)
Masai Mara NR	0.9%	0.481	0.206	0.137	0.069	0.023	1.81
Lake Nakuru NP	10.2%	1.682	0.721	0.481	0.514	0.449	0.93
Ol Pejeta WC	14.0%	0.754	0.323	0.216	0.307	0.481	1.60
Ol Jogi GR	16.6%	0.566	0.243	0.162	0.230	0.501	1.89
Lewa WC	10.2%	0.407	0.174	0.116	0.280	0.169	1.44
Aberdares NP-Sallent	10.5%	2.781	1.192	0.794	1.002	0.395	0.48
Nairobi NP	41.8%	0.705	0.302	0.201	0.339	0.684	0.82
Solio GR	35.7%	1.204	0.516	0.344	0.491	1.081	0.90
Ngulia RS	11.3%	0.830	0.358	0.237	0.405	0.854	3.25

Monitoring the habitat resources as well as rhino-population performance is useful in the light of changing vegetation in African ecosystems and the influences of competing browsers. Significant changes in browse abundance and species suitability can occur over 5-20 year periods, with large impacts on black rhino CC. Fencing of areas can also result in an excessive build-up of competing herbivores if numbers are not actively managed (such as the elephant build up in Ngulia RS). Also, large long-lived animals like rhino, if unmanaged in fenced areas, usually overshoot carrying capacity for several years before feedback from the habitat condition affects population performance. This causes a potential problem in that there can be a lag before population performance indicators start to indicate density dependent performance declines. Habitat monitoring procedures have been developed to help provide an additional early warning, and park ecologists and monitoring staff trained in their use (see Section 3.6.1).

Adcock, Amin *et al.* (2007) have shown that the actual browse availability and plant species composition (suitability), along with competing browsers, are integral in determining potential black rhino density within a given rhino area at a given rainfall and nutrient status.

Some areas have lower proportions of suitable browse present in their habitats than historical records show, or than expected from their nutrient status. The browsing pressure histories of the areas are hypothesized to have been one of the causes of this reduction in palatable browse, along with soil erosion and fire in some cases. For example, Masai Mara NR used to have greater relative abundances of *Acacia*s and other more palatable species (e.g. *Grewia*'s) compared to recent conditions (Mukinya 1977, Walpole 2002, Walpole *et al.* 2004). Solio GR also once had large stands of the highly palatable *Acacia drepanolobium,* which were greatly reduced primarily by high black rhino numbers developing several years after the reserve's inception (Brett 2001). Ngulia RS had declining levels of palatable species and increasing relative levels of less palatable *Premna* from primarily elephant impact (Brett and Adcock 2002). Ol Pejeta WC has been shown by Birkett 2002 to have declining stand of *Acacia drepanolobium* due to browser pressure. Browsers are certainly known to cause declines in and suppression of young *Acacia* woodlands (Prince and Van der Jeugd 1993, Belsky 1990, Augustine and McNaughton 2004). Several of the Kenyan sites also show signs of reductions in other palatable species, especially *Grewia,* which are reduced to dwarf status in many areas (Amin, Adcock *et al.* 2006).

In some Kenyan areas, fire also impacts browse species: Okello (in prep.) showed that densities of *Grewia* sp., *Cadaba farinosa, Rhus natalensis,* and *Lycium europaeum* were reduced by between 50% and 100% after a fire. None of these species showed signs of coppicing after being burned, and all *Grewia* sp., *Cadaba farinosa, Rhus natalensis,* and *Lycium europium* died months after the fire, despite the fact that fire did not entirely consume them during the burn. The use of fire in certain of Kenya's protected areas may have become more common in the last decade through influences from southern Africa. However, there needs to be caution in its use as several east African species of importance to browsers may not be well adapted to southern African fire regimes. The consequences of burning for black rhino need to be carefully evaluated, and fire regimes need to be carefully adapted to account for browser needs in these areas.

In some Kenyan areas *Tarconanthus camphoratus* has increased. The exact role of grazing and browsing pressure in promoting these invasions is not known. However this species may suppress and out-compete more palatable species, few of which grow beneath this species' canopies.

The Initial black rhino CC and browser CC models should be refined on an ongoing basis using rhino performance data and improved plant species suitability, habitat, vegetation and competing browser information. This process should also continue as a research activity into the overall conceptual understanding of black rhino ecology, feeding back those insights relevant to management. A summary of habitat and browser density condition in the nine Kenyan study areas (2005) is given below (from Adcock, Amin *et al.* 2007)

Masai Mara NR
Total browser biomass exceeds browser CC in this area, with elephant and wildebeest impacts contributing the most to "browse" pressure. Frequent fires are also cumulatively impacting browse and preventing recovery. Never-the-less, good browse resources for black rhino exist, mainly in and around the eastern hills of Mara, but it seems as if disturbance from Masai livestock prevent black rhino from colonizing all this area permanently. More generally, Mara's high rainfall and good soils have the potential to produce ample browse for rhino, and numbers should certainly be perhaps double those observed. The black rhino however require large range sizes to find browse in the exposed Mara plains. It is hypothesised that the general high disturbance and browse impact environment in the Mara, from herders and livestock, elephants, wildebeest, fires, and possibly tourism and low levels of poaching, are cumulatively contributing to reduced rhino performance and increased emigration of rhino from the area.

Lake Nakuru NP
Total browser biomass is near total browser CC in this area, which has very good levels of suitable available browse for black rhino along with good rainfall and ground water supply, providing green resources almost year-round. Black rhino densities should be able to increase to ~0.7 rhino per km^2, but buffalo primarily, with other browsing species, are also competing with rhino and may limit rhino population performance and increase, if not controlled.

Ol Pejeta WC
Total browser biomass exceeds browser CC in this area, with black rhino themselves, elephant, buffalo and giraffe contributing much to browser impacts. Unless competitors and to a lesser extent the black rhino numbers are controlled, it is hypothesised that rhino population performance will decline. Browse resources at Ol Pejeta WC were showing high levels of impact by black rhino and other browsers.

Ol Jogi GR
Total browser biomass exceeds browser CC in this area, with black rhino themselves, and giraffe contributing much to browser impacts. Ol Jogi GR had high levels of favourable browse availability for browsers, which has contributed to rapid population increases to exceed CC. However, most suitable browse resources at Ol Jogi GR are showing high levels of impact by black rhino and other browsers. Unless competitors and especially the black rhino themselves are controlled, it is hypothesised that rhino population performance will decline and long term habitat CC will be compromised.

Lewa WC
Elephant densities are resulting in total browser biomass exceeding browser CC in Lewa WC. This area has modest overall availabilities of highly favourable black rhino browse, and has potential for rhino densities to increase to > 0.2 rhino per km^2. Factors which could limit this potential are: a) female rhino (with calves) especially seem reluctant to use Ngare Ndare forest, possibly due to disturbance from humans or perhaps predator or even buffalo. This is an area with much available browse although of only moderate suitability. b) The Lerai forests have large amounts of highly suitable browse for black rhino, but human disturbance again may limit black rhino use of these areas, c) Fire can be useful in maintaining grassland vigour, but needs to be applied with great caution so as not to lead to declines in available browse for black rhino. The well-bushed valley slopes and riverine habitats (besides those already mentioned) are very important for the rhino . Close monitoring of burns need to be ongoing to learn the best approach to fire management.

Aberdares NP-Salient
Herbivore and rhino population estimates for this area are not accurate, but even so they suggest that total browser densities are way below levels expected given rainfall, soils and abundant browse resources. When combined with predation and poaching pressure in the Salient, the low nutritional quality of browse is hypothesised to be limiting to browser reproductive output in the Salient. This low output help may explain the worrying black rhino situation prevailing in the Salient.

Nairobi NP
This area has black rhino making up c. 42% of the total browser biomass, which is itself near/just below the estimated total browser CC of the area. The relative low densities of competing browsers (for reasons unknown), along with the good levels of suitable standing browse resources including good riverine bushland, riperian forest, and upland forest habitats, may have allowed black rhino to reach the high densities observed. The black rhino themselves could be near or slightly over their own maximum potential CC, as suitable food resources at Nairobi NP are showing signs of fairly heavy rhino browsing pressure. Disturbance effects on rhino of invading cattle in the riperian areas are a problem, as this is a key habitat for the black rhino.

Solio GR
This area has black rhino making up c.36% of the total browser biomass, which is itself close to the estimated total browser CC of the area. The relative low densities of competing browsers (for reasons unknown), along with the good levels of standing browse resources including good riverine and wetland habitat, may have allowed black rhino to reach the high densities observed. The black rhino themselves could be near or slightly over their own maximum potential CC, given that suitable food resources at Solio GR are showing signs of fairly heavy rhino browsing pressure. Buffalo may compete with the rhino for understory woody herbs in the riparian areas

Ngulia RS

Total browser biomass greatly exceeded browser CC. Rhino and elephant numbers built up simultaneously from the early '90's. The very large standing browse resource levels acted as a buffer to slow impacts on rhino, allowing them to reach probable high densities (although good estimates of actual black rhino numbers were not available in 2005). However, cumulative browser impacts began to reduce CC in the rhino feeding layer, especially once elephants had removed most of the vegetation lying above 2m. The black rhino population growth rate declined in recent years (Ouma-Okita 2004) as a result. The sandy soil texture of Ngulia RS results in plants with deep rooting and good underground resources, allowing probable rapid re-growth once browse pressure is decreased (with elephant removals). However, the heavy pressure to date has severely impacted the most favourable species (eg. *Grewia*s) which may take many years to recover.

To date, management has sought to manage Kenyan rhino areas at around their MPCC levels. The estimates of ECC have allowed managers to take 75% of this figure as a ballpark estimate of the MPCC level. Excess animals are then removed to maintain densities near the estimated threshold MSY level, thus maximising rhino productivity. Lake Nakuru NP, Nairobi NP, Ngulia RS, Ol Jogi GR and Solio GR have rhino in excess of their estimated MPCC. These sanctuaries and other developing ones (Ol Pejeta WC, Mugie RS, Lewa WC) will need animals to be translocated on a regular basis to maintain their populations at or below MPCC.

Table 8 below shows rhino numbers and the initial KWS estimates of carrying capacity numbers in Kenyan sanctuaries, illustrating how removal decisions need to be made.

Table 8: Rhino numbers, initial KWS estimated carrying capacities and surplus rhino in established Kenyan sanctuaries (2006), illustrating how removal decisions need to be made. (The CC findings of the Darwin project have not yet been incorporated into the Kenyan rhino strategy).

Reserve	Area (km^2)	ECC	MPCC	2006 Rhino Numbers	Surplus Rhinos	Comments
Aberdares NP (Salient)	126.8	104	78	10	-68	Further introductions can only be undertaken after understanding and especially addressing factors leading to population decline.
Lake Nakuru NP	149.3	68	51	61	10	Removals will be required soon.
Lewa WC	250.4	83	62	53	9	Growing population - removals will be required once management level is reached.
Nairobi NP	116.9	67	50	64	14	Removals will be required soon.
Ngulia RS	62.2	53	40	64	24	Most elephant now removed and Sanctuary being expanded, 10 rhinos to also be moved into IPZ being created in nearby Rhino valley.
Ol Jogi GR	46.7	19	14	22	8	The reserve has now been expanded to ~200 km^2 with a greater ECC (to be determined) - three rhinos are to moved into the expanded area in July 2007.
Ol Pejeta WC	87.2	84	63	49	-14	Population probably exceeds rhino CC which is probably not as high as estimated. Removals of rhino and competing browsers are needed.
Ol Pejeta WC extension*		96	72	30	-42	Population recently created - further introductions from Ol Pejeta WC may be required in the future.
Solio GR	63.1	61	46	91	45	Removals required urgently. Plans underway to remove 30 black rhinos to Ol Pejeta WC in March 2007.

New areas will be required to take surplus rhino, and the challenge is whether to create new sanctuaries, IPZs, or a combination of these options. There are pro and cons of these management models, dependent on infrastructure, security, available manpower, management and biology. Each situation will have to be assessed carefully and the selection of the most appropriate model will depend largely on prevailing socio-economic and rhino density considerations in the area or region concerned.

4.5 Target annual growth rates for different management models

Where rhino are free-ranging in open systems which are harder to protect from poachers (such as Masai Mara and Tsavo), population growth expectations are lower than for well-managed and protected populations below CC in enclosed areas. Therefore different minimum target annual growth rates should be set for the different management / security situations prevailing in different areas.

4.6 Conservation of the highland rhino ecotype

Two possible ecotypes of black rhino have been traditionally recognised in Kenya, lowland[3] and highland[4]. However the criteria for this distinction seem arbitrary and have no firm scientific basis. Trypanosome resistance in lowland animals is quoted as the example but there is no evidence that highland animals do not develop resistance with exposure. Whether isolation over many thousands of years would lead to reduced resistance is open to debate and the apparent increased susceptibility of white rhino, a grassland species, might suggest this. In the Kenya, these populations have not been truly isolated and the majority of animals in the Aberdares are probably related through introductions to lowland origin animals – or "hybrid origin". The majority of rhino (88.5%) in Kenya are part of 'hybrid' populations founded by rhino originating from highland and lowland areas (Table 9). Metapopulation management should encourage maximum conservation of genetic heterozygosity and with only about 10 animals in the Aberdares NP the option to manage them as a separate ecotype may not succeed, although there is a chance that it could.

Table 9: Sources/origins of founders of Kenya rhino populations (end of 2006).

Area/Year	POP 2006	Low land POP	High land/ Hybrid POP	Total # introduced	Indigenous or re-introduced and source of founders
Aberdares NP (Salient)	10	0	8	2	Nyeri Indigenous, Supplementation from Solio GR
Chyulu Hills NP	21	0	0	0	**Indigenous**
Meru NP	20	0	21	21	Reintroduced from Nairobi NP, Lake Nakuru NP, Lewa WC
Nairobi NP	64	1	3	4	Reintroduced from *Darajani, Kapiti, Kitengela, Nyeri, Tsavo East NP
Lake Nakuru NP	81	0	4	4	Reintroduced from Solio GR, Nairobi NP, Kitengela, Nyeri
Ngulia RS	64	3	1	4	Reintroduced from *Kitzwuzi, *Taita, *Tsavo West NP (Indigenous), Nairobi NP
Tsavo East NP	26	0	47	47	Reintroduced from Nairobi NP, Solio GR, Ngulia RS, OL Jogi GR, Lewa WC
Laikipia NC	13	0	11	11	Indigenous, Nairobi NP
Lewa WC	53	1	7	7	Reintroduced from *Shaba, Kitengela, Nyeri Solio GR, Ol Jogi GR, Mathews range, Meru NP
Mugie RS	24	0	20	20	Reintroduced from Nairobi NP, Lake Nakuru NP, Solio GR
Ol Jogi GR	28	1	4	4	Reintroduced from Ol Jogi GR (Indigenous), *Kiboko, Solio GR
Ol Pejeta WC	49	0	12	12	Reintroduced from Solio GR, Nairobi NP, Lewa WC
Solio GR	94	3	5	8	Reintroduced from Solio GR/ Lamuria, *Darajani, *Kiboko, Embu, Nyeri, Rumuruti, Isiolo, *Tsavo East NP
Mara Triangle	2	2	0	2	***Indigenous**
Masai Mara NR	35	0	0	0	***Indigenous**
Il Ngwesi Group Ranch	1	0	1	1	Reintroduced from Lewa WC

*Bold represent low land/ tsetse/ trypanosomiasis areas; not bold areas represent highland; 89.7% are now hybrid

[3] rhino inhabiting environment which has the presence of potentially pathogenic endoparasites and their vectors; mainly trypanosome and their carrier the tsetse fly (*Glossina* spp). [4] rhino inhabiting enviorment which has absence of potentially pathogenic endoparasites and their vectors; mainly trypanosome and their carrier the tsetse fly (*Glossina* spp) which could put them at risk when exposed to these parasites after translocation to lowland areas.

4.7.1 Alternative Harvesting Strategies

The SADC Rhino Management Group (RMG) workshop on biological management recommended that in larger populations, Set Percent (%) Harvesting should be implemented (Goodman 2001, Emslie 2001). With Set % Harvesting one needs to obtain a population estimate each year and to translocate a set % of the population. The theory behind this is that provided a population is harvested below its r-max (which for rhino is around 8-9%), its density will adjust to the level which can sustain that particular level of off-take. In other words numbers will adjust to the level where the annual removals are sustained by births. The advantage of this strategy is that reliance on estimates of ECC is reduced and the animals themselves set their productive density. If ECC changes over time (e.g. following vegetation succession), the population will also adjust its density to reflect this. (although the problem of large time-lags in rhino density dependent responses to changing vegetation complicates matters). There are a number of variants of Set % Harvesting and the one recommended by the SADC RMG Black Rhino Biological Management workshop which Kenya participated in was the following.

1. Estimate ECC.
2. Estimate population size accurately each year.
3. Do nothing if the population is under 50% of ECC.
4. If the population has just reached or exceeded 50% of ECC for the first time then for an initial period of a few years remove 5% of the population each year (allows for a "soft" introduction to harvesting). After a few years review progress. If the population is still increasing as expected, ideally increase offtake levels to 6 or 7% (just below r_{max} of 8-9%, or else if management wants to me more conservative, keep removing at 5%. Review and adjust removals again after a few years. Removals should be spread throughout the area being harvested and not only restricted to certain easily accessible areas while leaving other areas effectively unharvested.
5. If the population has exceeded 75% of ECC and especially if it has exceeded ECC, reduce densities to 75% of EEC (in one year if possible) and from the next year on remove 5-8% annually depending upon how aggressively one wishes to manage for growth.
6. Population models should be used to assist with predicting performance under a range of removal scenarios. The social impact of removals may need greater consideration.

When harvesting for growth from small populations one should either keep or maintain populations at or below 75% of ECC or undertake set % harvesting but only remove animals every 3 years or so. For example, instead of taking off 6% per year one could take off 18% of the population every three years. The smaller the population is, the more important the choice of individuals to remove. The strategy however can be adapted to the area and population.

4.7.2 Translocation history

Translocation history of black rhino in Kenya prior to 1992 can be found in Anon. (1993). A total of 130 black rhino were translocated between 1992 and 2006. Since 2001 two new populations have been created, Meru NP (re-established) and Mugie RS, with a founder population of 20 rhino each. Tsavo East NP, Ngulia RS, Laikipia NC and Ol Pejeta WC (extension) were also restocked with 48, 14, 10 and 30 rhino, respectively. Solio GR, Nairobi NP and Lake Nakuru NP were the main donors of 21, 19 and 67 rhinos respectively. Lewa WC donated a rhino to establish the Il Ngwesi Group Rhino Ranch in 2002. No translocations took place into or from Chyulu Hills NP, Mt Kenya NP, and Masai Mara NR (Figure 40). There are currently no rhino in Mt Kenya NP. Chyulu Hills NP and Masai Mara NR are managed as indigenous populations.

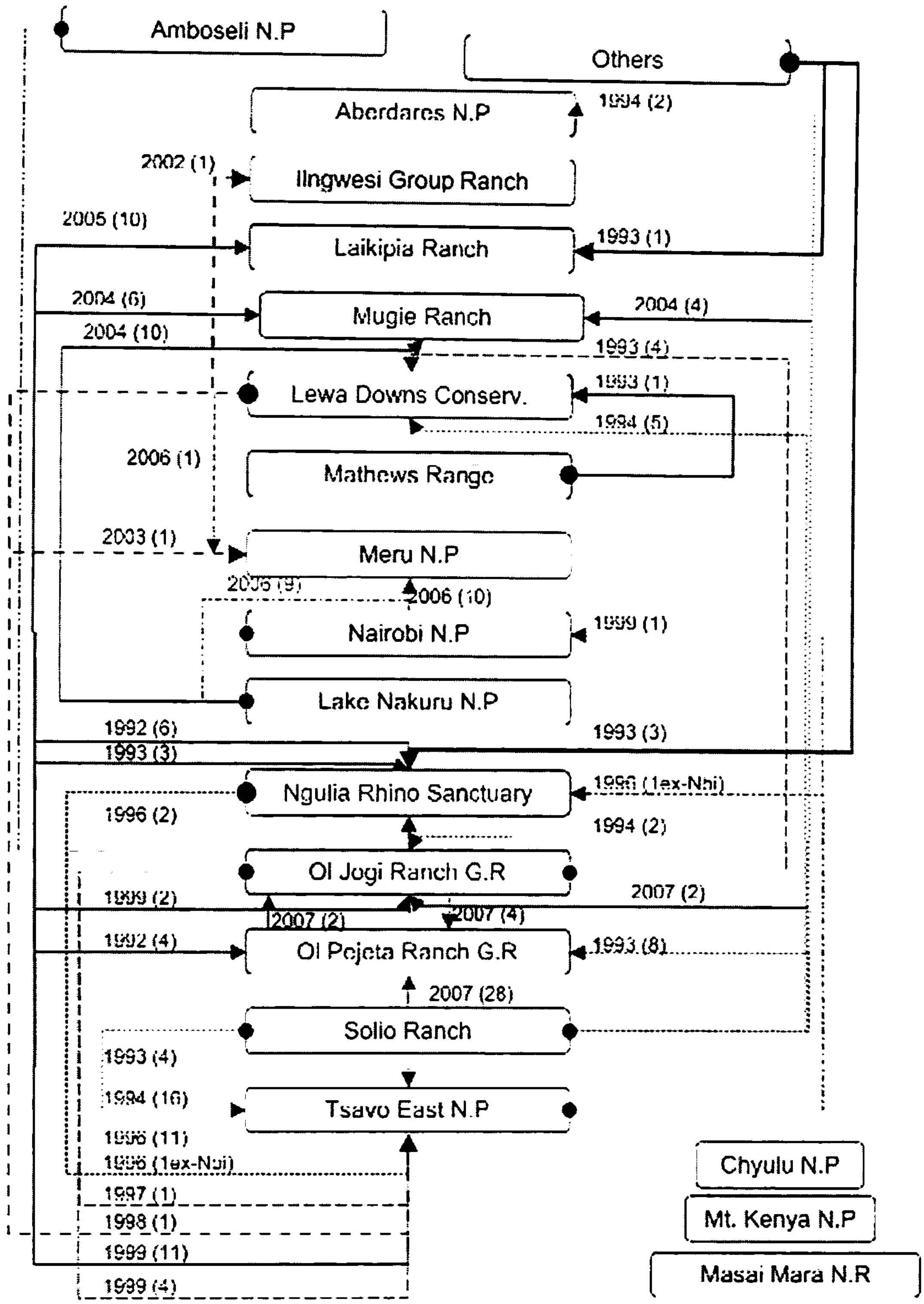


Figure 40: Translocation history of *D. b. michaeli* in Kenya (1992-2006). Figures in brackets indicate the number of rhino translocated in a given year. The arrows originate from source population and point to the recipient population. Data from Anon. (1993); Oloo & Okita-Ouma (2000); Mulama & Okita-Ouma (2004) and Okita-Ouma & Wandera (2006).

4.7.3 Capture and translocation procedures

The candidates for removal should be determined by factors such as the population age and sex structure, lactation status of female candidates, condition of the animals, past history of the candidates and kin relationship. In addition, to promote long-term genetic viability, an animal needs to be translocated in every 10–20 years (owing to high mortality rates affecting introduced adult males it is probably best to introduce adult females than males). The timing and composition of translocations and introduction of rhino to a new rhino sanctuary may be critical to carrying out successful stocking and minimising mortality (numbers translocated will depend on the harvesting strategy and the status of the recipient population). Long distance moves across Kenya should be avoided as much as possible. General animal reintroduction guidelines developed by IUCN (1998) and well-established best practices, adapted for local use need to be followed. More specific detailed guidelines for translocation and introductions of rhino has been lacking. Higher level generic rhino translocation guidelines are currently being developed by IUCN SSC's African Rhino, Asian Rhino, Veterinary and Reintroduction Specialist Groups. Detailed guidelines for translocating black rhino have also just been produced (Morkel and Kennedy-Benson 2007; du Toit 2006).

Figure 41: A female rhino being translocated from Nairobi NP to Tsavo East NP.

The basic system is to immobilise the selected individual with an opioid drug (usually etorphine hydrochloride) with an added tranquiliser. This drug cocktail is usually administered by dart from the ground, a vehicle or helicopter. After the animal is immobilised it is stabilised, biologically sampled, ear notched and prepared for loading (Figure 41). The loading procedure involves partial reversal of the narcotic to allow the rhino, under rope control, to rise and walk into a specially constructed transport crate. Longer acting tranquilisers are used according to the transport period and method of pre-release management at the introduction site. The animals are monitored for over-heating and any other problems that might occur during the journey and appropriate measures taken (Kock *et al.* 2007). Recently distributed releases (throughout new reserve but near water) of drugged black rhinos have been used successfully by both SANParks and Ezemvelo-KZN-Wildlife when setting up a number of new of South African populations. Using this new approach all equipment and people are removed before a single person administers the antidote and leaves the scene. This method seems to result in less stress to the animals that often start to feed immediately after recovering once the antidote has been administered. With this approach it may not be necessary to boma rhinos in the recipient area if there are no disease challenges (such as Trypanosomosis for introduced highland animals).

4.8 Extension of existing areas and creation of new rhino populations

To achieve higher growth rates and maintain maximum productivity, surplus rhino within enclosed rhino reserves must be translocated out of a sanctuary on a regular basis. A set of guidelines for assessing new areas has also been developed by KWS rhino programme. A total of seven areas (Tsavo West NP including Ngulia RS extension, Laikipia NC (restocking), Kongoni range, Mt. Kenya NP, Meru NP, Ol Pejeta WC (extension), Ruma NP and Mugie RS) were assessed during the last strategy period. Out of these areas, two (Mugie RS and Meru NP) were selected. The new rhino sanctuaries received an initial translocation of 20 black rhino in each of the two areas while 10 rhino were moved to restock an existing population in Laikipia NC (Table 10). Ngulia RS extension will be completed in June 2007[5] and some rhinos from the original sanctuary will be moved into the extension area by November 2007. Thirty rhinos are to be translocated into Ol Pejeta WC (extension) in February 2007[6] from Solio GR and Ol Jogi GR. Lewa WC has proposed expansion of the sanctuary to include Borana community lands.

Table10: Potential areas and the current status/progress in their development as rhino reserves.

Potential Areas	Progress as of December 2005
Mugie RS	Mugie RS created in 2004 with a founder population of 20 rhino translocated from Lake Nakuru NP, Nairobi NP and Solio GR.
Meru NP	Founder population of 20 rhino translocated in 2006 from Lake Nakuru NP, Nairobi NP and Lewa WC.
Tsavo West IPZ	Detailed plans are being developed for rhino to be translocated from Ngulia RS in 2007.
Ngulia RS extension	Planned to be completed in June 2007. Approximately 10 rhino to be moved in November 2007 from the sanctuary to colonise the area.
Laikipia NC	10 rhino were translocated in 2006 from Nairobi NP to build up the existing population. Only five survived.
Ruma NP	Detailed habitat and security assessments are currently in progress.
Chyulu Hills NP	The management plan is to build up the numbers from the existing population as it is an indigenous population.
Ol Pejeta WC Extension	Assessments carried out in 2000; Carrying Capacity estimate of 96 rhino was determined; 30 rhinos are to be translocated into the extension area from Solio GR and Ol Jogi GR in February 2007[7]
Ol Jogi GR (extension)	Detailed habitat and security assessments are to be carried out in 2007. Four rhinos were translocated from Solio GR into Ol Jogi GR (2 males and 2 females into the original and extended area respectively). There are plans to add a further three female rhinos from Nairobi and Lake Nakuru NPs in August 2007.
EAC countries	EAC Rhino Management Group is being developed.

4.8.1 Priority future conservation areas

The policy of protecting and breeding black rhino in relatively small fenced sanctuaries has been, and will continue to be, a vital element in sustaining and increasing above 5% growth in black rhino numbers in Kenya. The present well-established rhino sanctuaries only have an estimated total capacity of approximately 531 rhinos with MPCC of 398. The challenge is that in current fenced areas there is little space left and there are few new potential areas within Kenya except for the large free-ranging areas of Tsavo, Meru and Laikipia. The Aberdares NP-Salient population also needs additional rhino to increase its viability, provided issues of browse nutrients and poaching and predation are attended to. The ultimate objective is to use the sanctuary populations as a 'breeding bank' of actively managed rhino for the provision of a continuous supply of surplus rhino to restock areas capable of supporting large populations. Priority areas need to be

[5] This was completed in June 2007
[6] This was completed in February 2007
[7] Thirty black rhinos were translocated into the extension in March 2007

selected for initial or further stocking within the next 5 years and conservation of black rhino in the long term, together with the current rhino conservation areas.

Using the initial KWS estimated ECC and management levels given in Table 8, the potential availabilities of rhinos for translocation in the next 10 years are shown in Table 11. A growth rate of 6% has been used based on the performance of these sanctuaries in the past 5 years.

Key: r = annual growth rate (%), ML = management level, Trans = number of rhino available for translocation

Table 11: The projected availability of rhinos for translocation from rhino sanctuaries: 2007–2016.

National Park or Reserve	r (%)	ML	2006 Total	2007 Trans * inc. 2007 growth	2008 Trans	2009 Trans	2010 Trans	2011 Trans	2012 Trans	2013 Trans	2014 Trans	2015 Trans	2016 Trans
Lewa WC	6	62	53	0	0	0	5	5	5	5	5	5	5
Nairobi NP	6	50	66	20	3	3	3	3	3	3	3	3	3
Lake Nakuru NP	6	51	63	16	3	3	3	3	3	3	3	3	3
Ngulia RS	6	50	64	15	3	3	3	3	3	3	3	3	3
Ol Jogi GR	6	14	25	14	1	1	1	1	1	1	1	1	1
Ol Pejeta WC	5	63	49	0	0	0	0	3	3	3	3	3	3
Solio GR	8	46	34	45	3	3	3	3	3	3	3	3	3
Totals	-	-	377	88	13	13	18	21	21	21	21	21	21

NB – Chyulu Hills NP and Masai Mara NR populations have so far been managed as indigenous populations. Mugie RS and Meru NP rhino sanctuary have been established in the last three years with founder population of 20 rhinos. In Feb 2007, 27 black rhino were moved from Solio GR; four from Ol Jogi GR and one from Ol Pejeta WC. Ol Pejeta WC received 28 rhinos, while Ol Jogi GR received four rhinos.

4.8.2 Greater regional focus

Currently across the historic range of the eastern black rhino, there are no rhino in northern Uganda and Rwanda, and less than 60 in northern Tanzania. Uganda lost all it's rhino in the 1970s, while Rwanda lost its last black rhino in July 2006. In Ethiopia, there are only unconfirmed reports of some rhinos in the south of the country. These East African former range states are potential areas for re-stocking and for regional metapopulation management of the sub-species.

The establishment of the East African Community Rhino Management Group (EAC-RMG) was conceived, during the 2004 7th AfRSG meeting, to initiate cooperative planning and management of *D.b. michaeli* with the primary focus on local and regional cooperation under the political and institutional umbrella of the existing East African Community Natural Resource and Environment Secretariat. A concept paper was subsequently developed by KWS and Zoological Society of London (ZSL) and sent to the National Wildlife Authorities of Kenya, Tanzania and Uganda. A working group comprising the National Rhino representatives of Kenya, Tanzania and Uganda, IUCN AfRSG chairman and key partner organisations discussed the setup and implementation timetable at the 2006 AfRSG meeting in Swaziland. Kenya, Tanzania and Uganda have all agreed to the formation of the EAC-RMG. An inaugural meeting is being planned by KWS, Flora and Fauna International (FFI) and ZSL through the EAC secretariat.

The goal of the EAC-RMG is "To promote the establishment and maintenance of a viable and well-distributed metapopulation of 2000 eastern black rhino as flagship species for biodiversity conservation within the East African region through coordination and provision of technical support". The short-term objective is "To increase the regional population of *D.b. michaeli* by at least 5% per annum to 900 individuals by 2015". Among its many benefits it will allow easier sourcing and translocation of eastern black rhino between Kenya and the other East African countries.

4.9 Reducing densities of competing browsers

The browsing of other game species can reduce food supply to black rhino, and contribute to inducing vegetation changes which affect black rhino carrying capacity. Table 12 shows where there are or have been high densities of competing browsers and the progress that has been made in addressing the situation.

Table 12: List of rhino reserves which have, or previously had, a high density of competing browsers.

Reserves	Competing Species	Recommendation/Action
Ngulia RS	elephant (mainly), giraffe, buffalo	All 255 elephants were successfully moved out in 2006. Sanctuary is being expanded by an extra 26 km².
Lake Nakuru NP	buffalo and impala	Translocation of surplus animals to other parks and areas. The park management together with the resident scientist should determine the numbers to be translocated. They also need to identify possible destination areas and prepare a budget and source for funds for this operation.
Ol Pejeta WC	Giraffe, elephant	Reserve expansion in 2005 has temporarily reduced the density to acceptable levels.
Lewa WC	Elephant	High numbers are impacting rhino browse; control is needed.
Ol Jogi GR (Pyramid section)	Eland, impala, giraffe	Browser numbers need to be reduced to lower overall browser biomass to allow browse recovery and benefit black rhino.
Solio GR	Buffalo	Impacting leleshwa forest and bushland herb layer, areas important for black rhino.

4.10 Control of invasive species

The potential for the invasive alien plants *Lantana camara, Tarchonanthus camphorates and Caeslapinia decapetala (and possibly others)* to destroy prime black rhino habitat is very great, and should be investigated immediately. The costs and difficulties of eradication increase exponentially with each season of delay. It cannot be over-emphasised as experience elsewhere has shown that if left too long the problem will become so great that infestations cannot be practically or economically dealt with. Important habitats for black rhino would be destroyed. Table 13 below shows the extent of the problem in the worst affected rhino areas.

Table 13: Invasive plant species in rhino conservation areas

Reserve	Species	Status
Nairobi NP	*Lantana camara*	Some areas near main park road have been targeted. Other serious infestations further in the park and along park boundaries (in and out) need to be located and tackled as rapidly as possibly, using expert-advised control solutions.
Lake Nakuru NP	*Lantana camara,*	Colonising prime black rhino habitat thus requires urgent eradication. Surveys to find and map all infestations are urgently needed. Community awareness needed re. not planting Lantana
	Tarchonanthus camphorates,	Bush clearing sites could be tested for efficacy. Monitor replacement vegetation.
Aberdares NP	*Caeslapinia decapetala* (Mauritius Thorn)	Assessments to establish the distribution and density completed; report being produced.
Laikipia NC	*Tarchonanthus camphorates*	Assessments required to determine extent of impact. Undertake test clearing to learn about management of this species and regrowth of other species.
Meru NP	*Lantana camara*	Assessments required to determine extent of impact.

Control methods recommended by expert agencies should be compiled immediately. Expert input should be sought regarding *Lanatana camara* control due to the very high potential of this species to devastate black rhino habitats. Where needed, research should be carried out on manual and chemical control methods for *Tarchonanthus camphoratus.* The work should also extend and cover the area outside park as well, including an awareness and education programme. Local community could benefit from clearing the invasive species in selected areas. There are also other harmful alien plants which should be tackled even if not yet abundant, to nip them in the bud and save future massive problems and expense.

4.11 Genetic studies

There were no significant genetic studies undertaken in the previous strategy period. Blood and tissue samples collected from immobilised animals and sample tissue from selected rhino using biopsy darting can be used to assess levels of genetic variation within chromosomal and mitochondrial DNA. It can also be used to answer specific questions about lineage and genetic variability through genetic analyses, including the use of DNA fingerprinting and the use of mini-satellite DNA probes. Faecal DNA analysis is being planned for the Chyulu Hills NP rhino population.

4.12 Disease monitoring

Perissodactyla is an order of animals comprising of only three surviving families equids, tapirs and rhinos. From a disease risk perspective this has one advantage in that the diversity of disease agents for a species tends to be related to the population size and the numbers of closely related species. If a species has a large population and many close relatives it provides ideal conditions for parasite and pathogen evolution.

The close relationship between rhinos and horses, especially in anatomy, physiology, parasites, disease, nutrition and response to drugs (Morkel and Kennedy-Benson 2007) and the large amount of knowledge on horse veterinary issues provides us with opportunities to better understand diseases in rhinos. Owing to the cryptic nature of the rhino, knowledge of disease in free-ranging populations is still scanty and most literature relates to captive rhino that show an array of bizarre conditions and these appear to relate to conditions of confinement (Kock *et al.* 1992). In free-ranging conditions in East Africa there are reports of syndromes that often relate to periods of starvation or stress and here opportunistic pathogens and parasites were the proximate cause of death. Translocation has enabled closer examination of rhino and many veterinary reports relate to these events. In these instances ill health or death occurs from trauma and opportunistic infections or exposure to novel disease agents or toxins. Viral disease appears rare although various antibodies can be detected. Bacterial disease, such as tuberculosis (Keep & Besson 1973) and anthrax (de Vos 1980), most probably do occur whilst the most common cause of death from bacteria is associated with post-traumatic wound infection with streptococci and staphylococci (Clausen & Ashford 1980) or bone infection with a lumpy jaw syndrome evident from skulls (Kock, pers. obs.) but reported cases are mostly speculative with the causative agent unknown. Some internal parasitic infections have been associated with mortality especially in young or stressed animals but whether these contributed to death is not certain and filariasis with associated ulcerative dermatitis is common but of little impact. Trypanosomosis has been a problem for white rhino exposed through introduction into tsetse fly zones and this species appears more susceptible than the black rhino especially to *T. brucei* (Kock *et al.* 2007). On rare occasions with extreme stress and challenge black rhino can succumb and without previous exposure will show some anaemia, leukopaenia and thrombocytaemia (Clausen 1981; Mihok *et al.* 1992, 1994; Kock *et al.* 1999). Babesiosis and theileriosis have been recorded in the black rhino under unusual environmental conditions where insect "storms" resulting in heavy tick and parasite challenge occurred (Nijhof *et al.* 2003).
In the Ngorongoro episode the entire rhino population appeared to succumb and it was not proven whether this was an introduced pathogen or simply one that emerged under these extreme environmental conditions and stress. There had been a recent introduction of a rhino from South Africa, which was one possible source. The possible link between increases in ticks, filariasis or other parasite loads and a lowered nutritional plane associated with habitat changes should also be considered where rhino mortalities or calf losses increase without other explanations.

With so little known of infection in the rhino any opportunity to handle a live animal or examine a carcass of a rhino should involve a thorough examination and comprehensive biological sampling. Baseline studies are few with some work completed on internal parasite burdens but how significant the different species isolated are in disease pathogenesis, is poorly understood. With poaching as the main cause of death over the last 100 years, it is not surprising so little is known of disease epidemiology in rhino but as populations recover and numbers increase disease patterns should emerge and will need to be studied (Schulz & Kluge 1960; Round 1964; Hitchins & Keep 1970; Windsor & Ashford 1972; Keep & Besson 1973; Silberman & Fulton 1979; Clausen & Ashford 1980; De Vos 1980; Clausen 1981; Soll & Williams 1985; Kock & Kock 1990; Kock *et al.* 1992; Kock *et al.* 1992; Mihok *et al.* 1992, 1994; Knapp *et al.* 1997; Kock *et al.* 1999; Fischer-Tenhagen *et al.* 2000; Williams *et al.* 2002; Nijhof *et al.* 2003).

4.13 Post translocation monitoring

It is not possible to conduct a translocation of any species of animal without causing a significant amount of stress to the individual(s) concerned. In a translocation, rhinos are removed from their "safe environs" and thrust into an unfamiliar world where the location of food and water resources are unknown, where many of the disturbances, which may be of an entirely different and unknown nature, will be perceived as threats and where there may be harassment/danger from established rhinos. There is particularly a high risk of mortality in the first few months of introduction. Female breeding performance is also generally sub-optimal during the first few years following introduction. However, animals can settle into a consistent breeding pattern within months and the risk of mortality can be minimised by: (1) intensively monitoring the translocated animals (normally through radio tracking) and removing animals into bomas if deemed appropriate and/or providing treatment quickly where needed; (2) studying the animals' movement patterns and social interactions with any existing rhinos, refining and evaluating different release methods and undertaking adaptive management; (3) providing optimum conditions (sufficient water sources, space, good habitat and protection) for the animals to settle down quickly. Following the intensive monitoring phase, routine monitoring (normally through daily patrols) over the long term is required for biological management and law enforcement.

Experience has clearly shown that despite the risks, translocation has been an essential part of any successful metapopulation management strategy. In the longer term, translocated populations have out-performed long established existing natural populations. Translocations can also contribute to increased performance in donor populations such as has happened in Solio GR and Nairobi NP.

4.14 Nutrition

The nutrition of rhino is of particular concern in management of rhino in sanctuaries, and of rhino confined in bomas. The chemical defences of food plants may have an important influence on the suitability of rhino habitat. This particularly applies to changes in species composition at high browsing intensities towards less nutritious and more heavily chemically defended species. Such changes may increase the toxic load on rhino without supplying the nutritional quality of diet required to detoxify the diet. Studies are required on this aspect, and on the relationships between the nutritional value of black rhino diets and population performance. This will help in the understanding of how spatial and temporal variations in the quality and availability of food resources are impacting on rhino health, reproductive success, and the carrying capacity of an area. Likely indicator plant species can also be identified for monitoring rhino–habitat interactions and habitat status, and for assessing the need for nutritional supplements in specific habitats.

Mineral supplements should continue in particular black conservation areas known to suffer from deficiencies or excess of certain minerals in the soil and vegetation (e.g. Lake Nakuru NP).

5 Protection

5.1 Background

The biggest threat to rhino comes from the demand for their horn, and the resultant poaching of rhino and trafficking in horn in an attempt to satisfy this illegal demand. The survival of all rhino species therefore depends to a very great extent on (1) the ability of managing authorities, private owners, custodians and communities to prevent or at least minimise poaching in their areas and (2) the success of worldwide conservation efforts to reduce the incentives to criminal poachers and traffickers, and reduce illegal trade in rhino horn worldwide.

Rhino poaching is likened to a fire. Once it has flared up and got out of hand, organised commercial poaching becomes extremely difficult to stop. This is why it is so important to "keep a lid on" poaching, maintaining it at low levels where it can be manageably contained. Successful protection will not only involve reacting after an event or incursion in the field, but also include pro-active measures such as use of intelligence networks. Successful protection is also not simply a question of adopting a militaristic "fortress approach". Getting the support and cooperation of neighbouring communities for the conservation effort can also greatly enhance rhino security and protection. If criminals believe that they will be able to poach rhino and trade in their horn without being caught; or if they are caught and convicted they will not be given deterrent sentences, poaching and illegal horn dealing are likely to be stimulated. However, if poaching and dealing cases are routinely investigated and prosecuted successfully, with stiff deterrent sentences being handed down by the courts this will reduce the illegal activities.

5.2 Current legislation

Under the ratified CITES treaty, to which the Republic of Kenya is a party and signatory, the black (and white) rhino is listed under Appendix I, which prohibits all trade in rhino products. Under the Kenya Wildlife Act (1976), all hunting of rhino is banned, and any illegal hunting carries the maximum penalties. Any import or export of live rhino (black and white) or rhino products from Kenya may only be permitted by the CITES secretariat through provision of a permit by the KWS as the wildlife management authority.

5.3 Investigation, prosecution and sentencing

A professional approach to the investigation of crime will help to achieve the law-enforcement aim of reducing the incidence of the illegal hunting of rhinos. The training of personnel to detect and identify rhino horn and its derivatives will impact on the illegal international trade in these products by increasing identification at times when horn is recovered in operations within Kenya. The discovery of a crime can take place by any person in the field, at any time. This means that all field personnel should be familiar with a few basic rules about what to do in such an eventuality. This information is the basic minimum, which should be provided to all field personnel in order to maximise the chances of recovering the most clues from the scene. Training courses were held for both "Scene of Crime Analysis" in 2003 and "Identification of Rhino Horn" in 2005. However, most of the trained staff are no longer in a position to be apply the skills they learned mainly because of transfers to other departments. The most effective and sustainable approach would be to train trainers who can then train field personnel. To ensure that all recruits have the basic skills this training should be included in the Manyani field officer and ranger training programme. A similar sustainable training programme should also be put in place for private and local county reserves.

High legislative penalties are unlikely to act as deterrents unless the sentences passed reflect the seriousness of the crimes. Under the Wildlife Act (Part V), "any person unlawfully in possession of, or who unlawfully deals in any Government trophy" (including rhino and rhino horn) "shall be guilty of an offence and liable to a fine not exceeding 10,000 Kshs, or to imprisonment for a term not exceeding 12 months, or to both". Penalties for illegal hunting of any animal in a National Park are as follows: "a fine of not less than 5,000 Kshs and not more than 20,000 Kshs, or to imprisonment for a term which shall not be less than six months, and not more than three years, with or without corporal punishment, or to both". Minimum penalties are not specified for offences relating to rhino, maximum penalties have rarely, if ever, been imposed for such offences, and typically fines of around 5,000 Kshs (two-three weeks average salary) or custodial sentences of the order of 1-2 months have been handed down in recent years. These penalties haven't been updated in over 30 years and are well below those of a number of other rhino range states leading to concerns that over time a poacher may make more money by selling the horn and paying the fine and will be undeterred by the penalty. Increases in penalties actually imposed for any illegal activities connected to rhino are needed, in order to provide a substantial deterrent to would-be offenders. New legislation is urgently required for provision or increase in minimum penalties specified for the illegal hunting of rhino and the illegal possession of, or trade in rhino products. The Presidential statement of the specially protected status of the black rhino is highly relevant in this regard.

The existing KWS black rhino horn stock pile and trophy record keeping and reporting is standardised at KWS Headquarters. Management of white rhino horn should be fully and legally integrated into this system with the physical stock pile maintained separately by KWS. The stockpiles should be randomly audited so that the effectiveness of security measures can be monitored.

The Kenya Rhino Programme is assisting in the development of a continental rhino chemical horn fingerprinting tool (Amin, Emslie *et al.* 2003). Samples of rhino horn have been collected following AfRSG protocol and provided for isotope and element analysis. Such "horn fingerprinting" of each key and important rhino population in Africa, and selected remnant populations should in time allow the origin of poached horn to be determined. Already the technique has been developed to the level that the species of rhino and region the horn came from can be reliably identified (Figure 42). Work is currently under way to refine the method so that it can be used to predict accurately the source of horn down to a park level. This will assist in obtaining successful prosecution in many cases, and in improving knowledge of trade routes.

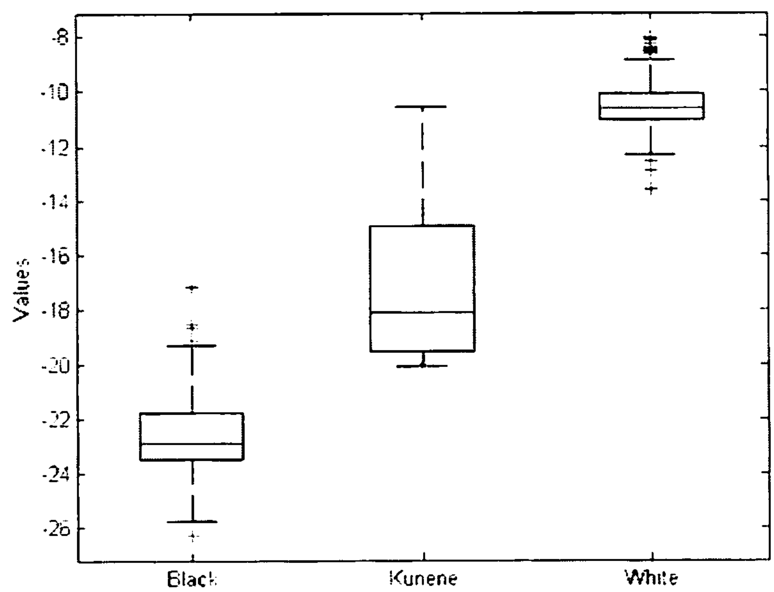


Figure 42: Distribution of $\delta^{13}C$ by species distinguishing between "desert" black rhino from Kunene and all other populations of black and white rhino. A strong relationship exists between $\delta^{13}C$ values in black rhino horn and rainfall with highest $\delta^{13}C$ values being recorded in very arid areas with high coefficients of variation. The low erratic rainfall in Kunene is therefore related to the unusually high $\delta^{13}C$ values recorded for the "desert" black rhino in this area (Amin, Emslie *et al.* 2003)

5.4 Anti-poaching

The sanctuary/rhino surveillance approach has been a key factor in halting poaching in most rhino areas of Kenya and also keeping poaching to low levels in other areas. However, it is has become apparent that levels of security and anti-poaching are inadequate in some conservation areas (such as Tsavo East NP and Aberdares Salient) and hence patrol systems and methods need to be reviewed and updated accordingly.

One particularly potent deterrent to poachers, apart from stiff penalties, is a high frequency or likelihood of being detected by anti-poaching patrols (see Leader-Williams 1988; Milner-Gulland & Leader-Williams 1992), and hence the intensity of patrol coverage. The AfRSG recommends that generally, smaller reserves (<300 km^2) should be staffed at the level of at least one field ranger per 10 km^2 and preferably higher (Emslie & Brooks 1999). In larger national parks and reserves (>200 km^2), ground surveillance should be supplemented by a mobile specialist anti-poaching unit (APU) that can help in an emergency and also act as an internal check on other field-ranger patrols. In very large parks attempt should be made to have at least as many field rangers as the square root of the area in km^2. This is a guide and each location will have specific requirements. For example, higher number of rangers will be required for sanctuaries bordering settled areas (e.g. Lake Nakuru NP, Aberdares NP), to enable maintenance of perimeter fencing and patrolling inside the park, and also in operational areas (e.g. Tsavo NP, Meru NP), where high levels of patrol effort will be essential in order to detect and intercept poachers.

Analysis of data in the Kenyan Black Rhino Management System has shown that on average 25% of the rhino-monitoring personnel are not available for patrols (leave, sick, on other duties, etc.). This needs to be reduced significantly and also taken into account when calculating required minimum staff strengths.

The number of rhino poached remained relatively high over the strategy period. From 2000-2002, 21 rhinos were poached (3.5% of the total population at the end of 2000) and from 2003-2005, 22 rhinos were poached (3.4% of the total population at the end of 2003) (Table 14). The poaching of white rhino increased: six (3.5%) were poached in 2000-2002 compared with 10 (4.6%) in 2003-2005.

Despite the increased poaching threat in 2003-2005, and the improvement in the efficiency of law enforcement efforts in Kenya over the same period, the percentage of poached horns recovered declined (Table 14). This may suggest that poaching syndicates are becoming more sophisticated in their ability to avoid detection by law enforcers (Simon Miledge, TRAFFIC personal communication)

Table 14: Summary of rhino mortalities, horn seizures and law enforcement 2001-2005

Trends 2000-2002 to 2003-2005		2000-02	2003-05	Trend from 2000-2002 to 2003-2005
Mortalities	Total number of detected mortalities	39	55	Increase
Field detection rates	% expected actually detected	50	53.7	Improving (patrol effectiveness)
Poaching	Total number of poaching (detected)	21	22	Constant
Poaching severity	% total mortalities owing to poaching	53.8	40	Slight decline
Poaching impact	% total population poached over 3 yrs	3.5	3.3	Constant
Seizures & cases	Total number of horns seized	38	3	Decline
Law Enforcement (LE)	% of horns seized compared to detected rhino poached	117.1	34.1	Horn seizure efficiency: good

There has also been recent increase in violent confrontations. In 2006, there were four recorded incidents of gun-fire exchange with rhino poachers, as many as the total from the previous six years put together. This might be linked to the increase in price of horn in Yemen (E. B. Martin, pers. comm.).

Intelligence networks should be enhanced particularly in the high-risk areas. The information gathered enables conservation departments to be proactive, sometimes being able to wait undercover to intercept poaching gangs entering protected areas. People intent on illegally obtaining rhino horn often try to extract information from park staff about security, and numbers and whereabouts of rhino. Staff should be warned about this, and rewarded for informing park authorities of such attempts.

Law-enforcement staff will always perform best when well trained and well motivated. The KWS Manyani Field Training School trains all new KWS rangers in weapons handling and maintenance, anti-poaching procedures, communications, and first aid. New training modules should be added as required (wildlife crime and law, scene of the crime analysis, basic training in monitoring and use of field equipment). The development of a comprehensive anti-poaching training manual, relevant to the conditions and situations rangers are likely to encounter, would also be very useful. If emergency reaction plans are well rehearsed (e.g. on discovering an animal has been poached or finding poachers in the area), there is a good chance that poachers will be apprehended and successfully convicted. Park management need to also ensure that all field personnel are collecting accurate information on patrol movements, poaching / illegal signs and sightings of threatened species. Continuously updated operational maps of security incidents also need to be maintained to ensure that law-enforcement patrols are meaningfully deployed and used to assess security effectiveness. A dedicated security/law-enforcement database system is also required in the large unfenced areas. The timely analysis of information can significantly assist in anticipating threats and deploying effective patrols. All security staff in private sanctuaries should also be strongly encouraged to join the police reserve to enhance their powers and legal status, with applications made through the correct channels (i.e. the District Security Committees).

Motivation and commitment can be enhanced by keeping staff informed about recent developments and successes in law enforcement, and explaining how their job fits into the wider international picture of combating poachers and traffickers. There is also a need to raise awareness about wildlife crime and law in the surrounding communities.

[illegible] involvement of communities

Conservation will fail in the long term if Kenya's people and politicians perceive wildlife areas and rhino as luxuries that exist only for the enjoyment of wealthy foreigners, and which use valuable land for no greater benefit. Only when neighbouring communities are convinced that conserving wildlife and its habitats also brings long-term social and economic benefit, will the rhino find a permanent place in modern Kenya. The challenge is to develop community-based wildlife management programmes that provide incentives for protecting rhinos. Where people have benefited directly from rhino conservation, through ecotourism ventures or employment in rhino monitoring and protection, the rhino have also benefited significantly. Experience throughout Africa has shown that maximum protection of rhino is attained when, in addition to law enforcement at the national and international levels, the rhino are supported within a social and economic environment in which they are seen locally as assets.

As capacity within Kenya's highly protected fenced populations is being reached, threats to free-release sites must be a priority for consideration and action. Some attempts have been made at gaining support around Tsavo and Meru PAs through conventional approaches to community development, including schools, water-dams, clinics, etc., but this is proving to be difficult to sustain and benefits largely did not reach the people most affected by wildlife conflict and in need. There are ongoing and new initiatives to re-establish rhino in Meru NP and as free-ranging populations in Tsavo but community issues have not been adequately addressed to ensure long-term success as shown by the losses of rhino in Tsavo East NP. The main challenge to conservation now is to achieve a radical change in local community relations through improved dialogue, socioeconomic benefits and conservation-sensitive land-use planning.

Owing to previous drastic decline in their numbers and range, the recovery of viable black rhino population in natural habitats and sanctuaries in Kenya is of great importance. The survival of the remaining population and its enhancement is dependent on intensive security, monitoring and active biological management. These forms of management require well-trained and highly motivated surveillance, monitoring, security, veterinary, capture and research staff. In addition, sufficient good-quality equipment, well-maintained infrastructure and effective operation of the Kenya Rhino Programme are necessary. Sustained financial resources are therefore crucial for the successful implementation of the programme.

Black rhino can only be conserved successfully with involvement of all stakeholders. KWS on its own is not able to achieve the overall objective without mutual support and sharing responsibility with its stakeholders. Strong mutual relations with private rhino sanctuaries through the Association of Private Land Rhino Sanctuaries need to be maintained. Local-community involvement in rhino conservation programmes, resolution of wildlife-community conflicts, conservation incentive schemes and awareness / information sharing linkages are becoming increasingly important.

Specific training and capacity building in rhino protection, monitoring and management were the key elements identified as requiring urgent attention. More than 150 rhino monitoring and security staff have been trained in various aspects of rhino conservation (Table 15).

All the training has been of high quality (undertaken by experts with good training material) but some was not sustained owing to high staff turnover. The relevant skills development activities should be institutionalised by incorporating it into the officer and ranger training programme at the KWS Manyani Field Training School. This will ensure that all relevant staff coming into the State rhino conservation areas have the basic skills in wildlife (rhino) conservation, security and monitoring. Refresher and more-advanced training will ensure skills retention. The Darwin Rhino training courses achieved a level of sustainability through the training of trainers and subsequent mentoring and support (see Section 3.2.1). A clear reporting line structure with staff terms of reference has helped to significantly reduce the high turnover of trained staff. Rhino staff undertaking under-graduate and post-graduate training should be bonded to the programme for a minimum period of at least 3 years after training.

Training and support to private, county council and community rhino areas also need to continue in the areas of rhino monitoring, habitat assessment, data analysis and reporting. In addition training and support should also be provided as needed in areas such as intelligence gathering. Where appropriate, field assessments should be carried out to ensure high standards are maintained.

Good-quality field equipment is necessary for monitoring and surveillance. Binoculars are an essential piece of equipment for observing rhino. Many of the identification characteristics of rhino cannot be seen without binoculars (Figure 43). Ideally, each member of staff on patrol should have a pair of good-quality binoculars. GPS receivers are also necessary items of monitoring equipment to provide valuable information on rhino distributions, home ranges and habitats, and patrol movements (Figure 44). Digital cameras with sufficient optical zoom and resolution help in the development of high-quality master ID files thus enabling a reserve monitoring programme controller to quality control and correctly classify sightings records, as well as providing good evidence to back minimum population estimates based on known animals. Sufficient amount of good-quality monitoring equipment is required in several State rhino areas and this is being addressed by the KWS-ZSL project funded by the EAZA Rhino Campaign.

Table 15: Summary of training conducted (2001 – 2006)

Type of training	Areas	Numbers	Being applied / improvements?
Training of instructors in rhino monitoring	All rhino areas	28 staff passed and accredited	Yes (see below).
Training of field rangers in rhino monitoring	All rhino areas	approximately 150 rangers	Yes - but instructors need to ensure training is carried out on regular basis. There is also a need to have a basic training module on wildlife monitoring at KWS Manyani Field Training School so all new recruits possess basic set of skills when they join KWS.
Training in research and management	Kenya Rhino Programme	two scientists completed master's degrees in conservation biology and wildlife management (one received distinction); one field officer completed bachelor's degree in Wildlife Management	Yes all trained staff contributing significantly at research and management levels.
Training in sanctuary management	State rhino areas	15 rangers completed certificate and diploma courses (three received first-class awards)	Yes all trained staff contributing to the national rhino programme.
Training in Scene of Wildlife Crime Analysis	State and private rhino areas	18 staff trained and accredited	No - Majority not in position to actively apply learned skills due to staff transfers. Need to institutionalise by incorporating into the KWS Manyani Field Training School programme so all officers and rangers possess the basic set of skills.
Training in Rhino horn and derivative ID	State and private rhino areas	15 staff trained and accredited	No Majority not in position to actively apply learned skills due to staff transfers. Need to institutionalise by incorporating into the KWS Manyani Field Training School programme so relevant officers possess the required skills.
Radio telemetry and GPS	State and private rhino areas	15 staff trained and accredited	No Majority not in position to actively apply learned skills. Need to institutionalize by incorporating into the KWS Manyani Field Training School programme so appropriate officers and rangers possess the required skills.
Training in field procedures and tools (data quality control, maintaining master rhino ID files, Kifaru[4] GIS rhino management system)	State and private rhino areas	24 staff trained	Yes – trained staff need to ensure the systems are kept up to date.
Training in data analysis and production of annual park and national reports	All rhino conservation areas	20 staff trained	Yes annual reports produced since 2004.
Training in rhino browse assessment	State and private rhino areas	15 staff provided basic training with 8 selected staff provided further advanced training	Yes – this requires specific skills and interest in plant ecology. The trained team has now conducted assessment of one new area.
Training in population estimation using RHINO software	Kenya Rhino Programme	four staff trained	Yes – population estimates for four areas obtained so far.
Training in radio telemetry and GPS	Kenya rhino and veterinary staff	10 staff trained	Yes all translocated rhino fitted with radio transmitters and tracked. Additional staff

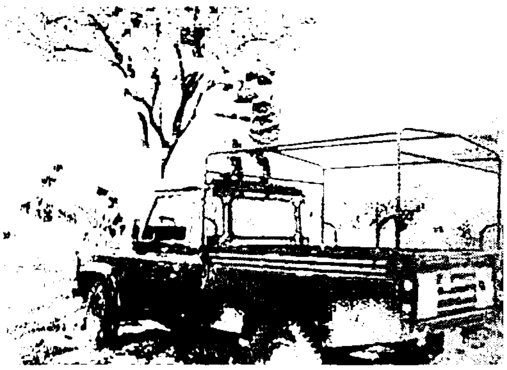


Figure 43: A ranger scanning the area, for rhino / illegal activities, using a pair of binoculars.

Figure 44: A ranger taking a location measurement using a Garmin GPS receiver.

The night census and monitoring exercise carried out regularly during the dry season at fixed water holes in Tsavo West NP Ngulia RS has proven to be invaluable since its initiation in 1996. For the majority of the Ngulia rhinos, this has been the most reliable method for monitoring their health and breeding status (Figure 45). Night-monitoring equipment has greatly aided the field staff in the identification of the animals. Twelve third generation night optical viewers with light-sensitivity levels of 10^{-4} lux (starlight) have been procured through KWS-ZSL project funded by USAID. These have improved the rhino surveys at the waterholes. The use of nigh photography using digital cameras has also provided much-needed information on the animals for verification and population estimation.

Figure 45: Black rhino at a waterhole in Tsavo West Ngulia RS

Computer systems (including printers, solar based power supply systems where needed) for field data storage, analysis and reporting were procured and set-up in all areas except Chyulu Hills NP through the USAID grant. Laptops were also obtained for scientific work through the UK Darwin Initiative project. These have been maintained, used well and the resulting information from monthly and status reports have been applied for informed decision-making. The Rhino Programme has also established a system for assessing/reporting equipment and transport needs in State rhino conservation areas to improve planning and fund raising which has mostly been reactive in the past.

6.4 Generation and use of funds

6.4.1 Economic and tourism potential

All black rhino in Kenya are important and valuable animals for tourist viewing, and, as one of the 'big five' game species, provide as much viewing satisfaction to visitors as elephant, lion or leopard *Panthera pardus*; this factor has increased with the specie's endangered status and general scarcity. However, the best rhino habitats are generally areas of dense bushland or forest, where black rhino are unlikely to be sighted by visitors, unless the animals are attracted to particular lodges or viewing sites (e.g. The Ark Lodge in the Aberdares NP Salient). In general, the more open the habitat and the higher the density of rhinos and, in particular, the more habituated the animals are to tourist vehicles, the more rhino are likely to be seen by paying visitors and therefore the more valuable they are for tourist viewing. White rhino can play an important role because being grazers they can be seen much more easily in open grassland areas. The presence of rhino appears to be a major contribution to park/reserve gate revenues (Table 16). Lake Nakuru NP gate receipts have almost doubled since 2000 as one can now easily see white rhino and there is a good chance to see black rhino. About 80% of the visitors that visit Tsavo West NP visit Ngulia RS. One can virtually be guaranteed a sighting of black rhino in Nairobi NP because of their high density and the particular tameness of several well-known individuals. The present and future 'showcase' rhino sanctuaries, such as Nairobi NP and Lake Nakuru NP are therefore also very important sources of revenue and need to be managed carefully. Realising this, KWS has established a system of fair revenue retention for State rhino conservation areas. Thus, increased revenues should be allocated to managing rhino areas as detailed in annual work plans. This will act as a motivational tool for rhino conservation areas hence boosting the species conservation efforts.

Table 16: State rhino areas visitor statistics from 2000 to 2005.

Park Name	2000	2001	2002	2003	2004	2005
Aberdares NP	44,039	40,214	41,163	37,469	44,039	48,337
Lake Nakuru NP	162,358	201,335	229,808	216,654	256,966	344,598
Meru NP	5,590	8,229	6,563	5,210	6,417	8,935
Nairobi NP	112,227	100,471	90,447	80,042	92,544	99,927
Tsavo East NP	123,332	132,427	152,776	131,555	158,478	180,077
Tsavo West & Chyulu Hills NPs	75,533	78,969	76,046	69,840	92,658	105,749
Total	1,200,758	1,265,301	1,467,002	1,253,728	1,402,052	1,674,693

6.4.2 KWS funding

Financial self sufficiency and sustainability is one of the core objectives of KWS. This is especially critical given the expected reduction in the government subvention and competition for financial resources from other sectors. Nonetheless, the government in the last 3 years (2004 to 2007) has increased its annual budget allocation to KWS by 100% i.e. from 0.7 billion Kshs (*c.* UK£4.7 million) to 1.4 billion Kshs (*c.* UK£9.4 million). The proportion of KWS budget allocated to the Kenya Rhino Programme has also increased significantly. KWS is identifying alternative sources of revenue to reduce dependency on tourism-related revenue, steam-lining the collection of and accounting for revenue and actively lobbing for enhanced long-term funding from the government, partners and communities. KWS (Endowment) Fund was envisaged in Sec. 5A of the Wildlife (Conservation and Wildlife) (Amendment) Act. Once it is set up the funding of specific expenditures and programmes (e.g. rhino conservation) could be designated to this fund. This would provide predictability in budgeting and the implementation of planned activities and strategic and management plans.

6.4.3 Donor & NGO support

KWS allocates annual funding, particularly for recurrent costs, to each State rhino conservation area (through the respective area wardens) and the Rhino Programme at KWS headquarters. However, each rhino conservation area, particularly the fenced rhino sanctuaries, carries a heavy maintenance burden, and over the years, the continuous assistance of several donors and NGOs for maintenance of rhino areas, key activities (e.g. translocations) and provision of emergency funding has been crucial to their success.

To ensure a consistent level of funding over the long term, both internal and external financial support will continue to be necessary. With the government of Kenya now committing funds for operational costs, donor support is being encouraged for capital items and specific projects.

During the past 5 years, donor funds and KWS contributions have in many cases been harmonised with agreed annual work plans. Several annual planning meetings for allocating/using funds were held and proposals and annual work plans developed, between Kenya Rhino Programme and donor partners through the agreed co-ordination mechanism. Supporting NGOs included African Wildlife Foundation, Chester Zoo (North of England Zoological Society), Eden Wildlife Trust, Frankfurt Zoological Society, Frefrei Geboren, Rhino Rescue, Save the Rhino International, UK Government Darwin Initiative, United States Agency for International Development, US-Fish and Wildlife Service, WWF, Zoo D'Amnevile, Zoological Society of London, and several other individual supporters.

The leadership shown by KWS in recent years in taking increasing responsibility for determining strategy and financing work plans for rhino and other species is a very encouraging sign, ensuring independence from external, often conflicting influences from the global conservation and animal welfare community. A high dependence historically on donor funds resulted in undue responsibility given to agencies with poor ownership of the problem or solutions for conservation amongst Kenyans.

6.4.4 Government of Kenya support

Central government support to the Kenya Rhino Programme in the past strategic period included:

- Ratification of the 2001–2005 strategy. This gave the strategy a stronger base for implementing the activities and obtaining support from partner organisations.
- Tax exemption (VAT and Duty), through the Ministry of Wildlife and Tourism, for equipment imported into the country for rhino conservation.
- Increased allocation of funds to KWS that directly benefited rhino conservation; for example, removal of elephants from Ngulia RS and purchase of four new rhino monitoring vehicles.

There is also a need for central government assistance in areas such as processing of private sanctuary and community police reservist applications and renewal of firearm permits.

6.4.5 Private sector support

The private land rhino sanctuaries have and are continuing to play a significant role in providing financial ad technical support in rhino management, monitoring, science and conservation in general. This includes providing funding and necessary resources for translocations, which is a key component in metapopulation management, and developing proposals for funding. There is also an increasing area of land allocated to rhino conservation on private lands; for example, Lewa WC is seeking expansion and collaboration with Borana community lands, Ol Pejeta WC expanded its rhino conservation area by additional *c.* 300 km^2, Ol Jogi GR opened up an extra *c.* 200 km^2 for rhino conservation, while Mugie Ranch set aside *c.*100 km^2 where a new black rhino sanctuary was established.

Community engagement and participation

During the last strategy period community issues did not receive much attention. There was greater focus on biological management of enclosed/fenced rhino populations. The highly protected fenced populations are now reaching or have already reached capacity and new areas are required for re-stocking. Threats to free-release sites must therefore be a priority for consideration and action. The communities surrounding these free-release sites will require to be engaged in positive interaction in rhino conservation; for example, through rhino conservation education programmes, involvement of community leaders in conservation activities (e.g. translocations - captures and releases) and establishment of community monitors in appropriate areas. Ways in which communities can benefit positively from rhino conservation should also be explored; for example, through sharing of tourism revenues, entrepreneurial opportunities, employment and skills development, establishment of community-based natural-resource management programmes and community rhino conservation areas (e.g. Naikarra/Laleta).

Background

The conservation and management of wildlife in Kenya is vested in KWS, a parastatal organisation under the Ministry of Environment, Natural Resources and Wildlife. It is charged with the implementation of the Wildlife Policy (1975) and the Wildlife Act (revised in 1989), and general planning and management of wildlife in Kenya. All black rhino in Kenya are State-owned. KWS is therefore responsible for the implementation and monitoring of the black rhino conservation and management strategy. To achieve the overall goal of the strategy all stakeholders (private sector plus NGO partners, donors and KWS) are required to work together under a well co-ordinated and managed system with proper organisational and management structures.

The Kenya Rhino Programme currently has two operational committees to oversee and advise on Rhino Conservation matters. These are the Rhino Management Committee (RMC) — a forum for all stakeholders to consult on all rhino related matters and review the management of all rhino conservation areas; and the Rhino Executive Committee (REC) headed by the KWS Director — responsible for policy formulation and all executive decisions on implementation of technical issues. A third committee recommended in the existing strategy, the Rhino Technical Committee (RTC) to provide technical advice to REC was not set-up. Its creation is now a priority. There is also the Association of Private Land Rhino Sanctuaries (APLRS) which is a registered association with its own membership and terms of reference focused on representation of the interests of the owners and managers of rhino sanctuaries on private land, and liaison between the Association and KWS. Members of the REC are appointed by the Director of KWS while the RMC is constituted by the Rhino Coordinator (RC).

The REC has so far met once a year. The meetings primarily focussed on: the review of the annual status reports and progress on the implementation of the strategy; the establishment of new rhino populations including the creation of Mugie RS, Meru NP Rhino Santuary; the Tsavo West IPZ and extension of existing areas; rhino translocations; enhancement of security; and the establishment of the EAC-RMG. It made key decisions in each of these areas and, therefore, has been effective. It will be useful for the REC to meet more regularly (every 6 months) and the establishment of the RTC will help in making technical recommendations or decisions. There should be a review of the composition of the rhino management committees (e.g. the REC should also be represented by the chairman of the APRLS), the role and responsibilities of the committees should be monitored and assessed for effectiveness, and the frequency of meetings should be increased to enhance coordination.

The management of rhino involves several KWS departments (Research & Planning Department, Security Department and Wildlife Department). Coordination across all these departments down to the conservation-area level has been a challenge which needs to be addressed with a revised structure. Following restructuring of KWS in 2005 (as contained in the 2005-2010 KWS Strategic Plan), the Rhino Programme was placed in the Species Conservation and Management Department within the Biodiversity Research and Monitoring Division of KWS. The new KWS organisational structuring has decentralised activities from the headquarters to area wardens (Area Assistant Directors). The area wardens therefore assume full responsibility on all conservation and management issues in their respective areas. Rhino Wardens in the field report to senior wardens of the park, who then report to the area wardens. It has also been proposed that the field structure should have a scientist specifically in charge of endangered species including rhino in each area. The management and information flow / link between the rhino warden on the ground, the senior (park) and area wardens, district wardens, proposed species field scientist, Rhino Programme Headquarters (species programme) and rhino management committees needs to be clearly defined in a revised and effective coordination structure.

[illegible] and support

The Kenya Rhino Programme is administered at KWS Headquarters, at present falling under a Rhino Programme Coordinator/Senior Scientist, reporting to the Species Department Manager, Deputy Director Scientific Services (Research & Monitoring), Deputy Director Wildlife Services (Management) and Deputy Director Security (Protection & Security). The Kenya Rhino Programme Coordinator is in charge of administration, liaison with donors on various rhino projects and activities, rhino security and surveillance, research and monitoring, translocation and national status reporting.

All rhino conservation activities in each State rhino sanctuary [Nairobi NP, Lake Nakuru NP, Aberdares NP, and Ngulia RS (Tsavo West NP), Tsavo East NP, Meru NP, Chyulu Hills NP] fall under a Rhino Warden, reporting directly to the Warden or Senior Warden in charge of each area. These Rhino Wardens are responsible for (1) security and surveillance of rhinos, (2) management and maintenance of all necessary infrastructure (fencing, vehicles, water systems), as appropriate, (3) all rhino monitoring personnel and in enclosed sanctuaries fence maintenance staff, (4) data collection, quality checking and storage, (5) monitoring equipment and computer system, (6) training of monitoring staff in rhino monitoring, (7) production of monthly progress reports submitted to the Rhino Programme Office and Senior Warden and (7) production of park annual status report.

All security of rhino in Kenya is supervised and directed through the Division of Security in liaison with the Division of Wildlife Services, specifically the Senior Wardens and Rhino Wardens of each national park. Assistant research officers in each national park with rhino should supervise and participate in research work and, where necessary, in rhino population monitoring, surveys, data collection, analyses and production of research reports in collaboration with the Rhino Warden and Rhino Coordinator.

7.3.1 Veterinary support and interventions

All rhino captures and translocations approved by the KWS Director are carried out by the KWS Veterinary Department (under the Chief Veterinary Officer) and KWS Capture Unit (under the Officer-in-Charge of the Capture Unit). The Rhino Programme and Veterinary Department at KWS make every effort to ensure that captures and translocations are carried out efficiently and timely emergency veterinary care is provided. The Rhino Programme works closely with the Veterinary Department and provides support as needed (e.g. procurement of drugs and veterinary equipment, financial and transport facilitation and training of relevant veterinary personnel in radio telemetry and fitting of transmitters).

Some improvements are needed. A veterinarian should be deployed in each area to improve veterinary response time. KWS recruited seven veterinarians over the last 5 years to replace staff who had left. The Veterinary Department is progressively setting up field veterinary stations to enable a quick response to cases. One veterinarian has been deployed at Lewa WC to handle veterinary issues in Laikipia region and the North. A veterinary officer has also been posted to the Tsavo conservation area, while another has been posted to the Mara to handle cases within the Central Rift conservation area. The capacity for post-mortem examinations (laboratory equipment, staff and training) needs to be enhanced (e.g. definitive diagnosis of suspect anthrax cases has not been resolved. An operational KWS helicopter is also crucial for the work; lack of a helicopter between 2003 and 2006 delayed rhino translocations and veterinary interventions. However, competence in ground darting techniques needs to be enhanced as staff turnover can lead to problems in this regard. Although a dangerous method with appropriate fixed wind support, good communication systems competent safety officers and vets this is a highly feasible and economic method of capturing rhino. Sufficient vehicles and equipment are also needed to enhance response to veterinary cases. As knowledge of rhino disease is still in its infancy more effort is needed to establish normal patterns of infection and illness with confirmatory diagnosis achieved in as many cases as possible.

7.3.2 Terms of reference for rhino staff

Terms of reference (ToR) and reporting lines for management, security and scientific staff involved in the Kenya Rhino Programme were produced at different times between 2000 and 2003 and reviewed in 2005 following directive to decentralise KWS activities. A further review was done in 2006 following a job evaluation exercise. Revised ToRs for management and scientific staff (e.g. Rhino Wardens) have been produced.

7.3.3 Site-specific management plans

Site-specific management plans have been developed for five rhino areas (Lake Nakuru NP, Nairobi NP, Solio GR, Ol Pejeta WC and Ol Jogi GR). Management plans for other rhino areas also need to be produced and implemented. A mechanism for monitoring progress of site-specific plans should also be developed.

7.3.4 Status reporting and feedback

Training of 26 rhino staff in the production of park status reports was carried out in 2004 and subsequently detailed 2004 and 2005 park and national status reports were produced, reviewed (by the REC) and feedback provided to the park and rhino wardens. Prior to this, status reports consisted of a one-page summarised table of rhino numbers.

7.3.5 Regional cooperation

Currently, regional cooperation activities include the Mara-Serengeti joint security patrols and trans-boundary meetings, held at least once a year, involving all concerned Tanzanian and Kenyan stakeholders. There is also significant scope to expand the regional cooperation through the proposed EAC-RMG (Please see Section 4.8.2).

8 Case Studies

8.1 High density of browsers (Ngulia Rhino Sanctuary)

The Ngulia RS located in the central part of Tsavo West NP is completely fenced with an area of 62 km^2. It has been one of the more successful areas for the protection and breeding of black rhinos in Kenya since 1986 when it was created 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 rhino.

Following concerns on the deteriorating vegetation condition in the sanctuary (Figure 46), detailed analysis of population data and assessment of habitat estimated a 59% decline in the available rhino browse by 2005 (rhino food plants: below 2 m high) and 100% decline of browse material above 2 m high (Figure 47) and that the rhino population performance had been significantly declining over several years owing to high densities of rhinos (Figure 48) and competing browsers particularly elephants (Table 17) (Brett & Adcock 2002, Okita-Ouma, Amin *et al.* 2006). The annual growth rate had fallen to below the minimum national target of 5% (Okita-Ouma & Wandera 2006) and the situation warranted intervention. 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 (Anon. 1993), which was also no longer applicable owing to the significant degradation of habitat by competing browsers, notably elephant and giraffe. 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. The average body condition of both rhino and elephant had also deteriorated from an average "good" to "fair"–"poor".

Figure 46: A satellite image (2001) of Ngulia RS showing the extent of vegetation degradation owing to high density of browser species (especially elephant) within the sanctuary.

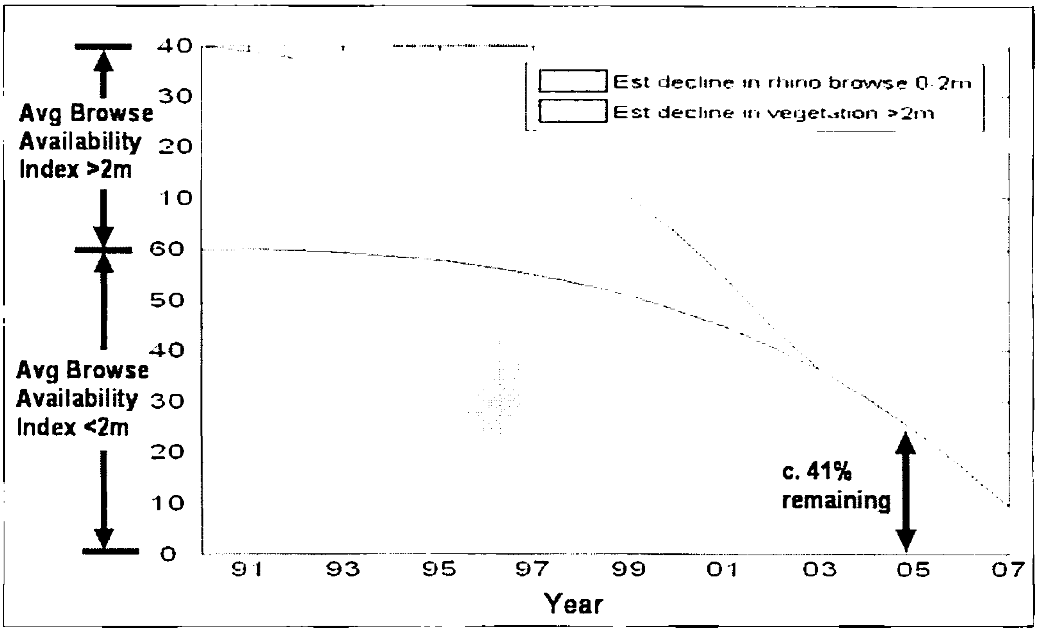


Figure 47: Estimated patterns of elephant impact on browse in the >2 m and of 0–2 m height ranges (updated from Brett & Adcock 2002).

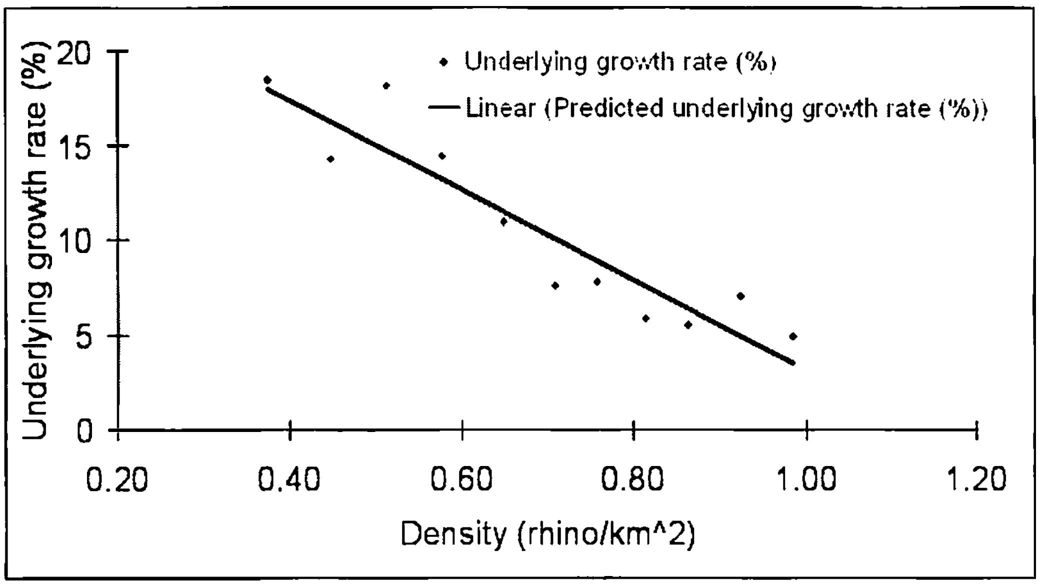


Figure 48: Linear relationship between rhino density and underlying growth rate in Ngulia RS. The graph shows that -22.60 x density +26.23 significantly explained 85.9% of the variation in the underlying growth rate ($F_{1,10}$=61.11; P=0.000). (updated from Okita-Ouma 2004).

Table 17: Estimated number of large herbivores in Ngulia RS (2005)

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

The overstocking was threatening the sanctuary's productive potential for rhino. 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 and a population crash. In similar situations, other black rhino populations have crashed (Hitchins 1968; Emslie & Brooks 1999; Emslie 2001).

The high number of large herbivores also imposed a major burden on the sanctuary's infrastructure, in particular 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 water holes provide the only source of water in the sanctuary during the dry season (July–October). With the increasing densities of herbivores there were dangerous water-access conflicts developing between the rhino and elephants and significant maintenance problems and costs associated with elephants digging up and breaking water pipes and fittings. Monitoring rhino was also becoming a hazardous exercise.

A number of approaches were considered for improving the breeding performance of the rhino population and the productivity of the sanctuary (Brett & Adcock 2002; Okita-Ouma & Amin *et al.* 2006). This included (1) reduction and control of numbers of competing browsers in the sanctuary particularly elephant but also giraffe and buffalo (which can take over 25% of their diet as browse); (2) expansion of the sanctuary; (3) destocking of rhino from the sanctuary by establishing a population outside the fenced area within an IPZ in Ngulia and Rhino valleys, Tsavo West NP.

The extension of the sanctuary by an extra 26 km^2 started in June 2006 and planned to be completed in June 2007[8]. Rhinos will be translocated in to the extended area rather than allowing them to move in naturally (rhinos are poor colonizers) and also to ensure vacuums are not created. The removal of elephants from the sanctuary began in October 2005 and was completed in October 2006. Removal of the elephants from the sanctuary was a considerable success and technical achievement for the KWS (Figure 49). A total of 255 elephants were removed from the sanctuary (Okita-Ouma *et al.* 2007). 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 rhino. The next phase is to reduce the rhino densities inside the sanctuary to below the Maximum Productivity Carrying Capacity (MPCC) level by moving rhino into the sanctuary extension and translocating surplus rhinos into the surrounding valleys (IPZ) as a complementary unfenced population in Tsavo West NP.

[8] This was completed in May 2007

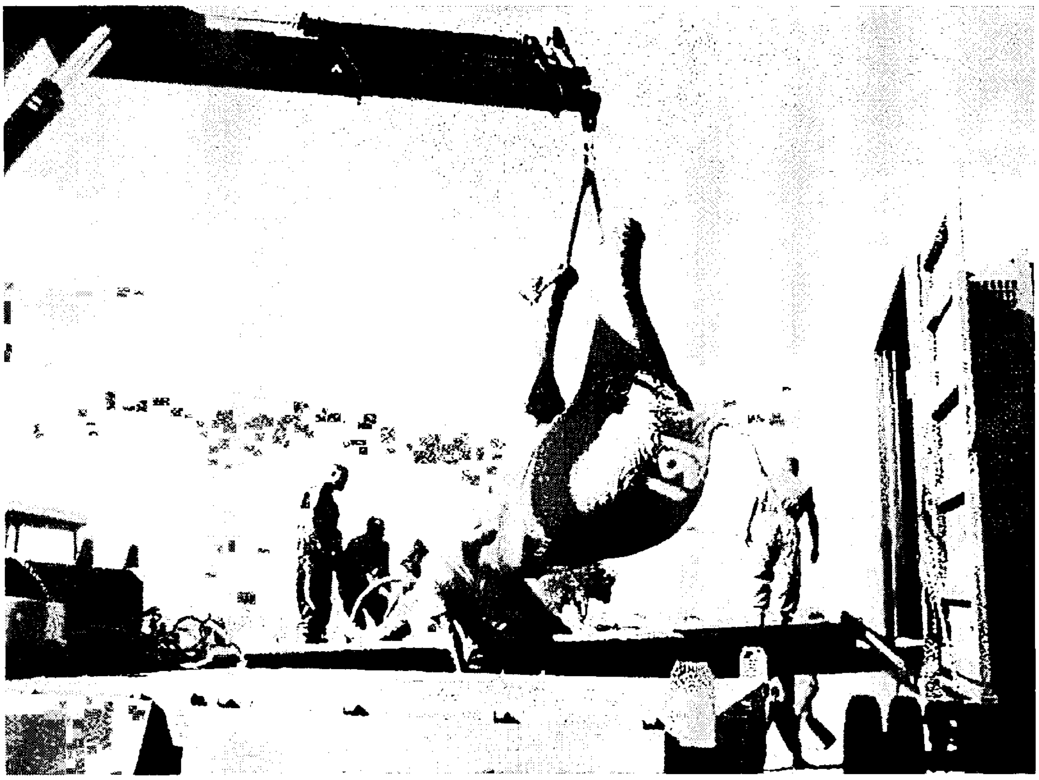


Figure 49: An elephant being loaded on to an Iveco lorry.

8.2 Successful harvesting population (Nairobi National Park)

Nairobi NP was the first National Park to be established and gazetted in East Africa in 1946. It covers an area of 117 km^2 and is partially fenced leaving approximately 20 km perimeter on its southern boundary for animal migration. In 1946, when Nairobi NP was originally gazetted, only a few rhinos were known to pass through the area. The spreading settlement of the capital city caused six rhinos to take up residence in the Park by 1962. Two batches, totalling 34 black rhinos from source localities in both highland and lowland areas of Kenya, were moved into Nairobi NP from 1963 to 1968. Little monitoring took place during the 1970s, and first estimates after the stocking were made as part of the country-wide survey initiated in 1982. The accuracy of the estimates from the early 1980s was in doubt, because an individual identification study in 1988 produced a total of 55 rhinos with a high proportion of calves.

The first removal of rhinos from Nairobi NP took place in 1984 and 1985 when two rhinos were translocated to Lewa WC, and one further rhino was removed in 1987 to Lake Nakuru NP. Three orphan rhinos were introduced to Nairobi NP in 1983, 1986 and 1988, from Amboseli NP and Masai Mara NR. In 1989, rhinos in Nairobi NP were recognised to be at or close to carrying capacity, estimated to be around 65 rhinos or a density of 0.55 rhinos per km^2. It was decided by the management at the time to manage the population between 50 and 60 rhinos. Since then, Nairobi NP has been a major source of rhinos for the sanctuary programme. Sixty-seven rhinos have since been harvested for re-stocking other areas between 1989 and 2006 (Figure 50). The current MPCC estimate is 50 rhinos.

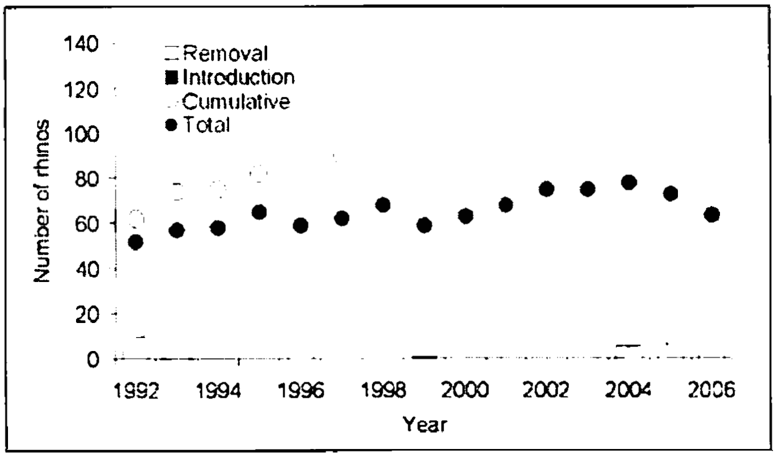


Figure 50a: shows a total of 67 rhinos translocated from Nairobi NP between 1992 and 2006. This translated to average annual off-take of 6.24%.

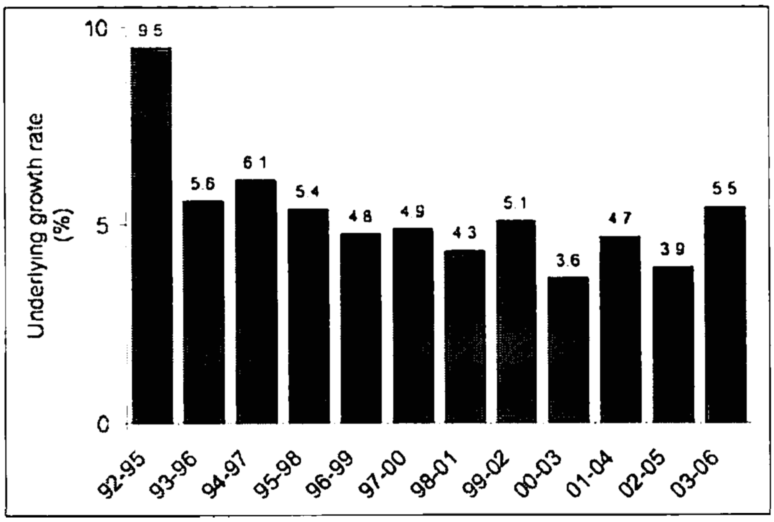


Figure 50b shows the resultant average growth rate of 5.4%.

8.3 Declining highland population (Aberdares National Park

The Aberdares forest was known to hold one of the highest densities of black rhino in Kenya in the 1940s and 1950s, with densities of at least one rhino per km^2 estimated (Anon. 1993). Rhinos were a considerable hazard for security forces operating in the Aberdares forests during this period. Most of the forested areas and suitable rhino habitat were found outside of the National Park in the forest reserves at lower altitudes surrounding it, though large numbers continued to be found in the 70 km^2 Aberdares NP - Salient.

During the late 1970s and early 1980s the Aberdares forests suffered extensive illegal hunting of rhinos, particularly from poachers using packs of dogs. Snaring was and still is a significant problem in the area. The tourist lodges in the Salient (Ark and Treetops) had always been visited by large numbers of rhinos, but the decline in the rhino population was also witnessed here, particularly at Treetops. The rhino population in the Karameno forest area was completely eliminated during this period. Estimated rhino numbers in the National Park fell from 450 in the early 1970s to 132 in 1982, and down to 30 in 1987 (Sillero-Zubiri & Gotelli 1991). The last major outbreak of rhino poaching in the National Park was in 1984. There are signs that the population has declined due to suspected poaching in the last few years. Most of the present information on the Salient rhino population is derived from sighting records at the Ark and Treetops lodges and a number of known rhinos have not been sighted in the last couple of years. A pilot survey based on transects in 2006 also found

Figure 51: Typical terrain with dense vegetation in the Salient, Aberdares NP.© KWS Rhino Programme & ZSL, 2005.

very few indirect rhino signs. It is assumed that the number may be as low as 10 individuals. An accurate figure for the total number of black rhinos in the Aberdares is currently not available due to the difficulty in sighting the few remaining rhinos in the dense vegetation and rugged terrain (see Figure 51). Besides poaching through snaring, the only other potential threat to the rhino population in the Aberdares are predators - spotted hyaena (*Crocuta crocuta*); some adults carry signs of hyaena attacks in the form of missing ears and tails. However this is not unusual in rhino populations in areas with spotted hyenas and with the exception of Ngorongro, hyenas have not been implicated as a possible major cause of black rhino population declines. No cases of predation on black rhino by lions in the Salient have been recorded.

The Aberdares NP Salient was identified as a priority area for the development of a rhino sanctuary from 1983 onwards (Jenkins Unpublished a,b; Kenya Rhino Rescue Project 1985). An ambitious plan was drawn up to fence the entire National Park, funded and coordinated by the charity Rhino Ark (Kuhle 1989). Phase I of this plan, fencing of the Park boundary of the Salient, was successfully completed in 1990. It became clear that further phases would have to follow the forest reserve boundary outside the National Park, to include the main areas of potential rhino habitat inside the fenced area. The fencing of Aberdares NP was completed in 2007 (Figure 52).

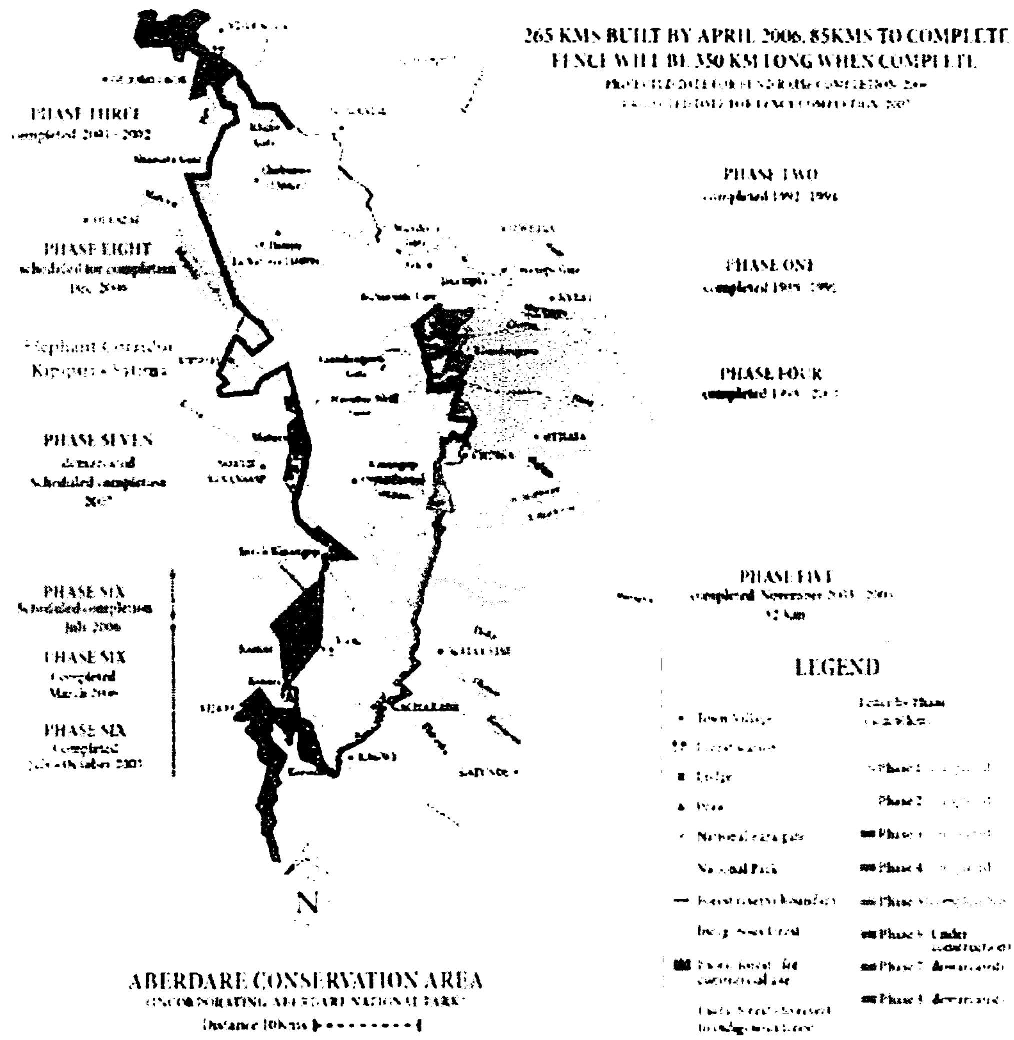


Figure 52: The fencing of Aberdares NP (*courtesy of Rhino Ark*).

The fences have been designed more as a general barrier to wildlife from leaving the park/reserve and raiding crops in settlement areas outside, particularly to elephants, baboon (*Papio cynocephalus*), and burrowing wildlife (e.g. bushpigs *Potamochoerus porcus*). To this end, Boral ring-lock mesh wire, buried to about 1 m deep, has been a key component of the Aberdares fence, in addition to anti-baboon devices in particular sectors.

An accurate census of the population will only come after at least a year of intensive surveys/monitoring of the Salient and surrounding areas. Individual identification work at hides placed at salt licks, in addition to those at the present lodge sites, would help. A dedicated patrol system should be established with information on patrol movements, illegal activities and rhino sightings (direct and indirect) integrated into a GIS to help in deployment of patrols. Adequate security, fencing and monitoring are essential conditions for protection and translocation of black rhinos to the enclosed National Park and forest reserve areas (e.g. Chebuswa, Karameno), which could absorb large numbers of surplus rhinos from Solio GR. A viable population needs to be established and as a first step, trial releases of two to three rhinos into selected areas of the Aberdares Salient bounded by the new fence line is required following the set-up of a proper monitoring system. Further introductions can then follow into these areas of the Aberdares NP and forest reserves, depending on the initial releases and subsequent intensive monitoring of the rhinos' movements, including the use of radio-telemetry, and accumulation of better knowledge of the distribution and numbers of rhinos in the Salient.

[illegible]
(Tsavo West National Park and Masai Mara National Reserve)

The numbers of rhinos in Tsavos dramatically declined through 1970s and mid-1980s. Estimates suggest that only 10 rhinos survived throughout Tsavo ecosystem by 1988 down from an estimate of more than 7,000 in early 1970s. A fenced sanctuary (Ngulia RS) was established in Tsavo West NP in 1986 to begin the process of re-establishing a viable rhino population within the Tsavo ecosystem. The Ngulia RS was complimented by a free-ranging approach without the need for electric fencing in Tsavo East NP. Here 48 black rhino from Solio GR and Nairobi NP were released between 1993 and 1999 for re-colonisation.

Security threats, mainly from neighbouring Somalia, have been intense for this population and have claimed lives of both rhinos and rangers. The severity of poaching threat is still high but being addressed through a range of security mechanisms. There are plans to set up an IPZ in the Tsavo West NP where security threat is perceived less compared to that in Tsavo East NP. The establishment of large secure-breeding nuclei in several areas of Tsavo NP have the best prospects of eventually producing a large wild population numbering over 100 rhinos (as already achieved in the restocking of Kruger NP with rhinos translocated from the Hluhluwe-Umfolozi Game Reserve). Given adequate security by highly motivated team, the potential of Tsavo NP for holding at least 5,000 black rhino still exists.

The number of rhinos in Masai Mara also declined during the 1970s owing to poaching for horn. This free-ranging population, also considered indigenous used to range the entire Mara ecosystem which consists of the Masai Mara NR. Naikara-Laleta community lands, Transmara and the Serengeti. The Masai Mara population has been stable since early 1990s but the population in Naikarra-Laleta has declined to probably one rhino while only three are known to reside in Transmara. There is need to determine factors that could be contributing to Masai Mara's sub-optimal growth rate which are currently thought to be: frequent fires; grass interference and sparse suitable browse availability possibly as a result of browsing pressure; the reserve used to have greater relative abundances of *Acacia*s and other more palatable species (e.g. *Grewia*'s) compared to recent conditions (Mukinya 1977; Walpole & Matankory 2002; Walpole *et al.* 2004).

8.5 Site level operational support (Ngulia Rhino Sanctuary)

Developing direct site support initiatives can have major conservation benefits at both the local and national programme level. A good case study is the ongoing operational support collaboration between KWS and NGOs for the Ngulia RS.

Established in the mid-1980s the Ngulia RS is today a fully enclosed 62 km^2 sanctuary (with a further extension of 26 km^2 currently being constructed) located some 40 km inside the c. 9000 km^2 Tsavo West NP. Although the rhino population in Tsavo (which used to number some 7,000 animals in the late 1960s) was almost completely eradicated by poachers, the habitat remains one of the richest in East Africa.

The Ngulia RS was setup as a way of re-establishing a large population of black rhinos within the central part of Tsavo West NP, using a simple electric-fencing system to keep re-introduced rhinos within one area so that a secure breeding nucleus could be formed. Because the sanctuary is surrounded by good rhino habitat it is possible to establish a large free-ranging population within this sector of Tsavo West NP. Ngulia RS has been at the forefront of implementing and testing the programme's monitoring elements.

Regular funding collaboration between KWS and NGOs (ZSL, AWF, Eden Trust, WWF) has helped to maintain Ngulia RS's crucial artificial water holes in a fully serviced operational condition. This site-support link has also enabled ranger housing and transport provision to be improved, helped relocate damaging elephant populations, extent the sanctuary and construct rhino translocation bomas for the IPZ (Figure 53). The site relationship has also helped secure additional USAID funds for the set-up of the computer monitoring system (including solar panels and battery) and field equipment for the monitoring team, and the UK Darwin Initiative grant monies through ZSL were used with technical support for implementing the monitoring and biological components of the national 5 year strategy.

Such site-support collaborations can also directly benefit surrounding local communities. Examples range from enhanced engagement outreach capacity of the conservation programme through to infrastructural development projects such as improved water access (Figure 54), education centre at park headquarters and school facilities. Local-community engagement initiatives of this nature can significantly raise the perceived value of, and subsequent support for, the rhino conservation programme from which such additional resource opportunities are derived.

As would be expected, sustained, close working partnerships driven by needs determined by the management authority and rhino managers in Kenya of the nature described throughout this report, provide the best chance of realising the greatest conservation impact.

Figure 53: Essential infrastructure and equipment support

Figure 54: A water borehole system for the buffer zone community

Adcock, K., (2001): User guide to the Rhino Management Group Black Rhino Carrying Capacity Model Version 1. SADC Regional Programme for Rhino Conservation.

Adcock, K. (2005): Visual assessment of black rhino browse availability version 3. Darwin Initiative and SADC Regional Programme for Rhino Conservation.

Adcock, K., Amin, R. & Khayale, C. (2007): Habitat characteristics and carrying capacity relationships of nine Kenyan black rhino areas. *Darwin Initiative Report.* Unpublished report. London: Darwin Initiative Secretariat, Department for Environment, Food & Rural Affairs.

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