Management of Black Rhino in the Ngorongoro Crater

A report on the workshop held at Serena Lodge, Ngorongoro, 3-4 September 2003

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EXECUTIVE SUMMARY

A workshop on the conservation and management of black rhinoceros (*Diceros bicornis michaeli*) in the Ngorongoro Crater was held at Serena Lodge, Ngorongoro Conservation Area (NCA) during 3-4 September 2003. This report summarises the formal presentations and informal working group reports that were given at the workshop. A consensus emerged from the meeting that active management was urgently required to ensure the long-term survival of black rhino in the Crater.

The main threats facing the small population of black rhino in the Crater were identified as: (i) genetic constraints due to inbreeding; (ii) slow population growth which was historically due to poaching and was currently due to high calf mortality; (iii) degradation of habitat; and (iv) lack of suitable calving areas where there was shelter, browse, water, little disturbance and few predators. Other threats to the rhino include (v) competition for browse from buffalo and elephant; (vi) disturbance from elephant; (vii) disturbance from tourist vehicles; and (viii) an increase in tick-borne diseases. The recommendations for counteracting these threats that emerged from workshop discussions are listed below.

Genetic constraints: (i) translocate breeding females into the Crater to increase genetic diversity; (ii) translocate the dominant breeding bull out of the Crater; (iii) identify suitable areas for establishing additional founder populations in the Serengeti Mara Ecosystem; and (iv) form a Serengeti Mara Ecosystem Rhino Working Group to facilitate metapopulation decision-making and cooperation between different conservation authorities.

Slow population growth: (i) maintain the high level of security in the Crater; (ii) translocate several breeding females into the Crater; and (iii) monitor cows and calves closely particularly when calves are less than 4 months old; and (iv) use non-lethal intervention when hyenas are observed threatening rhino calves.

Degradation of habitat: (i) restore the Lerai Forest by increasing the flow of fresh water into the forest (through the provision of an alternative water supply to lodges and settlements on the Crater rim), excluding elephants (using an electrified strand of wire), and irrigating surface soils to flush out salts; (ii) develop a Fire Management Programme to reduce encroachment of unpalatable shrubs on the Crater slopes, increase the palatability of moribund, inherently palatable shrubs, increase leguminous browse species, reduce the area invaded by weeds and maintain a greater area of grassland communities in a vigorous/non-moribund condition; (iii) develop a Vegetation Monitoring Programme that provides information for fire management decisions and determines the black rhino carrying capacity of the Crater; and (iv) develop an Alien Species Control Programme that monitors and controls the invasion of alien species into the NCA.

Competition for browse: (i) undertake research to determine which browse species are utilized by rhino, buffalo, elephant and other browsers; (ii) develop a policy dependant upon the results of this research.

Disturbance from elephants: (i) exclude elephants from Lerai Forest in the short term; (ii) monitor the effect of elephant exclusion on rhino behaviour and recovery of the Lerai Forest; and (iii) quantify elephant activity in rhino calving and browsing areas.

Disturbance from tourists: (i) develop a new vision for the Crater of minimising disturbance to the ecosystem; (ii) enforce strict control over the number of vehicles entering the Crater; (iii) disperse tourists to other regions of NCA; (iv) offer walking and horse safaris in the NCA to reduce vehicle pressure in the Crater; (v) close unwanted tracks; (vi) develop a Road Management Plan; (vii) keep the road between Lake Magadi and Lerai Forest closed; and (viii) consider a low maintenance road system (e.g. bitumen/murram mix).

Increase in tick-borne diseases: (i) determine the types of tick-borne diseases present in the NCA and quantify the risk that these diseases pose to rhino; (ii) determine the dynamics of tick populations in the Crater; (iii) continue with the assessment of using fire to control ticks; (iv) reduce buffalo numbers (which increase tick levels) by reducing area of tall grasslands through controlled burning; and (v) improve nutrition of rhino by managing vegetation with controlled burning (and thereby increase resistance to ticks / tick-borne diseases)

The conservation of black rhino in the NCA requires management action, political support and financial backing. A situation of “paralysis by analysis” must be avoided. Management should aim to take decisions quickly and to implement policy efficiently.

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1. INTRODUCTION

The number of black rhino in the Ngorongoro Crater decreased from ~110 in the early 1960's to ~20 by the mid 1970's primarily as a result of poaching. The rhino population has fluctuated around 20 individuals for the last thirty years and the last poaching incident was in 1995. The security in the Crater has greatly improved over the last decade and the risk of poaching is now much reduced. Despite the improved security, the rhino population in the Crater has not increased. Effective conservation of the Ngorongoro black rhino population is important because: (i) it is the most secure Tanzanian population of a Critically Endangered species; and (ii) it constitutes a major tourist attraction for the NCA and Tanzania as a whole. The Ngorongoro rhino frequently move through open grassland, unlike black rhino in other areas that tend to avoid open areas. Tourists consequently have a better chance to view these rhino than in most other parks and the Crater population has as a result become world-renowned. The long-term conservation of the Ngorongoro rhino is, however, under threat due to a combination of factors including: (i) the slow growth of the population; (ii) the risk of inbreeding; (iii) deterioration of rhino habitat; and (iv) the high incidence of tick-borne diseases. A workshop hosted by the Ngorongoro Conservation Area Authority was convened for rhino managers and scientists to discuss these threats and recommend the way forward for effective black rhino conservation in the Ngorongoro Crater. The workshop was held over two days and divided into Crater ecology on the first day and rhino ecology on the second. Presentations were given in the mornings and working groups on specific topics were held in the afternoons. This report summarizes the content of the presentations and the recommendations that emerged from the working groups.

2. CRATER ECOLOGY PRESENTATIONS (3 SEPTEMBER 2003)

2.1 A brief overview of ecological problems in the Ngorongoro Crater

Victor Runyoro, Ngorongoro Conservation Area Authority, Tanzania

The Ngorongoro Crater ecosystem is under increasing pressure due to tourism and human settlement. Threats to the ecosystem include the dieback of the Lerai Forest, an increase in the area of tall, moribund grasslands, the invasion of alien plants and an increase in the area under cultivation outside the Crater. The dieback of the Lerai Forest has been ascribed to altered hydrology, damage by elephants and an increase in soil salinity. Changes in grassland condition have been linked to altered management. Prior to 1974, Masai pastoralists used fire and livestock to maintain the Crater grasslands in a shorter and more palatable condition than occurs at present. Trends observed in wildlife populations include: (i) an increase in buffalo from a few individuals in the 1960’s to several thousand in 2003, possibly as a result of less burning and reduced competition from livestock after Masai pastoralists left the Crater; (ii) a decline in numbers of wildebeest from approximately 15,000 in early 1960’s to approximately 6000 in late 1990’s, possibly due to competition from buffalo; (iii) a decline in eland from approximately 300 in the late 1970’s to less than 50 in 2003, possibly due to reduced availability of browse; (iv) a recent decline in lion from 67 in 2000 to 41 in 2001, possibly as a result of disease; (v) a decline in hyena from 469 in the 1960’s to 350 in 2003, possibly due to declining wildebeest numbers; and (vi) the lack of growth in the black rhino population. The main threats facing rhino in the Crater are: (i) increasing disturbance by tourist vehicles; (ii) changes in habitat; and (iii) high mortality of calves. Up to 150 vehicles have been recorded in the Crater at one time, which is regarded as unacceptably high disturbance to wildlife. Additional threats to wildlife and the wider ecosystem of the NCA include: (i) disturbance of migration routes by expanding human settlements and associated cultivation; and (ii) diminished water flow into the Crater due to lodges and human settlements. The wide diversity of ecological problems requires a holistic approach to management.

2.2 Roads and tourist pressure

Bruno Kawasange, Ngorongoro Conservation Area Authority, Tanzania

The road network within NCA can be divided into two main categories: (i) administrative roads, which are used for anti-poaching patrols and access to ranger posts, towns, villages, wards and protected areas; and (ii) tourist roads, which provide access to wildlife viewing areas and lodges. The roads are categorised further into three classes, depending on the width of the road and the cover placed on the surface. Class 1 roads are at least 7 meters wide and covered with at least 6 inches of murram (e.g. main road between Loduare Gate and Serengeti National Park). Class 2 roads are at least 5 meters wide and covered with at least 4 inches of murram (e.g. tourist roads in the Crater floor). Class 3 roads are at least 3

meters wide with no murram (e.g. road from Naiyobi to Kapenjiro via Empakaai ranger post). The NCAA is presently planning several new roads (e.g. Malambo road providing access to the north-eastern part of the Gol Mountains, and a road to Angata Kiti plain near Nasera Rock). The number of tourists visiting the NCA has increased from approximately 30,000 in 1983 to 250,000 in 2002. Vehicle numbers in the Crater have also consequently increased (up to 4000 vehicles per month recorded in 1997). This is problematic because the condition of Class 3 roads is deteriorating and disturbance to wildlife is often severe. The number of vehicles entering the Crater needs to be regulated and the expansion of Class 3 roads within the Crater needs to be halted. A Class 3 road network should be carefully planned and unnecessary tracks in the Crater should be restored to grassland. An acceptable limit to the number of vehicles in the Crater at any one point in time should be agreed upon and then rigorously enforced.

2.3 Range condition, ticks and fire management in the Ngorongoro Crater

Winston Trollope and Lynne Trollope, Faculty of Agriculture & Environmental Science, University of Fort Hare, Alice, South Africa

Approximately 1000 buffalo, 250 wildebeest, 100 zebra, 22 lions and 5 rhino died in the Crater during 2000 because of a severe drought which caused the affected animals to be in poor condition due to nutritional stress and therefore greater susceptibility to parasites and disease. Of particular importance was the abundance of brown ear tick (*Rhipicephalus appendiculatus*) and associated blood protozoal diseases. The abundance of ticks in relation to the standing crop of grass, botanical composition and presence of different herbivore species was consequently investigated at 33 sites in the Crater. The standing crop of grass was positively correlated with tick numbers. High tick loads were found on *Chloris gayana*, *Trifolium* spp., *Digitaria scabrum*; medium tick loads in *Cynodon nemfluensis*; and low tick loads in *Pennisetum mezianum* and *Themeda triandra* dominated grass swards. Areas with high tick loads and high grass biomass were used mainly by buffalo and areas of low tick loads and low grass biomass were used by other ungulate species. Grass in a moribund condition (> 4t ha^{-1}) had particularly high tick loads. The nutritional value of *Chloris gayana* and *Pennisetum mezianum* as quantified using measures of crude protein and digestible fibre was poor. *Trifolium* spp. and non-moribund *Cynodon nemfluensis* had a high nutritional value. *Chloris gayana* has probably increased in the northwest of the Crater due to a decrease in the frequency of burning over the past 3 decades. Controlled burning would result in a reduction in tick numbers and therefore tickborne diseases, an

increase in the nutritional quality of the rangeland, and a reduction in herbivore pressure on areas frequented by black rhinos. Management recommendations are: (i) a controlled burning programme should be implemented immediately; (ii) areas dominated by Decreaser or Increaser I grass species and in a moribund condition (> 4t ha^{-1}) should be considered for burning; (iii) not more than 10% (2500 ha) of the Crater should be burnt at any one time; (iv) the minimum area burnt should not be <500 ha in order to prevent overgrazing of burnt rangeland; (v) an annual vegetation monitoring programme (10 days of survey; 5 days of data analysis) should be implemented to assist fire management decisions. This would have to be preceded by the development of a survey of the vegetation based on the underlieing geology and soil types in the Crater; and (vi) the research programme should be expanded to investigate the effects of fire on ungulate habitat selection, grass composition, tick loads and the plant species utilized by black rhino.

2.4 Hydrology of the Ngorongoro Crater

Jaco de Klerk, Hydrology Consultant, Gauteng, South Africa

The dieback of the Lerai Forest, which was first noted in the 1960's, is thought to be due to a reduction in the flow of surface and subsurface water through the forest (Venter & Morkel 2002). Tree mortalities are associated with fungal infection that in turn has been ascribed to drought stress imposed by high salinity levels and a reduction in water availability. Other factors such as damage to bark of mature trees by elephants are also thought to play a role in the dieback. The flow of surface water in the Crater is easily manipulated due to the flat topography. Restoration of the original hydrological functioning of the Lerai Forest was attempted in 2002 by: (i) constructing a gabion on the canal draining the swamps below Ngoitokitok and thereby increasing the flow of water into Gorigor Swamp and Hippo Pool; and (ii) increasing the flow of water entering the Lerai Forest through partial diversion of the Lerai Stream. Effective restoration of the original hydrology and salinity status of Lerai may be hindered for two main reasons: (i) extraction of water by lodges and NCA headquarters reduces the amount of water entering Lerai by around 25%; and (ii) saline groundwater from Lake Magadi may have entered Lerai. In the past, recharge of fresh water into the groundwater may have prevented saline water from moving into the forest. The quantity of water extracted and the dynamics of saline groundwater in the Crater are, however, unknown and require further investigation. An alternative source of water for lodges that is not part of the Crater hydrology should be found.

2.5 Geochemical investigations in the Ngorongoro Crater

Anthony Mills, Department of Soil Science, University of Stellenbosch, South Africa

(a) *Lerai forest dieback.* Soils profiles were sampled to a depth of 3.5 m in the Lerai Forest and in healthy *Acacia xanthophloea* forests in NCA and Lake Manyara National Park. Soils in Lerai Forest were significantly more saline and alkaline than soils in healthy forests. Salinity was deemed to be a major factor causing the death of trees in the Lerai Forest. Salt accumulation may be due to: (i) movement of sodic water from Lake Magadi into Lerai due to diversion of fresh water into the lake; and (ii) a reduction in the flow of fresh water through Lerai. Flood irrigation of surface soils in Lerai could flush out salts and enable recruitment of *Acacia xanthophloea* seedlings. Experimental plots are recommended. Other research priorities include investigating: (i) the amount of water extraction on the rim; (ii) soil and groundwater salinity changes through time; (iii) the effect of elephants on tree recruitment in the Lerai Forest.

(b) Bidens schimperi *distribution*. The invasion of grassland by weedy forbs (such as *Bidens schimperi*) reduces forage availability for ungulate species. Tourism is also adversely affected by invasions of weeds as animals are difficult to view within the dense stands of weeds. Seven paired topsoil samples (0-10 cm) were taken in dense stands of *Bidens schimperi* and in adjacent non-invaded grassland. Distribution of *B. schimperi* appeared to be governed by soil chemistry. Soils from non-invaded grassland were more calcareous, had a higher pH and had lower water-soluble concentrations of K, Cl and SO_4 than *B. schimperi* soils. Application of lime to topsoils is likely to reduce *Bidens schimperi* recruitment. Experimental plots would be required to determine the effect of different levels of lime application on *B. schimperi* recruitment.

(c) *Trace elements in earth licks*. As part of an investigation to develop a greater understanding of geophage by wild and domestic ungulates the iodine concentrations of four earth licks in NCA were investigated. Iodine concentrations were not high relative to expected values for iodine in soils. The cobalt, copper, manganese and zinc concentrations of a sample from the Seneto Spring earth lick were also within expected ranges for soils. The selenium concentration (5 ppm) in this sample was, in contrast, several times greater than values reported for soils in the literature. Selenium may be an element sought by animals practicing geophagia in the Crater. Further research is underway to investigate this hypothesis.

2.6 Management of invasive plants in the Ngorongoro Conservation Area
Wayne Lotter, Sappi Forests, South Africa & Llewellyn Foxcroft, South African National Parks, South Africa

Regarded as the second greatest threat to global biodiversity, invasive alien species pose a significant threat to many of Africa's conservation areas. All ecosystems, including those in well-protected national parks can potentially be invaded by alien species. Light infestations of alien plants are evident in the Ngorongoro Conservation Area. There is a great risk that these infestations will become more severe with time as the plant populations mature and spread. High-risk aliens occurring within the NCA include *Caesalpinia decapetata*, *Acacia mearnsii*, *Lonicera japonica*, *Eucalyptus* spp. and *Lantana camara.* A number of other well-known invasive alien species have been identified outside the NCA, in the vicinity of Karatu and elsewhere. An alien control programme is recommended to prevent major alien infestations in the future. Alien species management objectives need to be set which are in line with the broader conservation objectives of the NCAA. An early detection and monitoring programme should be developed and implemented. Regular surveys need to be conducted, known infestations and key areas and habitats should be monitored, the introduction of known and potentially invasive alien species should be prohibited and existing ones phased out, and an educational awareness programme instituted to curb further introductions. Following the confirmation of management priorities the implementation of control actions should be integrated where possible with other management programmes such as controlled burning to complement weed treatment efforts. A comprehensive alien plant management plan should be compiled. Biological control options should be investigated, in collaboration with appropriate institutions, especially for highly invasive species in close proximity to the NCA. Appropriate research should be conducted to inform adaptive, integrated management. Two noticeable weedy indigenous species in the Crater are *Bidens schimperi* and *Gutenbergia cordifolia*. These are pioneer plants that appear to benefit from drought conditions and are likely to be replaced by grasses in time. Burning or mowing may be effective in removing these weeds and careful monitoring is advised.

3. RHINO ECOLOGY PRESENTATIONS (4 SEPTEMBER 2003)

3.1 Managing small populations of black rhino: the Namibian experience
Pierre du Preez, Ministry of Environment and Tourism, Namibia

Black rhinos in Namibia occur in national parks, communal lands and privately owned "custodianship farms". The distribution and population growth rates of rhino are carefully monitored to enable long-term conservation planning. Black rhino are presently found in Etosha NP (700), Kunene NP (136), Waterberg NP (32), Hardap NP (9) and custodianship farms (114), with the total number in Namibia estimated to be 991. The main threat to rhino in Etosha is encroachment of human settlements and associated poaching risks on the northern borders. The rhino population in Etosha appears to be breeding well. In contrast, the population growth in Kunene has decreased over the past twenty years. The advantages of conserving rhinos in small populations include the following: (i) many prime habitats can be utilised; (ii) rapid population growth can be achieved; (iii) founder populations can be established; and (iv) risk of disease or poaching affecting the whole population is diminished. The disadvantages are that: (i) some populations are in marginal habitat; (ii) management is intensive; and (iii) costs are great because there is no economy of scale. Namibian policy is that active management of small populations is required. Breeding bulls should be swapped between areas and populations should be supplemented with unrelated females to ensure gene flow. In small populations, one to two animals should be moved per generation to prevent manifestation of social problems within the population. Populations should not be skewed towards male biased sex ratios or older animals. Conflicts with elephants (monopolization of preferred habitats by elephants or direct disturbance of cows with young calves) should be avoided if possible. Human disturbance from tourists and researchers should be minimized. Non-breeding animals can be translocated and used for testing the suitability of untried habitats. A founder population should be in excess of twenty animals. Based on experience in Namibia, recommendations for effective management and long-term conservation of black rhino in Ngorongoro include: (i) excluding tourists from prime habitat by closing roads; (ii) excluding elephant from the Lerai Forest using a electrified strand of wire erected at a height of 2 m; (iii) minimizing excessive disturbance from research and monitoring; and (iv) supplementing the population with unrelated breeding animals to reach as size of at least 20 individuals.

3.2 Ngorongoro black rhino population dynamics: what does the data tell us?

Richard Emslie, IUCN African Rhino Specialist Group, South Africa

The Tanzanian rhino management plan developed in 1998 set a goal of increasing the current population of *Diceros bicornis michaeli* of 60 individuals to 100 individuals by 2018 through active metapopulation management. Between 1964 and 1966, 108 individually recognizable black rhino were observed in the Ngorongoro Crater. Research at this time indicated that calf mortality was low and that low fecundity prevented the population from growing. Following a wave of poaching in the late 1960s and early 1970s rhino numbers in the Crater have been low (~20) and the female:male sex ratio has been high (2.27:1). Excluding one female (Fausta) who has not produced a calf since 1984 from calculations, the inter-calving interval of rhinos in the Crater during 1993-2003 was 2.88 years. This inter-calving interval is moderate to good and suggests that fecundity and/or nutrient deficiencies are not limiting population growth. The average age of first calving (6.9 years) is also moderate to good in comparison to other populations. The proportion of calves in the population is acceptable, but is a biased measure due to the skewed sex ratio of adults. Overall breeding patterns are therefore within expected ranges. Adult mortality of rhino was high during 1975-2003 (6.8%) and even higher during 1993-2003 (8.3% - mainly as a result of disease). Without the sex ratio being skewed to females the population have been extirpated as this level of mortality is unsustainable. Continued high levels of security in the Crater should reduce mortalities to poaching to a minimum and enable greater population growth. Neonatal mortality is estimated to be between 25% (minimum estimate based on observed mortality) and 45% (maximum estimate based on intercalving intervals and calves presumed predated before being observed). These levels of neonatal mortality are extremely high and are believed to be due to predation by spotted hyenas. If man-induced mortalities are treated as removals, the estimated population growth over 1993-2003 was 8.03%, which if achieved over the next 10 years would result in a population of 35 individuals. The threat of inbreeding and loss of genetic diversity requires further research and possible intervention through the replacement of the dominant breeding bull. A conservation plan for black rhino in the Crater should aim to achieve maximum growth and through supplementation a miminum population of 20 animals. Some restoration of the Lerai Forest and controlled burning to improve browse availability may be necessary before new animals are introduced to the Crater.

3.3 Habitat and nutritional conditions for black rhino in the Ngorongoro Crater
Keryn Adcock, African Rhino Specialist Group, South Africa

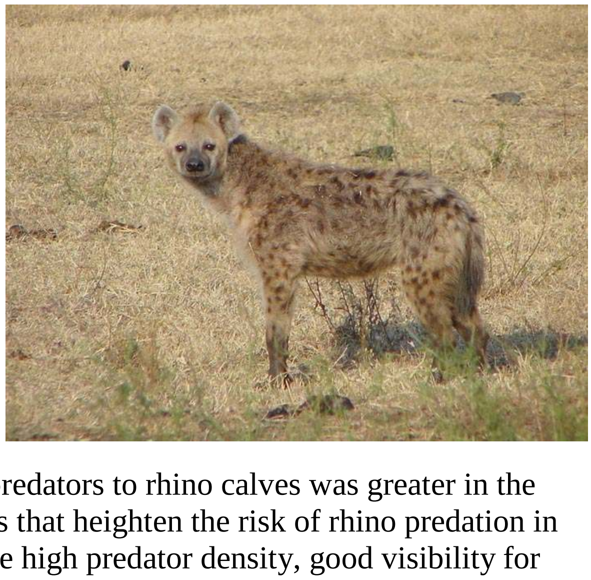
The quantity and dynamics of browse available to black rhino in the Ngorongoro Crater is unknown and it is consequently difficult to determine the potential black rhino carrying capacity. It is, however, suggested that the rhino carrying capacity of the Crater has decreased since the 1960's. Several habitats frequented by rhino have changed in structure and become less suitable for rhino. These include: (i) the Lerai Forest where trees and understorey have died back; (ii) the Gorigor and Mandusi Swamps which appear to have decreased in area and lost much of their leguminous shrub cover possibly due to increased herbivore pressure; (iii) the slopes of the Crater where non-palatable bushes (*Lippia*, *Lantana* and *Clausena* species) have encroached into prime rhino habitat that previously comprised short *Acacia lahai* and leguminous shrubs/forbs; and (iv) grasslands where there has been an apparent decline in palatable forbs and an increase in "tall" unpalatable grasses over large areas of the Crater floor. Availability of browse may also have decreased due to: (i) the decrease in mean annual rainfall (~950 to ~800 mm over the period 1963-2000 at the NCA HQ); and (ii) the increase in other ungulates in particulary the buffalo population. The intensity of browsing (measured in black rhino equivalents) in the Crater has increased from

~250 to ~750 over the period 1964-2003. Rhino range size increased from 15km^2 in 1964-66 to 31.5 km^2 in 1981-82 suggesting that either carrying capacity decreased or that rhinos occupied larger areas due to reduced intra-specific competition. There is an urgent need for a study of current range size. A preliminary model of possible changes in browse availability suggests that rhino carrying capacity in the Crater may have declined from ~0.42 rhino km^{-2} to ~0.1-0.2 rhino km^{-2}. The current rhino density is approximately 0.064 rhino km^{-2}. Rhinos may be limited by the availability of browse towards the end of the dry season. To improve the accuracy of the carrying capacity estimate it is recommended that: (i) preferred and important browse species for the Crater rhino are determined; and (ii) the Crater vegetation (especially the distribution and quantity/quality of browse) is mapped. Habitat conditions for black rhino in the Crater could be improved through fire management (by reducing unpalatable shrub and tall grass and possibly increasing the number of leguminous shrubs in grassland and swamp habitats) and restoration of the Lerai Forest. Oldupai and Ndutu are other areas within the NCA that were evaluated for their habitat suitability for the establishment of additional rhino populations. Carrying capacities for these areas are estimated to be ~0.15 and 0.04 rhino km^{-2}, respectively. Oldupai appears to have greater available browse than Ndutu. It is suggested that Ndutu can only support rhino at very low densities and the likelihood of rhino ranging over very wide areas is high. Accurate mapping of browse and water resources is recommended before any translocation of rhinos to new areas is undertaken.

3.4 An ecological assessment of predation risk on rhinos in the Ngorongoro Crater

Philip Stander and Lise Hanssen, Predator Conservation Trust, Namibia.

It has been hypothesized that high levels of calf predation by spotted hyena and/or lion in the Ngorongoro Crater have prevented growth of the black rhino population in Ngorongoro over the past decade. This hypothesis was assessed by comparing predator risk to rhinos in the Crater to Etosha National Park, Namibia through an analysis of data on the numbers of lions, hyenas, rhino calves and other prey numbers. This analysis gave the following results: (i) Predator density was much greater in the Crater than Etosha (156 vs 3.1 predators per 100 km^2, respectively); (ii) The ratio of predators to total prey was greater in the Crater (1:45) than Etosha (1:59); (iii) The predicted number of rhino calves available to predators per year was greater in Etosha (17) than the Crater (0.1-0.8); (iv) The proportion of rhino calves to other suitable prey was greater in Etosha (0.08% by numbers; 0.03% by biomass) than in the Crater (0.003% by numbers; 0.001% by biomass); (v) The ratio of predators to rhino calves was greater in the Crater (1:0.0012) than in Etosha (1:0.03). Factors that heighten the risk of rhino predation in the Crater include large carnivore group sizes, the high predator density, good visibility for predators and a lack of suitable calving areas. The lethal management of predators to try to reduce predation on rhino calves in the Crater is believed to be unfeasible both logistically and politically. It is recommended that more breeding female rhinos are introduced into the Crater to bolster the rhino population and that more optimal rhino habitat in the Serengeti-Mara ecosystem is sought for the establishment of additional rhino populations.



3.5 The status of black rhino in the Serengeti National Park
Titus Mlengeya, Chief Veterinary Officer, TANAPA, Tanzania

The total number of the Eastern Black Rhino *Diceros bicornis michaeli* in Tanzania is currently estimated at 60. From 1970 to the late 1990's poaching reduced the rhino population in the Serengeti-Mara Ecosystem from over 2000 animals to almost local extinction. There are currently two isolated populations, one near Moru Kopjies in the south (~10 animals) and another on the border with the Masai Mara National Reserve (~10 animals). Rangers conduct regular patrols to monitor the health and growth of the populations. Challenges facing effective conservation management of these rhino populations include: (i) low reproductive performance in young females; (ii) long distance wandering of heifers; (iii) restricted genetic flow; (iv) disease; (v) poaching; and (vi) slow decision-making on management interventions. Active management is strongly recommended. Translocation and exchange of rhinos is necessary to increase genetic diversity. New bulls are required for both populations. The establishment of a new founder population in the central Serengeti is advised, because of the abundance of suitable browse, the availability of water and the minimal risk of disturbance. The Oldupai-Ndutu area is also potentially suitable, but there is a greater security risk in this region. There is an urgent need for quick decisions, effective implementation of policy, firm political support as well as financial support from government and NGO's.

3.6 Ngorongoro black rhino: current status and problems
Amiyo Amiyo, Ngorongoro Conservation Area Authority, Tanzania

The number of black rhino in Ngorongoro Crater decreased from ~110 in the early 1960's to ~20 by the early 1970s. At present the population comprises 10 adults (3 of which are breeding males and 5 are breeding females), 3 sub-adults and 3 calves. The main breeding bull (John) has dominated since 1993. Ten of the 16 rhino in the Crater are John's offspring. It is likely that another bull (Mikidadi) will soon displace John as the dominant bull. Twenty calves have been born since 1990 of which seven have since died including four due to predation. Six adult rhino have died since 1990 of which the causes of death were disease (2), poaching (1 or 2), injury (1 or 2) and old age (1). Effective and sustained monitoring of rhino has reduced the risk of poaching. The greatest threats to the long-term conservation of the rhino are now ecological change and disturbance from humans. In 1966, there were 17 rhino resident in Lerai Forest. There are now no resident rhino in the forest probably due to dieback of trees and understorey and a consequent reduction in browse and shelter. Several factors are probably involved in the dieback. These include a reduction in water flow through the forest, increased elephant pressure, accumulation of salts in the soils and flooding during El Nino. *Acacia xanthophloea* is becoming reestablished outside the original forest towards thecrater rim but is not forming suitable rhino habitat. Other threats facing the rhino include: (i) an increase in elephants, which compete for browse, disturb rhino cows and calves and remove trees/cover used by the rhinos; (ii) an increase in buffalo which increase tick loads and, like elephants, compete for browse and disturb cows and calves; (iii) an increase in human disturbance due to tourism pressures, which can delay cows returning to calves and agitate the inherently shy rhino; (iv) invasive plants (e.g. *Bidens schimperi* and *Gutenbergia cordifolia*) have reduced habitat suitability for rhino in many parts of the Crater; (v) a reduction in swamp habitat due to construction of drainage ditches; (vi) possibly increased predation on calves due to a reduction in bush cover in which cows can leave calves while they look for water; (vii) a reduction in available browse which may be causing malnutrition (especially in the dry season) which makes the population more susceptible to disease; (viii) protozoal blood parasites (e.g. babesiosis) are problematic when rhino are stressed during drought; and (ix) the high level of inbreeding is likely to manifest in abnormalities, reduced conception and greater calf mortality due to lowered immunity to disease, unless new rhinos are brought into the Crater.

3.7 Disease concerns for black rhino in East Africa

Elizabeth Wambwa, Chief Veterinary Officer, Kenya Wildlife Service.

Health risks for black rhinos include: (i) numerous tick species that cause diseases such as *Babesia bicornis* and *Theileria bicornis* which can result in rhino death under extreme conditions such as drought; (ii) biting flies, in particular *Glossina* species which are vectors for trypanosomiasis - a condition only likely to manifest clinically when rhinos are stressed; (iii) nematodes which cause skin ulcers; (iv) viral diseases such as rabies; (v) bacterial diseases such as Anthrax, Salmonella, *Pseudomonas pyocyanea*, coliform bacteria, *Clostridium* spp., and tuberculosis; (vi) Haemolytic anemia, which is usually linked to infection with *Leptospira interrogans* and can cause rapid death (within 48 hours of first symptoms); and (vii) trauma, disease and injuries sustained during and after translocation. Rhinos are routinely translocated in Kenya to increase metapopulation growth rates. Stresses exerted during translocation can, however, reduce immunity and increase the risk of infection. Resident rhinos also often fight with introduced rhinos which can cause injury or deaths. Nine rhinos have been killed by such incidents during 77 rhino translocations in Kenya. It is recommended that health and disease management play an integral role in the conservation of black rhino in the Crater. Before rhinos are brought into the Crater, for example, they should be rigorously screened for diseases and parasites. Serological investigations should be conducted in the Crater to determine the susceptibility of rhino to various infections and to develop a proactive disease management plan.

4. CRATER ECOLOGY WORKING GROUPS (3 SEPTEMBER 2003)

Small working groups were formed in the afternoons of both days. These groups were asked to identify management problems and solutions within their subject areas.

4.1 Working Group 1: Pasture, fire and ticks

Chair: Winston Trollope
Rapporteur: Amiyo Amiyo

4.1.1 Priorities that emerged:

- Development of a fire management plan;
- Development of a vegetation monitoring programme to assist fire management decision-making;
- Production of a map of the major vegetation units related to the major types of soils in the Crater;
- Identification of browse species favoured by rhino;

- Identification of management practices that increase the abundance of rhino browse species; and
- Development of a management plan for controlling plant and animal alien species.

4.1.2 Philosophies on management of black rhino and the Crater ecosystem

Black rhinos are a critically endangered species and resources should be allocated for their protection. Management should be holistic and aim to maintain ecological integrity and minimize the degradation of the Crater ecosystem.

4.1.3 Fire as a management tool in the Crater

Fire is an important ecological factor and could be used as a management tool in the Crater. Controlled burning can, for example, be used to reduce ticks and other parasites, especially after droughts. In addition, herbivore numbers within the Crater could potentially be manipulated by burning areas outside of the Crater, as herbivores are likely to be attracted to these burnt areas. It is recommended that a new fire management plan for the entire NCA be developed. Fire management decisions will require information on the composition and standing crop of grass swards in the NCA. A vegetation-monitoring programme is required for acquiring this data. Local communities should be advised on the correct use of fire by the NCAA and their cooperation with the burning policies should be sought. The fire regime traditionally used by the Masai should be investigated and considered when developing a fire management plan.

4.1.4 The ecological role of fire in the Crater

Grasslands: The effects of fire on grassland composition, forb abundance, the Lerai Forest, the slopes of the Crater rim and swamp vegetation are largely unknown and consequently a research programme is recommended. While fire is likely to reduce the dominance of tall grass communities, the precise effect of fire on grass species composition is not known.

Lerai Forest: The natural fire regime for the Lerai Forest is yet another unknown. The forest was not burnt by the Masai and there has been no documented fire for the past 40 years. A literature search to determine the effect of fire in *Acacia xanthophloea* forests elsewhere in Africa is advised.

Crater rim: The exclusion of fire from the slopes of the Crater rim appears to have altered the species, density and structure of browse. Burning this shrubland may increase available browse as rhino tend to favour regrowth of coppicing shrubs. Cool burns in a mosaic burning pattern are recommended i.e. some slope area should be left unburnt. Forest species such as *Celtis* spp. should be protected from the controlled burning programme. The erosion risk of burning on slopes should be quantified and monitored.

Swamps: Rhino browse on Munge swamps in the dry season. The potential role of fire in maintaining this habitat requires investigation. Fire promotes the growth of pioneer leguminous species in southern Africa and a similar effect may occur in the Crater. Leguminous species appear to be favoured by rhino and may therefore be desirable in terms of increasing dry season browse availability.

4.1.5 Cattle management

Trends in the number of cattle within the NCA should be monitored. The effects of cattle on wildlife populations in the NCA should be assessed. Cattle brought into the NCA should be subjected to routine veterinary procedures to prevent entry of diseases into the NCA. An acceptable maximum number of cattle within the NCA should be agreed upon and actions taken to ensure that this number is not exceeded. The number of cattle present in the Northern Forest Highland Reserve, in particular, requires investigation. The presence of cattle in the Crater should also be reassessed, given that the slopes above Seneto are being eroded and that cattle are potential conduits of disease into the Crater. An alternative salt supply should be provided on the Crater rim.

4.1.6 Rhino browse availability

A list of preferred rhino browse was compiled in the early 1960's. The status of these plants in the Crater and the preferred rhino browse of today require urgent investigation. A literature review should precede research in the field.

4.1.7 Native weeds - Bidens schimperi *and* Gutenbergia cordifolia

The effect of fire and mowing on the persistence of *Bidens schimperi* and *Gutenbergia cordifolia* is as yet unknown. Careful monitoring of the effect of these practices in comparison to "no intervention" is recommended to enable effective future management action. Management strategies should be developed that maximize conditions most appropriate for rhino i.e. increase the browse availability. Ecological studies are advised for determining how the timing of fire and mowing affect forb species favoured by rhino. These studies could be undertaken using vegetation-monitoring data.

4.1.8 Control of alien weeds

An alien control programme is recommended, whereby the introduction of plant and animal aliens is prevented and the existing alien infestations are controlled. The potential agents of introduction require identification.

4.2 Working Group 2: Roads, hydrology and soils

Chair: Philip Muruthi
Rapporteur: Anthony Mills

4.2.1 Problems associated with the road network within the Crater

The road network and increase in vehicle numbers within the Crater is problematic for several reasons:

- Vehicles disturb rhino and other wildlife;
- Traffic congestion, bumpy roads and dust compromise the tourist's experience;
- New tracks are created by irresponsible drivers and this impacts negatively on the grassland ecosystem;
- Maintenance of roads on an annual basis is costly and requires the use of heavy equipment which compromise the tourist's experience and disturb wildlife;

- Discarded gravel and rocks left adjacent to roads are unsightly and provide a habitat for alien weeds;
- Extraction of murram for road maintenance creates pits that are unsightly and provide a habitat for alien weeds.

4.2.2 A new vision for the Crater

The conflict between "wilderness" and "development" is clearly apparent within the Crater. A long-term vision is required to enable effective decision-making. It is recommended that the Crater should be managed to maximise wilderness values and minimize human impacts as much as is possible in a multiple-use landscape. Wilderness in this sense refers to functioning natural ecosystems as opposed to areas devoid of humans. Tourism should be managed in such a way that the Crater Ecosystem is not degraded. The present increase in roads and tourist vehicles is having a detrimental effect on the Crater. This requires urgent attention.

4.2.3 Managing roads and tourism in the NCA

A policy on the acceptable number of vehicles and tourists entering the Crater needs to be developed and strictly enforced. A booking system would enable easier control of tourist numbers. Permits should be issued for morning or afternoon visits to reduce numbers at any one time in the Crater. Larger game-viewing vehicles could be introduced to reduce vehicle numbers. A maximum of 50 vehicles should be allowed in the Crater at any one time.

Alternative tourist activities should be investigated to relieve pressure on the Crater. Tourists should be dispersed to other attractions such as Empakaai and the northern forests. Walking and horse safaris inside or outside the Crater should be offered to reduce vehicle pressure. A trial walking safari operation in the Crater and a trial horse safari operation outside the Crater are recommended. If the long-term vision in the Crater is "wilderness" then a policy of "no vehicles" and "walking visitors only" requires discussion.

The road network in the Crater needs careful attention and planning. Unwanted tracks should be closed as a matter of urgency. Guiding principles for road expansion or removal need to be developed. Construction of low-maintenance roads within the crater should be considered, particularly for the ascent and descent roads. The feasibility of utilising road surface materials more durable than murram should be investigated (e.g. a murram-bitumen mix which has a final colour similar to murram). A long-term rehabilitation plan is recommended for the murram pits in the Crater.

4.2.4 Hydrology in the Crater

A ditch was constructed from Ngoitokitok to Lake Magadi during the El Nino floods to preserve the road network. This action had a large impact on the hydrology of the Crater as water flow into Gorigor and Lerai Forest was greatly reduced. A gabion was constructed in 2002 to block the ditch and this is hopefully restoring the original hydrology. The effect of this gabion on water levels in Lake Magadi and the survival and recruitment of trees in the Lerai Forest require monitoring.

4.2.5 Extraction of water from Lerai spring

The volume of water extracted from Lerai spring by lodges and the NCAA Headquarters requires quantification. The effect of water extraction on the Lerai Forest is probably negative and alternative sources of water (e.g. boreholes) for lodges and other facilities on the Crater rim should be explored. The expertise of a geohydrologist for long-term water management on the rim is recommended. The impacts and extent of water pollution from lodge septic tanks and effluent systems should also be investigated.

4.2.6 Management of the Crater ecosystem and rhino population

It should be recognized that action will always be taken with imperfect knowledge. The problem of "paralysis by analysis" should be avoided. Short-term research projects are extremely beneficial for management, whereby experts are consulted for "big picture" assessments and planning. Longer-term research projects are also necessary e.g. detailed geohydrological survey.

4.2.7 Geophagy in the Crater

Geophagy – the eating of soil - is evident in many part of the NCA. This suggests that animals are seeking minerals from soils that are deficient in the herbage. Identifying the limiting nutrient or nutrients will add to the ecological understanding of the NCA. Nutrients that may be limiting the fecundity or health of rhino are of particular interest. Provision of mineral licks for rhinos may be a future conservation strategy if limiting nutrients are identified.

4.2.8 Dieback of Lerai Forest

The restoration of Lerai Forest as a suitable rhino habitat was highlighted as a major goal for conserving the rhino population in the Crater. Two main approaches for restoration are recommended: (i) an irrigation experiment that flushes salts from the soil profile; and (ii) exclusion of elephants from parts of the forest using an electric wire.

5. RHINO ECOLOGY WORKING GROUPS (4 SEPTEMBER 2003)

5.1 Working Group 3: Small population management

Chair: Matthew Maige
Rapporteur: Richard Emslie

5.1.1 Genetic problems facing black rhino in the Crater

Problems of inbreeding, genetic drift and loss of heterozygosity within the Crater rhino population are inevitable unless management action is taken. A metapopulation approach is recommended where: (i) security of rhino is rigorously maintained; (ii) dominant males are replaced every few years; (iii) as many unrelated animals as possible are added to the rhino population; and (iv) a new founder population of 20 animals is established within the Serengeti-Mara Ecosystem.

5.1.2 Predation on rhino calves

Spotted hyenas may kill up to 40% of young rhino calves in the Crater. Although rhino comprise a very small fraction of the hyena prey base, the high density of hyenas results in a high predation pressure on rhino calves. Reducing the number of hyenas in the Crater is neither feasible nor desirable as they are an integral part of the Crater ecosystem and are a major tourist attraction. The hyena population would be slow to recover from a culling programme and the long-term effects of a reduction in hyena numbers on the ecology of the Crater are unknown. Suggestions for minimizing the risk of hyena predation include: (i) restoring the Lerai Forest habitat so that rhinos can hide their calves more successfully; (ii) reducing the level of tourist and monitoring disturbance so that cows are not distracted from protecting their calves; (iii) studying hyena behaviour in the Crater to improve the understanding of hyena-rhino dynamics; (iv) creating a fenced-off nursery camp (although the logistics of implementing a nursery camp were deemed extremely difficult and makes this option inpractical at present); and (v) active non-lethal intervention when hyenas are observed to attack rhino calves

5.1.3 Maximising growth of the NCA rhino population

A rhino population outside the Crater, where predator densities are lower and habitats provide denser cover, is likely to grow faster than the Crater population. It is recommended that at least one new rhino population be established in suitable habitat elsewhere in the Serengeti-Mara Ecosystem. Other rhino populations in the Serengeti-Mara Ecosystem could in time be used to supplement the “slow-growing” Crater rhino population. Possible locations for a new rhino population include Ngare Nanyuki in the Central SNP and Ndutu or Oldupai on the boundary between the NCA and the SNP. The Crater is easier to secure than other areas and the present risk of poaching in the Crater is negligible. The security risk and habitat suitability of other areas in the Serengeti-Mara Ecosystem need to be assessed in order to decide where to establish new founder populations. Security at Oldupai, for example, may be problematic, and the habitat at Ndutu may not be suitable. The formation of a Serengeti-Mara Ecosystem Rhino Working Group is advised to facilitate metapopulation decision-making and cooperation between different conservation authorities.

5.1.4 The demise of the transient rhinos

Ngorongoro is increasingly an “island rhino population” with very little movement of rhinos in and out of the Crater. Translocation of rhinos from other areas is consequently an important management goal. The risk of poaching is greater outside of the Crater. Monitoring the movement of potential roamers in the Crater population (e.g. Runyoro) is consequently advised. Radio transmitters and/or trackers could be used for such monitoring.

5.1.5 Risk of chance demographics

If rhino calves in the future happen to be predominantly male, the growth of the Crater rhino population would be drastically reduced and the successful long-term conservation of the population would be at risk. It is therefore critical that new breeding females are brought into the Crater population to minimize this risk.

5.2 Working Group 4: Disease, ticks and genetics

Chair: Titus Mlengeya
Rapporteur: Elizabeth Wambwa

5.2.1 Ticks in the Crater

Ticks are agents of rhino diseases such as babesiosis and consequently it is recommended that management strategies be implemented in the Crater to reduce tick loads. To develop an effective tick control programme, a greater understanding of tick dynamics and effects is required. Research should be undertaken to determine: (i) the effect of livestock on tick loads; (ii) the risk of tick-borne diseases being transmitted to rhino; and (iii) the effect of fire on tick loads in the Crater. Fire is likely to be an effective tool for reducing tick loads. A tick control programme should be incorporated into a fire management programme for the whole NCA region. Effective control of ticks through controlled burning may negate the need for detailed research on the risk of tick-borne diseases affecting rhino.

5.2.2 Disease in the Crater

The disease risk to rhino in the Crater is largely unquantified. This is due to a lack of: (i) trained staff; (ii) opportunities for sampling; (iii) technical assistance; and (iv) laboratory equipment. The following suggestions were made at the workshop: (i) authorities and communities should be made aware of potential disease risks; (ii) the disease monitoring and evaluation programme should be continued; (iii) local facilities and vet expertise should be established in the NCA to carry out routine procedures; (iv) communication channels between wildlife and livestock vets within the NCA should be established; (v) collaboration with other institutions should be encouraged to utilize their technical expertise and specialized tests; and (vi) vets should be granted the authority to do immediate postmortems.

5.2.3 Genetic problems in the Crater rhinos

It is suggested that DNA studies be undertaken to determine the level of inbreeding within the Crater population. An East African metapopulation management plan for *Diceros bicornis michaeli* is required, with separate management plans for Kenya and Tanzania.

5.3 Working Group 5: Vegetation monitoring in the Crater

Chair: Martin Mulama
Rapporteur: Keryn Adcock

5.3.1 Vegetation mapping

It is recommended that vegetation maps of the NCA be updated and compared with the vegetation status in the past. This would entail: (i) collating historical information via a literature survey and interviewing older staff members; and (ii) undertaking co-ordinated plant and soil surveys to identify the major vegetation types related to the major soil units. The amount of palatable and unpalatable browse available in each habitat should be determined. Such information could be utilized for determining the present black rhino carrying capacity of the Crater. Collaborations should be established to increase the research and monitoring capacity of the NCA.

5.3.2 Vegetation management in the Crater

It is recommended that the composition and structure of vegetation in the Crater be managed to increase the habitat suitability for black rhino. This could include policies that: (i) keep elephant out of Lerai Forest in the short term; (ii) burn tall grass areas with the objective of reducing the buffalo population size; and (iii) increase the number of palatable browse species through the fire management programme.

5.3.3 Drought management

Food supplementation for rhino during periods of extreme drought was recommended for consideration, as targeted feeding of black rhino during drought has been successful in other areas. Some participants felt that this may prove impractical due to competition for supplemented feed from other herbivores.

6. CONCLUSIONS

Conservation of black rhino in Ngorongoro Crater and elsewhere in Tanzania will require continual input and commitment from managers, scientists, donors and politicians alike. The black rhino workshop at Ngorongoro in September 2003 was the start of such a process.

Key threats to the survival of black rhino in Ngorongoro and ways of mitigating these threats were discussed over a two-day period. Despite the wide diversity of representatives from government, conservation and science, a consensus emerged from the meeting that immediate action was necessary on a number of fronts.

The key issues raised are listed below:

- The number of rhino in the Crater is too low to guarantee their long-term survival. With a current population of 17 rhino chance events threaten the survival of the population.
- It is recommended that breeding females be translocated into the Crater to increase the number of rhino above 20 individuals and that the dominant breeding bull be removed to increase genetic diversity in future offspring.
- The restoration of the Lerai Forest into a habitat suitable for rhino is also a priority. This may be achieved by temporarily excluding elephant and by irrigating to flush salts from the soil profile.
- The development of a fire management programme in conjunction with vegetation monitoring is recommended for improving the suitability of some habitats for rhino.
- The Crater should be managed to maximise wilderness values and minimize human impacts as much as is possible in a multiple-use landscape.

- The implementation of the recommendations of the Ngorongoro Rhino Workshop, as outlined in this report, is primarily the responsibility of the Ngorongoro Conservation Area Authority, working in close collaboration with the international donor community.

- The formation of a Serengeti Mara Ecosystem Rhino Working Group is recommended to oversee the metapopulation management of *Diceros bicornis michaeli*. The immediate task at hand is to establish at least one additional founder population within the Serengeti-Mara Ecosystem. Kenya and Namibia have been exceptionally successful in building up black rhino populations through active metapopulation management. Tanzania is well positioned to achieve a similar success.

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The workshop was held at the Ngorongoro Serena Lodge. We thank the management and staff for providing excellent facilities and logistic support throughout the workshop.

We also thank Mr Elvis Musiba, representing the NCAA Board of Trustees, for his official opening of the workshop. The workshop was attended by 32 delegates from Tanzania, Kenya, South Africa and Namibia. The success of the workshop was due to the insight, experience and enthusiasm of all the delegates for which we are very grateful.

Matthew Maige, Tanzania National Rhino Coordinator, was tragically killed in the interval between the workshop and publication of this report. Mathew made a major contribution to the workshop and to rhino conservation in Tanzania. It is our hope that the implementation of the recommendations of this report will be a lasting legacy to him.

Appendix A

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Appendix B

List of technical reports produced by workshop delegates. Copies of these reports can be obtained from Frankfurt Zoological Society.

Amiyo, A.T. 2003. *Current status of black rhino in Ngorongoro Crater*. NCAA, Tanzania. pp 1-14.

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Trollope, W.S.W., Trollope, L.A. & Morkel, P. 2002. *Report on prescribed burning as a means of controlling the incidence of ticks, the current condition of the Lerai Forest and the infestation of forbs in the Ngorongoro Crater in Tanzania*. University of Fort Hare, South Africa and FZS, Tanzania. pp. 1-13.

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