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Wildlife and People: Conflict and Conservation in Masai Mara, Kenya






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FACTORS AFFECTING THE RECOVERY OF THE MASAI MARA BLACK RHINO POPULATION

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ABSTRACT

The black rhino population in Masai Mara National Reserve (MMNR) in Kenya is recovering after a major decline due to poaching. However, ecological changes in MMNR may affect the capacity for recovery. This study aimed to assess resource utilisation and the effects of woodland decline, cattle encroachment and tourism on habitat suitability in MMNR for black rhinos. Multivariate analysis and GIS technology were used to predict the growth and expansion of the population. Findings suggest that a long-term woodland decline has reduced the quality of food resources for black rhinos in MMNR, and that rhinos are dispersing to potentially more favourable, but unprotected, areas outside of MMNR. Equally, the presence of cattle inside MMNR has constrained rhino distribution and carrying capacity. Strategies for maximising the recovery of the population were identified. These include; (1) collaborating with Tanzanian authorities on cross-border rhino monitoring so as to secure areas in northern Tanzania to which rhinos may be dispersing; (2) undertake foot patrols within MMNR to increase sighting rates; (3) collaborating with monitoring groups outside MMNR on the Kenyan side of the border, in areas where rhinos are known to reside, and may be dispersing from MMNR, and; (4) preventing cattle and other livestock from entering the Reserve.

INTRODUCTION

The black rhinoceros (*Diceros bicornis* L.) in Africa declined throughout the 20th century, but most dramatically between the 1960s and 1980s as a result of illegal killing to supply the international demand for rhino horn (Leader-Williams, 1992). During this time it is estimated that over 95% of the population that existed in the 1960s was eliminated. Recently the situation has improved as a result of the concentration of the majority of wild rhinos into well protected areas administered by both government and private owners, and by intensifying anti-poaching efforts. Many populations have stabilised or recovered, and the continental population now numbers c.2,600 rhinos (Emslie & Brooks, 1999).

Kenya contains approximately 400 black rhinos, or 15% of the continental population (Emslie & Brooks, 1999). Within Kenya, MMNR is a key refuge for the endangered black rhinoceros. It currently holds around 23 rhinos, around 6% of the Kenyan population and 1% of the continental population (Walpole *et al.*, 2001). The MMNR black rhino population is unique in Kenya, as it contains only rhinos that are indigenous to the Serengeti-Mara ecosystem with no inwards translocation from other areas (Brett, 1993).

In the 1960s, MMNR contained a large population of around 150 black rhinos (Brett, 1993). In the 1970s and early 1980s, the population was decimated by poaching to supply the illegal trade in rhino horn, and declined to less than 15 individuals (Morgan-Davies, 1996). However, from the mid-1980s the population slowly begun to recover, due to increased security and surveillance by NCC rangers supported by Friends of Conservation, which at that time was known as Friends of Masai Mara. This study aimed to examine the recovery of the population since the poaching of the 1970s and 1980s, and identify ecological and human factors affecting it. In this presentation, three issues are considered:

- the dynamics of the black rhino population recovery.
- ecological change and its implications for black rhino habitat suitability.
- human disturbance of black rhinos in MMNR.

POPULATION DYNAMICS

Since the mid-1980s, twice-daily vehicle-based monitoring of the population has been carried out within MMNR by a team of NCC rangers, led by Sergeant Phillip Bett. Individual rhinos were recognised by a number of features (age, sex, horn size and shape, ear notches, body shape and nose wrinkle patterns), as have been widely used elsewhere. For each sighting, the individual(s) encountered and general area of sighting were recorded. For each patrol, regardless of whether a sighting was made, the date, start and end times, personnel involved and areas traversed were recorded. Periodically, between 1992 and 1999, GPS technology was used on patrols to record accurate locations of individual rhinos encountered (Walpole *et al*., 2001; Walpole, 2002). Most patrols took place in Keekorok Sector (Fig. 1) where all but one of the Mara rhinos resides.

In 1988, 20 rhinos were observed in MMNR. Considering only known births (*n*=25), deaths (*n*=7) and immigrations (*n*=5), the population grew to 43 individuals by 1999. However, by 'discounting' rhinos that had not been seen for two years or more (Leader-Williams, 1988), the population only reached a peak of 35 in 1993/94 before declining to 23 in 1998/99 (Fig. 13) (Walpole & Bett, 1999a; Walpole *et al*., 2001). It has since remained static at this level (P.Demmers, *pers comm*.).

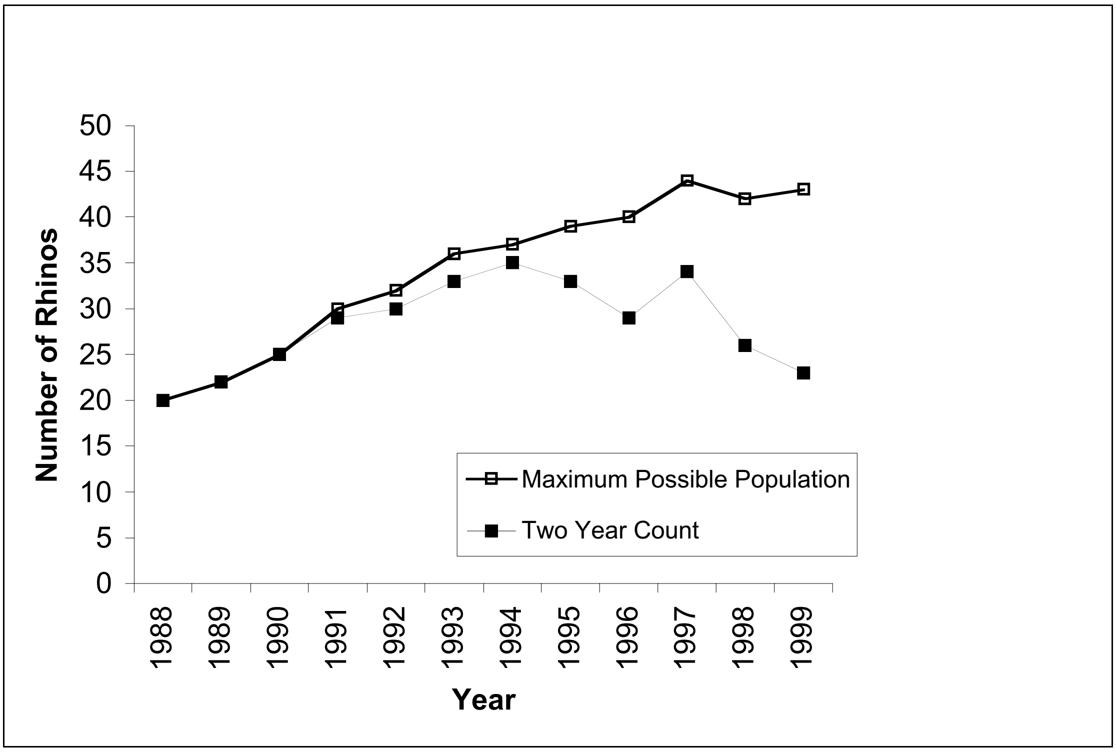

Figure 13. Population dynamics of the Mara rhinos, 1988 – 1999 (after Walpole *et al*., 2001).

During the 1990s, the black rhino population recovered to only approximately half the distribution and density at which it had existed in the 1970's (Table 3, Figs 14-15). Therefore, at no time in its recovery has the population reached the size, density or distribution of the population prior to poaching.

Time Period	Area (km^2)	Number of rhinos	Density (rhinos/km^2)
1971/72 (Total)	749	108	0.144
1971/72 (Keekorok Sector)	395	72	0.182
1994/95 (Keekorok Sector)	345	31	0.090
1997/98 (Keekorok Sector)	370	27	0.073
1999/00 (Keekorok Sector)	254	22	0.087

Table 3. Black rhino distribution and density in MMNR (after Walpole *et al*., 2001, incorporating data from Mukinya, 1973).

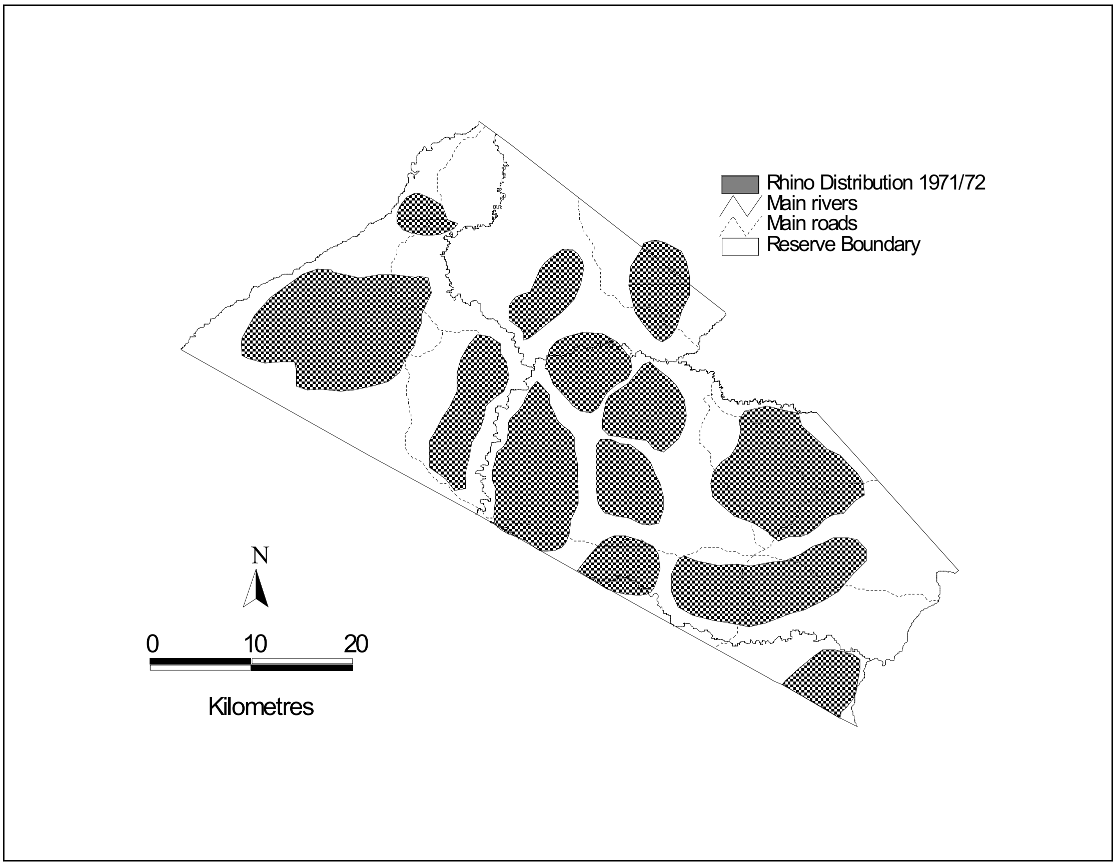

Figure 14. Rhino distribution in MMNR in 1971/72 (adapted from Mukinya, 1973).

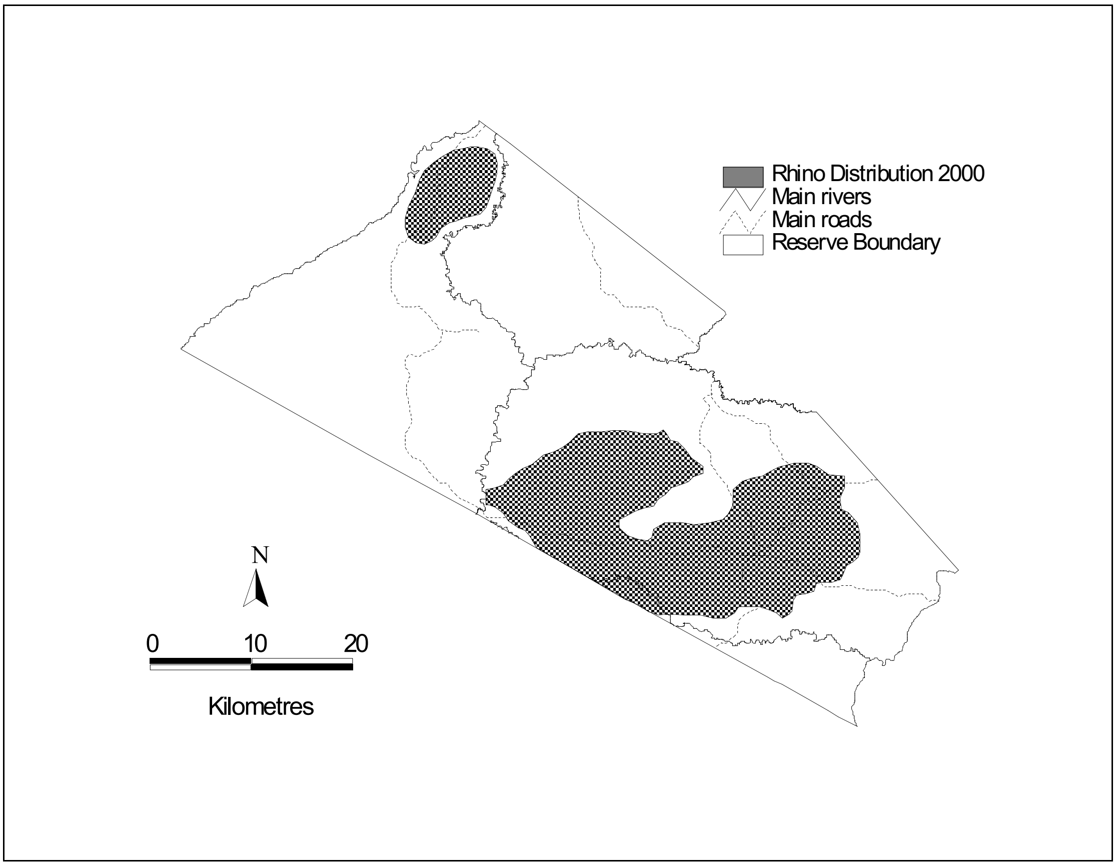

Figure 15. Rhino distribution in MMNR in 2000.

The apparent decline is not due to a failure of the population to breed. Over two thirds of the female population are accompanied by calves at any one time. Moreover, the mean intercalving interval was 35 months (Fig. 16), which is only slightly longer than average for black rhinos in the wild, and suggests that females are breeding well.

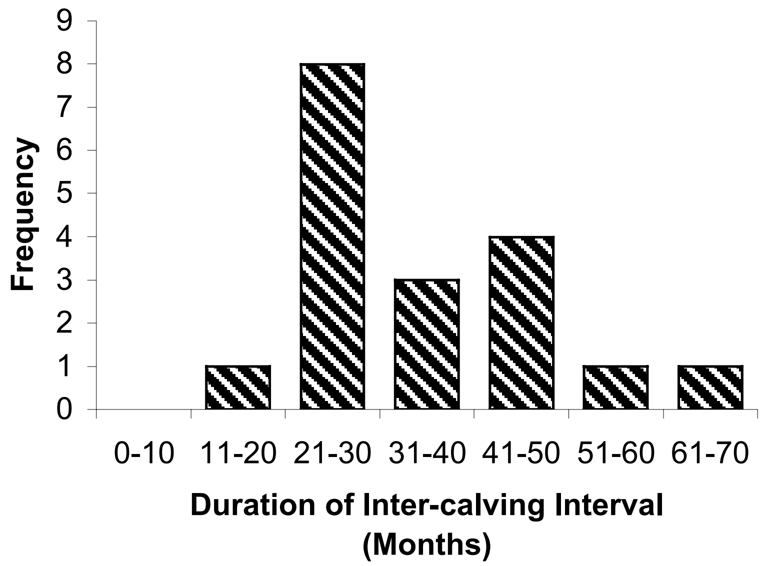

Figure 16. Inter-calving intervals of female rhinos in MMNR (n=18, after Walpole *et al*., 2001).

The most likely explanation for the decline is dispersal out of MMNR, and principally into northern Serengeti. Several of the rhinos living on the border have been seen south of Sand River within the Serengeti, so it is known that they can travel there. Moreover, a comparison of the age and sex structure of the current population with those animals known to have disappeared during the 1990s suggests that more sub-adults than expected have disappeared from the population, and that these are generally males (Walpole *et al*., 2001). Animals of this age that are about to leave their mother are actively in search of an area of their own, and can be expected to disperse from their natal area. This evidence supports, but does not confirm, the hypothesis that rhinos are dispersing out of MMNR, and that this is limiting the population recovery inside the Reserve.

Two possible explanations for this dispersal were considered in this study. Firstly, a decline in resource quality for rhinos within MMNR, and secondly increased human disturbance of rhinos within MMNR.

HABITAT CHANGE AND RESOURCE COMPETITION

The effects of woodland decline on woody resources were measured using data from relatively large permanent plots established by Dr Holly Dublin, which had been surveyed at approximately 2-year intervals since 1989 by the Masai Mara Ecological Monitoring Program (MMEMP). In addition, in 1999/2000, rhino feeding data were collected indirectly throughout MMNR. Browse utilisation and availability on a species/size class basis was recorded for every woody plant in small (10x30m) plots. Rhino feeding preferences were compared with those of a similar study conducted 30 years previously when the population was considerably larger and the vegetation of MMNR was somewhat different.

Results of long term research into habitat change reveals a decline in woody resources that rhinos rely on. Aerial photograph analysis revealed large declines in both *Croton* thicket and *Acacia* woodland density between the 1950s and 1980s (Dublin, 1991). Further research in the 1980s and 1990s showed a continued decline in both of these habitats to 1998 (Fig. 17; Obara 1999). Equally, analysis of the recent Acacia woodland plots revealed lower species diversity at lower densities (Fig. 18), suggesting that the remaining areas of woody habitat have lower plant diversity over small spatial scales.

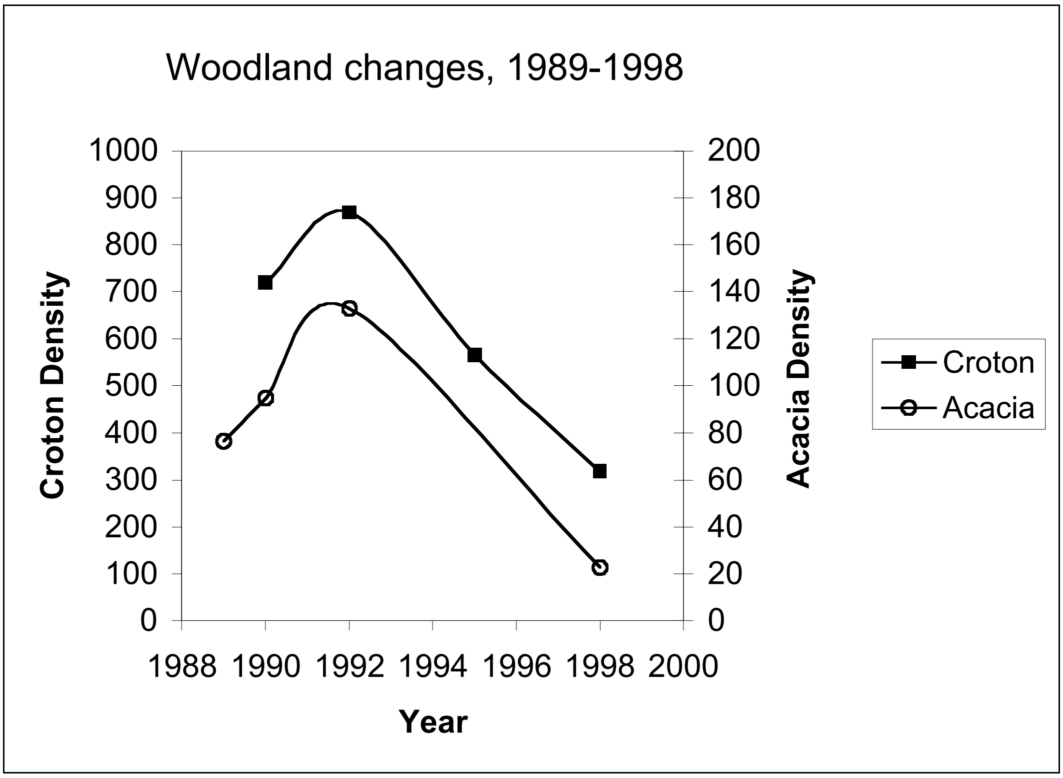

Figure 17. ***Croton*** **and** ***Acacia*** **decline, 1989 – 1998 (data from MMEMP).**

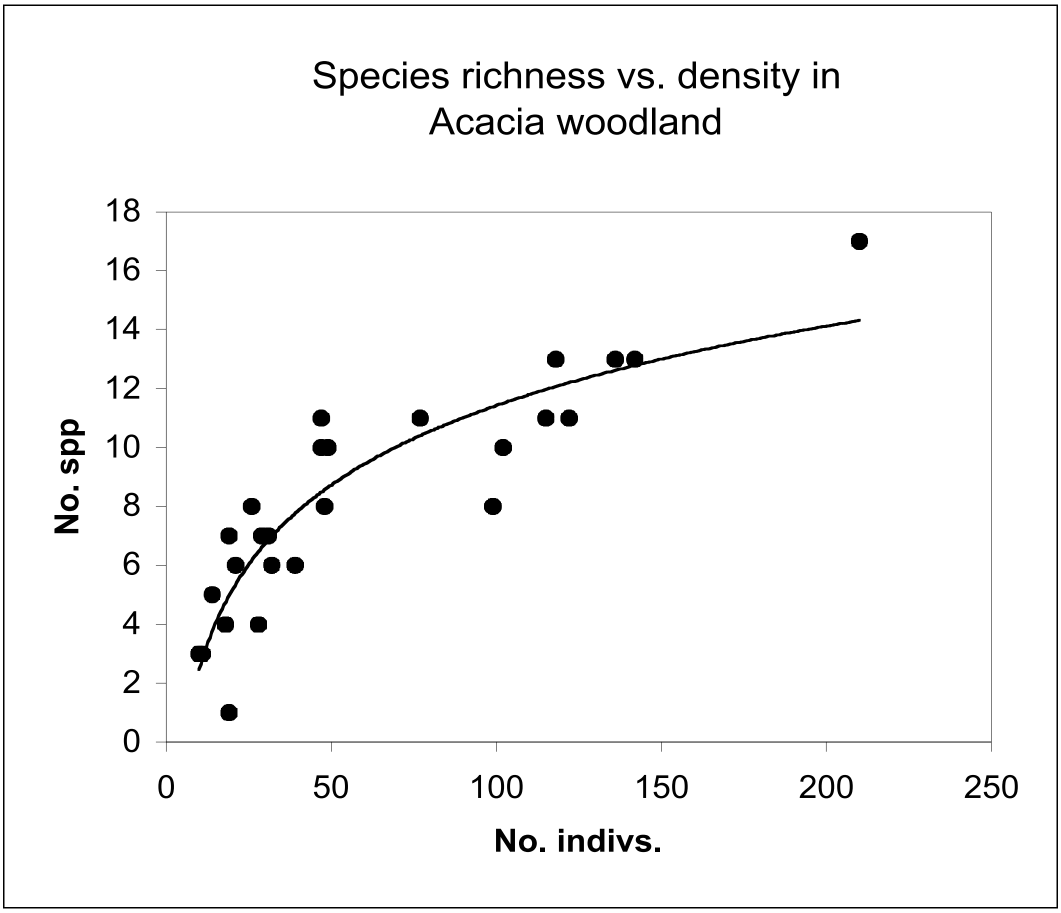

Figure 18. The relationship between density and species richness in ***Acacia*** **woodland.**

Dublin's work suggests this decline is a result of fire and elephant pressure (Dublin *et al*., 1990; Dublin 1995). Aerial surveys indicate that the elephant population in MMNR is increasing, thereby increasing the pressure on woody resources. At the same time, other wildlife is decreasing in the system, and browsers such as eland and giraffe appear to be decreasing faster than other species (Fig. 19). This evidence all supports the hypothesis that MMNR is becoming less valuable for browsers such as rhinos, partly due to elephant-induced habitat change.

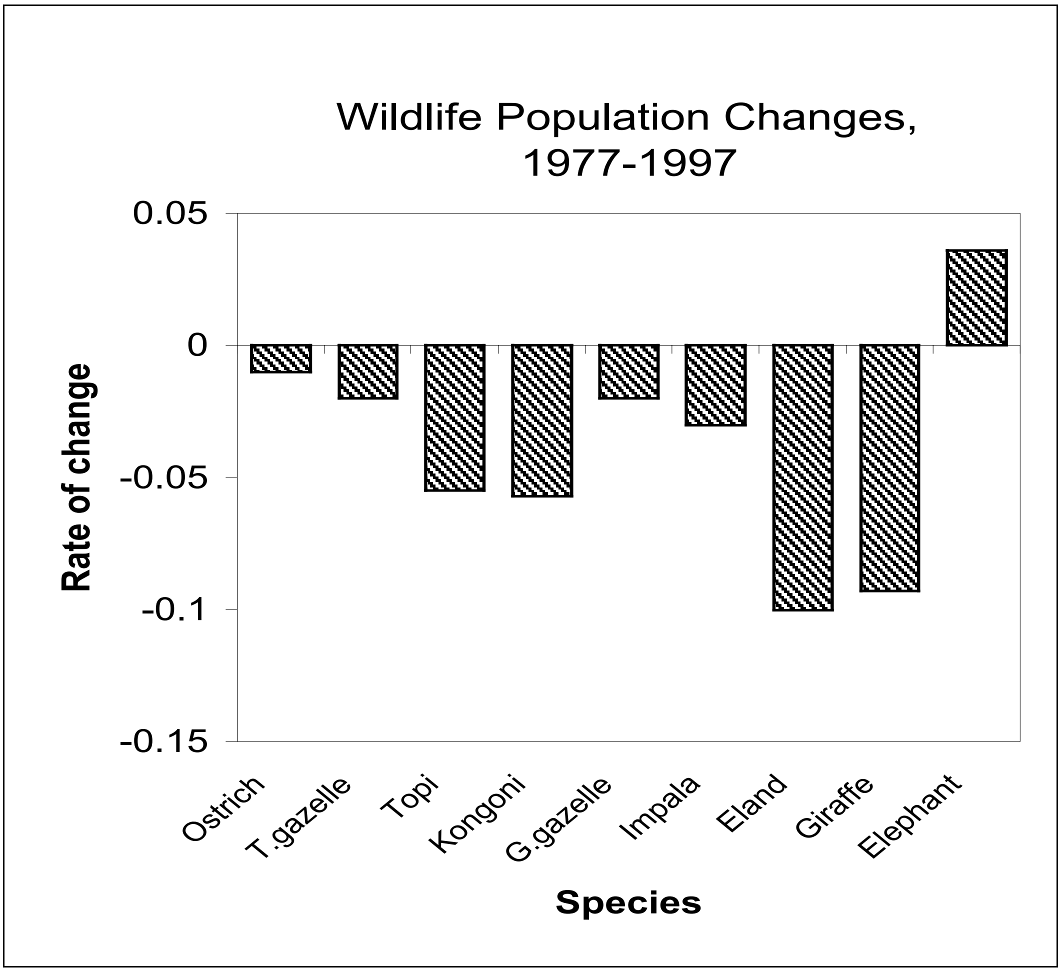

Figure 19. Wildlife population trends, 1977 – 1997 (data from Ottichilo *et al*., 2000).

Further evidence of a decline in resource quality can be gained from an analysis of rhino food preferences. A total of 48 species from at least 25 families were found to be utilised by black rhinos in Keekorok sector of MMNR. The species with the most rhino browsing offtake were *Grewia similis*, *Phyllanthus ovalifolius*, *Euclea divinorum*, *Croton dichogamus*, *Grewia bicolor* and *Flueggia virosa*. Together, these six species accounted for over 67% of all observed browse offtake. Only 15 species comprised over 86% of all observed browse offtake, suggesting that, whilst rhinos utilise a wide range of plant species, they rely on relatively few species for the bulk of their diet.

Evidence of rhino feeding was found on plants in *Croton* thicket, *Euclea* thicket, bushy luggas, and open and bushy grassland. Of these habitat types, most browsing evidence was found along bushy luggas, where *Phylanthus* and *Flueggia* species were favoured, and also in open or bushy grassland with high densities of *Grewia* species. *Croton* and *Euclea* thickets displayed some browse evidence.

Comparison with an earlier study by Mukinya (1977) revealed striking changes in black rhino diet in MMNR. Between 1972 and 2000, the favoured *Acacia/Dichrostachys* species declined in the diet considerably, whilst the less palatable *Croton* and *Euclea* species increased (Table 4). These changes would indicate a decline in the quality of available browse, although further analysis is needed to examine preferences in more detail.

Woody diet, 1972		Woody diet, 2000	
Species	**% of diet**	**Species**	**% of diet**
Acacia hockii	19.9	*Grewia similis*	18.3
Dichrostachys cinerea	19.1	*Phylanthus sepialis*	12.4
Grewia similis	10.1	*Euclea divinorum*	12.1
Croton dichogamus	9.1	*Croton dichogamus*	11.3
Acacia brevispica	7.2	*Grewia bicolor*	7.1

Table 4. Rhino feeding preferences, 1972 vs. 2000 (data from this study and Mukinya, 1977).

Taken together, the evidence presented here suggests that one reason for the suspected rhino dispersal out of MMNR could be a decline in the availability and quality of woody resources within MMNR. This is matched by an increase in woody resources in northern Serengeti (Sinclair, 1995). Elephants are thought to be beginning to expand out of MMNR into northern Serengeti, and it seems likely that rhinos are doing the same. Although unstudied, this area would appear to provide good resources for black rhinos but is lacking in law enforcement and is therefore insecure.

RHINO DISTRIBUTION AND CATTLE ENCROACHMENT

The distribution of black rhinos in MMNR was investigated using ArcView GIS and multivariate statistical analysis. Rhino location data collected with GPS units was overlaid with field data on the distribution of tourist lodges, vehicle tracks, tourism pressure and the distribution of cattle. Additional environmental data were obtained from satellite imagery.

A logistic model of rhino presence and absence in 1km^2 grid cells covering the whole of MMNR was constructed. This revealed that, after taking account of spatial autocorrelation (the likelihood that rhinos will occupy adjacent cells), rhino presence could be predicted on the basis of the presence of cattle (negative relationship) and the distance from drainage lines (negative relationship). Essentially, rhinos are more likely to be found close to drainage lines (a proxy for vegetation suitability), and where there are no cattle. Neither tourism pressure, expressed either as road density, vehicle density, or distance from lodges, nor elevation had any effect on rhino distribution.

This result can be illustrated by examining rhino and cattle distribution maps from 1972 and 2000 (Figs. 20-21). In both cases there is almost no overlap between where rhinos reside and where cattle encroach, suggesting that cattle disturbance affects where rhinos are to be found, and consequently diminishes the carrying capacity of MMNR. Anecdotal evidence from inside and outside MMNR support this conclusion.

The two distribution maps suggest that cattle encroachment is more severe now than in previous years. This may in part be due to the degazettement of parts of the northern and eastern borders of the Reserve two decades ago, and resultant human settlement of these areas. Human population growth in these areas has been high throughout the 1990s (Boydston *et al.*, *in press*), and this has fuelled the increase in cattle incursions into the Reserve.

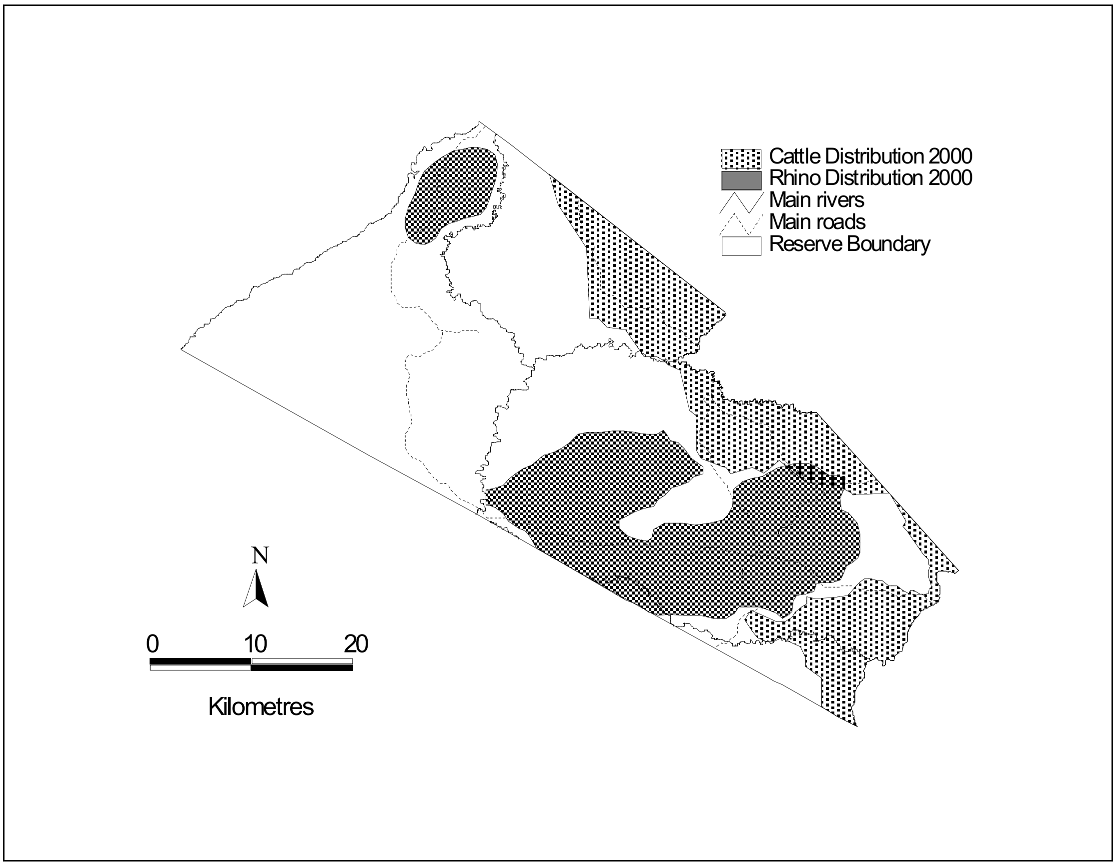

Figure 20. Rhino and cattle distribution in MMNR in 2000.

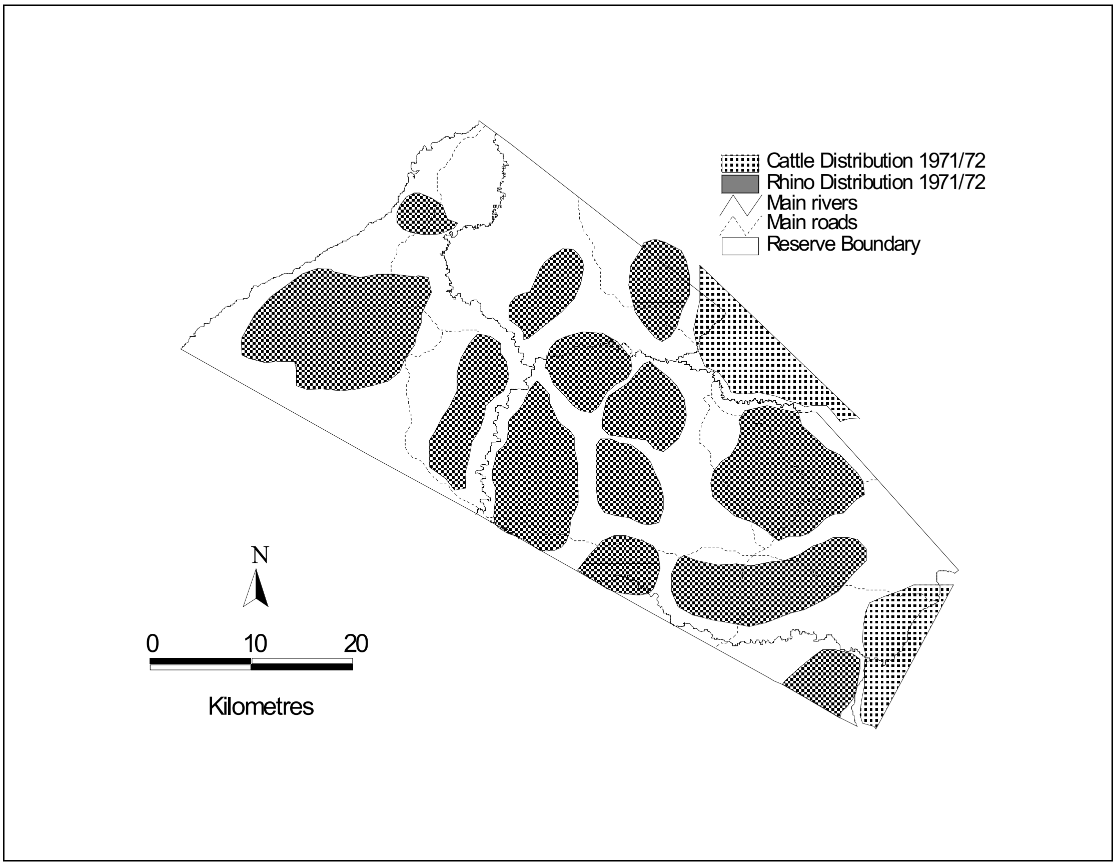

Figure 21. Rhino and cattle distribution in MMNR in 1971/72 (adapted from Mukinya, 1973).

CONCLUSIONS AND RECOMMENDATIONS

Woody vegetation decline in MMNR has occurred as a result of elephants and fire, and possibly with additional effects of tourism and livestock encroachment. As a result, it would appear that the Mara black rhinos have become constrained in their recovery. Their diet appears to have shifted towards more unpalatable species. Moreover, they appear to be dispersing from MMNR rather than recolonising it after the major poaching-induced population decline.

These observations would suggest a decline in carrying capacity for black rhinos that may affect the ability of the population to recover from poaching. Furthermore, this capacity is currently constrained by the continued presence of cattle inside MMNR borders. Whilst cattle do not compete directly with black rhinos for resources, they appear to disturb rhinos so that they do not make use of areas where cattle reside. This disturbance is probably a result of cattle bells, and the presence of herders and dogs with the cattle, the noise from which prevents rhinos from resting in thickets in areas where cattle occur.

The model of rhino distribution suggests that, with or without cattle, there is scope for further expansion of the black rhino population, which currently numbers 23. However, it would appear that rhinos are dispersing out of MMNR rather than into areas currently unoccupied within MMNR. It is likely that there are unoccupied areas contiguous to MMNR, especially in northern Serengeti, which are more favourable to black rhinos, which is why rhinos prefer to disperse out of MMNR. However, such areas are not patrolled by security forces, and represent a significant risk for rhinos. It is not yet known how many rhinos survive in northern Serengeti, but it is clear that this area must be secured for rhinos, and the population must grow there, before expansion of the population is witnessed within MMNR.

A presentation of some of the findings reported here was made at a National Rhino Planning Workshop held in Naivasha, Kenya by KWS in September 2000. At this meeting, the findings were discussed and a number of recommendations were made for the management and conservation of this population of black rhinos:

1. Develop collaboration with the Tanzanian authorities to establish cross-border monitoring of rhinos between the Serengeti and Masai Mara. This would help to secure the area for rhinos, and would establish the size and range of any rhinos currently residing there (Walpole & Bett, 1999b; Walpole *et al*., 2001).

2. Undertake foot patrols in hills and areas of thicker vegetation to check for undetected live rhinos and carcasses. The current method of vehicle-based patrols, although practical in a large area like MMNR, risks missing evidence of rhino presence. A planned combination of foot and vehicle-based patrols would increase rhino sightings and improve security (Walpole, 2002).

3. Increase the links between rhino monitoring programmes inside and outside MMNR on the Kenyan side of the international border, particularly with regard to foot patrol methods and the potential movement of rhinos between MMNR and adjacent areas. There are areas to the east of MMNR along the border where rhinos exist, which are unlikely to be isolated from the population within MMNR. Patterns of movement between these sub-populations need to be elucidated to help explain why rhinos seem to prefer unprotected areas beyond MMNR borders.

4. Increase efforts to keep cattle out of MMNR. It is clear from the model presented here, and from earlier reports, that high densities of cattle limit the distribution of black rhinos. A valuable test of this hypothesis would be to remove all cattle from MMNR over an extended period of time and see whether areas historically occupied by black rhinos are recolonised.

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