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
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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

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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.