SUMMARY

This study was initiated in an attempt to overcome the lack of information on the behaviour and ecology of reintroduced felids. Historically, translocation and reintroduction of large carnivores has been widely practised, but such efforts have been poorly researched and the little data which exist indicates these projects are largely unsuccessful. While lions and cheetahs have been intensively studied in numerous established populations, there is virtually no available data on their response to being translocated to a new region. Intensive monitoring of 13 lions, 15 cheetahs and their offspring which had been reintroduced into the Phinda Resource Reserve in northern KwaZulu-Natal was conducted for 40 months to collect information on various aspects of their behaviour and ecology. The study aimed to assess the success of such restoration attempts and to determine whether reintroduction is a viable method for the re-population of large felids in areas of their former distribution.

In contrast to most previous efforts to translocate or reintroduce large African felids, the present study used 'soft-release' methods to attempt to overcome problems typically associated with carnivore translocation. Most past attempts freed felids at the release-site within days or hours of capture without due consideration for various factors which intuitively may affect the success of such a release. The present study attempted to address such issues including possible trauma and disorientation associated with capture and translocation, the presence of resident conspecifics, the availability of space for released individuals and the probability of individuals leaving the release site and encountering conflict with humans. All individuals in the present study were held in captivity following their capture for 6-8 weeks at the release site prior to being set free. Release events were staggered and took place from different locations within Phinda for two reasons. First, it was intended to allow individuals sufficient time and space to establish home ranges before the potentially disruptive effects of subsequent releases. Secondly, it was hoped newly released individuals would be less likely to encounter territorial conspecifics soon after release by locating later release sites outside the home ranges of established individuals. The reserve lacked resident lions and cheetahs and was entirely surrounded by electrified fencing to attempt to discourage reintroduced cats from leaving the site (Chapter 2).

All reintroduced lions and cheetahs remained at the reserve. Animals generally did not display the excessive 'homing' behaviour characteristic of past carnivore translocations in other regions. Three groups of lions and cheetahs (largely young males) showed evidence of homing for two months following release, but all subsequently established home-ranges at the release site. The reserve's boundary fence was a critical factor in restricting post-release movements of felids. Unfamiliar and unrelated animals socialised during the pre-

release captivity period often remained together following release for long periods. This has important implications for translocation attempts where individuals are generally captured opportunistically, often after coming into conflict with humans. The study demonstrated that when exposed to a period of captivity, unfamiliar individuals of lions and cheetahs established enduring relationships which persisted long after release. This technique facilitated the formation of socialised groups which are probably better suited for reintroduction purposes than lone individuals (Chapter 3).

Reintroduced lions and cheetahs at Phinda which survived the crucial early post-release period established home ranges in the reserve, most of which endured for the duration of the study. This suggested that reintroduction may be a viable method for re-establishing resident felids. Lions (of both sexes) and male cheetahs were territorial whereas female cheetahs showed no signs of establishing territories and, in some cases, used the entire reserve as their home range. Lion individuals and groups used between 27.56km^2 and 130.20km^2 as their home-ranges in Phinda. Mean home range size of female groups was 52.83 km^2 $\pm$ 35.68 km^2 (range: 27.56km^2 - 105.60km^2, n = 3). Male home-ranges reflected their attempts to encompass as many female territories as possible and were as extensive as 78.7% of the entire reserve. Lions showed evidence of home-ranges shrinking during the dry winter, which probably reflected the distribution of artificial water sources in the reserve. The placement of such waterpoints may be an important issue for the management of predator-prey relationships in small reserves (Chapter 4).

Mean size of the territories of male cheetah coalitions was 92.89 km^2 $\pm$ 59.39 km^2 (range 56.79 km^2 - 161.44 km^2, n = 3). Territories were fiercely contested and fights between rival males resulted in four deaths of males during the study. The 'patchiness' of available preferred habitat may have exacerbated conflicts between male cheetahs. Such habitat, particularly open grassland, formed the core areas of both male and female cheetahs' ranges. In regions such as at Phinda where historical human influences such as cultivation and the removal of indigenous bulk grazers and browsers (for example, elephants) may radically alter the structure of habitats, the planning of a restoration attempt of cheetahs must include consideration of available suitable habitat. The 'rehabilitation' of human-altered landscapes may be an important factor affecting project success (Chapter 4).

The greatest cause of mortality to reintroduced felids was as a result of human activity, particularly poaching. Five reintroduced lions and two cheetahs were killed in wire snares. Other human-mediated causes of mortality included road-kills and poor boundary security which allowed individuals to leave the reserve and enter farming communities where they were ultimately killed by humans. Practitioners of reintroductions need to be aware of the influence of human activity on carnivore re-establishment and allocate

resources accordingly to moderate its effect. In a restoration project, this may be complicated by the demands of parallel development such as the incorporation of tourism activities, also a highly resource-costly process. Inter and intra-specific conflict with other large carnivores was also a significant cause of deaths of reintroduced cheetahs. While this is inevitable in any natural system, practitioners of multi-species reintroductions such as at Phinda should consider establishing competitively vulnerable carnivores prior to releasing ecologically dominant species. Delaying the release of lions until reintroduced cheetahs have had a chance to reproduce and their offspring have dispersed and established home ranges may ameliorate the effects of lion predation on cheetah re-establishment (Chapter 5).

Despite mortalities, population characteristics suggested lions and cheetahs are rapid and effective in re-colonising vacant areas. Most lions and cheetahs survived the critical early post-release stage (three months) and a minimum of 60% of females of both species survived to reproduce. Three lionesses bore litters before their third birthday and five males sired cubs at 26-28 months old which is generally earlier than in established populations. Cheetahs at Phinda probably also had opportunities to reproduce younger then elsewhere, though this is based on circumstantial evidence. The opportunity for hastened reproduction may have arisen as a result of low population density allowing normally subordinate individuals to breed earlier than in established populations. This was probably a significant factor in rapid population growth at Phinda. At least 43 lion cubs and 48 cheetah cubs were born during the study. 77% of lion cubs and 63% of cheetah cubs reached independence during the study and high rates of cub and sub-adult survival was a further factor contributing to rapid population growth. Increased cub survival (compared to other studied populations) was probably due to low density of established predators (conspecifics and competing species) and a high density of non-migratory game. Population modelling using the population viability analysis software VORTEX suggested that low mortality rates for juveniles and sub-adults is a critical factor for rapid re-establishment (Chapter 5).

Re-introduced lions and cheetahs foraged successfully following their release. Suitable prey species and abundance existed in the reserve for the post-release survival of reintroduced felids to be unaffected by their ability to acquire prey. Wildebeest, zebras, nyalas and warthogs made up 86% of biomass killed by lions. Wildebeest were clearly the most important species to lions which were killed at three times their availability, despite the greater abundance of species such as nyalas and impalas (Chapter 6). Predation by reintroduced lions on wildebeest resulted in a population decline in that species during the study period. This was probably due to the lack of predation-free refuges inherent in small, enclosed reserves so that wildebeest, as preferred prey of lions, could not move to areas of decreased predation pressure. The decline of wildebeest in the reserve prompted intensive

population management of lions (largely by capture and removal) subsequent to the study period and is clearly one of the most pressing concerns of re-establishing predator-prey relationships in small, enclosed conservation areas (Chapter 7).

Cheetahs preyed upon reedbucks at eight times their availability at Phinda and reedbucks also underwent a population decline during the study period. Nyalas and impalas were the other two most important prey species to cheetahs, the former constituting almost 50% of biomass killed by cheetahs. This is the first study of cheetah feeding ecology in woodland habitat and the first to demonstrate that cheetahs can specialise on an ungulate species almost twice as heavy as 'typical' prey species from other ecosystems such as impalas and Thomson's gazelles. Female cheetahs showed a pattern of hunting larger prey as litters grew, particularly where a high percentage of cubs survived resulting in considerable energetic demands on mothers. Hunting larger prey probably increased the risks of injury to female cheetahs (Chapter 6).

Aside from evidence that predation affected some ungulate populations, the study demonstrated significant behavioural changes by herbivores in response to felid reintroduction. Wildebeest and impalas underwent a 200% increase in vigilance behaviour in the first five months following the release of lions and cheetahs. Wildebeest and impalas in exclusion areas free of reintroduced felids did not show any change in vigilance. Nonetheless, many patterns of vigilance behaviour did not differ regardless of predation pressure. Female ungulates with juveniles were always the most vigilant individuals and central animals were always the least watchful in both predation conditions. This aspect of the study suggested that predation pressure is the principal influence on vigilance behaviour in ungulates and even very low risk of being preyed upon contributed to patterns of vigilance (Chapter 8).