CHAPTER 1.

GENERAL INTRODUCTION.

As human demands on ecosystems have increased, there has been a reduction or removal of species from their former range. Consequently, biologists and wildlife managers have been forced to adopt interventionist approaches to species conservation. Among the techniques gaining popularity is species re-introduction. Re-introduction projects attempt the re-establishment of a species in an area which was part of its historical range but from which it has become extinct (Chivers, 1991). In contrast, the term translocation applies where individuals are moved from one part of their existing range to another. While their objectives may differ slightly, the constraints, techniques and results of re-introduction and translocation have much in common (Chivers, 1991; Moore & Smith, 1990).

Large carnivores are frequent subjects for such projects. With increased human population pressures and continued fragmentation of the landscape, the remaining habitat of wide-ranging carnivores has become more and more critical. Their ecological demands and potential for conflict with humans make them among the first species to disappear from an area. However, ironically, large carnivores frequently symbolise wilderness to the general public who express great interest in their re-introduction. Despite this high profile with the public, high cost and logistical complexity of such projects, many efforts involving large carnivores have received little post-release monitoring and factors determining success are poorly understood (see Linnell *et al,* 1997, for review).

Although there are increased efforts to repatriate carnivores to areas they once occupied, large carnivore re-introduction is a complex process. For a project to have any chance of success, three main factors need to be addressed, each presenting considerable challenges to re-introduction attempts (Peek *et al*, 1991; Reading & Clark, 1996). First, there are methodological considerations which require extensive logistical and financial resources. Secondly, the level of communication with and involvement of local human communities will invariably affect programme results. Finally, addressing the ecological requirements of the re-introduced species is critical to success.

The influence of these parameters is poorly studied in reintroduction (and translocation) efforts of most carnivores. While recent significant advances have been made in schemes to re-establish north American canids and ursids (Fritts, 1992; Smith & Clark, 1994; Linnell *et al,* 1997), data for felids is sparse. Information from Africa where restoration efforts frequently clash with the subsistence requirements of local communities is even poorer. Some recent efforts have made important contributions where 'problem' individuals of servals (Van Aarde & Skinner, 1986), leopards (Hamilton, 1981; Grimbeek,

1992) and lions (Stander, 1992) have been translocated away from a conflict situation with humans. However, there has been no intensive study conducted on a large-scale reintroduction effort of any large African carnivore. As Mills (1998: 87) recently stated, "The only documented study of the post-release behaviour of a large African carnivore is that of Hamilton (1981) with leopards in Kenya."

In South Africa, recent dramatic political changes have seen a surge in wildlife-oriented tourism (Wells, 1996). As a result, governments, tribal communities and the private sector are re-evaluating historical patterns of landuse. Many areas formerly given to agriculture or other landuses generally incompatible with wildlife are being restocked with indigenous wild species. Although these projects are motivated largely to satisfy the tourism market, the potential for significant conservation and ecological value is considerable. The ultimate aim of many of these projects is to re-establish populations of the large carnivores. As important 'drawcard' species for tourism, the interest in reintroduction of lions, cheetahs and other large predators is high.

One of the first such projects to be initiated on a relatively large scale began in 1992 at the 170 km^2 Phinda Resource Reserve in northern KwaZulu-Natal (hereafter Phinda; see Chapter 2 for details). Phinda management placed emphasis on lions and cheetahs as the 'endpoint' of their reintroduction scheme which introduced over 1000 indigenous animals into an area formerly comprising mixed agriculture, game farms and wildlife land (Chapter 2). Between March 1992-April 1994, Phinda released 13 lions and 15 cheetahs, wild-caught from locally abundant populations in Namibia and South Africa (details are provided in Table 2, Chapter 2). Animals were acquired essentially fortuitously which resulted in varying degrees of relatedness and familiarity. Phinda management invested considerable resources in the involvement of surrounding communites to educate them about the release of lions and cheetahs (Chapter 2). A crucial component of this program was a guarantee that reintroduced felids would be constantly monitored by radio-telemetry. This presented an opportunity to conduct the first intensive study on reintroduced cats and address some of the areas where information on carnivore reintroduction was lacking.

Lions and cheetahs are ideal subjects for such a study. Both species have undergone a profound reduction in distribution and exist largely only in specially set-aside conservation areas (Nowell & Jackson, 1996). However, in southern Africa, populations are locally abundant and, therefore as subjects for experimental manipulations of this sort, do not have the conservation value of more endangered species where use of even a few individuals for reintroduction schemes may meet substantial opposition (Clark & Reading, 1996). Accordingly, any information gathered on lion and cheetah reintroduction may be of

value not only for the restoration of these species but also of similar, more threatened species. Furthermore, lions and cheetahs readily encounter conflict with humans as soon as they leave conservation areas and there is a need to establish a protocol for the successful translocation of these 'problem' animals which, otherwise, are invariably killed.

With the considerable challenges and lack of information surrounding felid reintroduction, the present study was initiated to attempt to elucidate factors which may contribute to project success. In particular, key questions the study aimed to address are as follows:

1) Post release movements and behaviour.

Experience from reintroduction projects largely on non-felids illustrates there may be many obstacles facing attempts to re-establish large felids (Linnell *et al,* 1997). At Phinda, many of the potential problems facing carnivore translocation were absent. There were no resident populations of lions or cheetahs, nor of other potential competitors or predators such as leopards and spotted hyaenas which, intuitively, would affect the likelihood that released animals will find spaces in which to settle (Hamilton, 1981). Further, the entire boundary was secured with electrified fencing (Chapter 2) limiting, at least to some extent, large excursions immediately following release which have characterised carnivore translocation efforts in the past (Linnell *et al,* 1997). Finally, translocated lions and cheetahs were held for extended periods in captivity at Phinda prior to being released, a strategy which appears to increase project success in non-felids (Moore & Smith, 1991; Carbyn *et al,* 1994).

The first aim of the present study was to document the post release behaviour and movements of reintroduced lions and cheetahs to assess factors which may be important in the process of re-establishment. Specifically, I ask what do the movements and behaviour of re-introduced carnivores immediately after their release indicate about their response to translocation? Also I examine the question of translocated carnivores being prone to 'homing behaviour ' (Linnell *et al,* 1997) and consider if different methodology can alleviate this (Chapter 3).

2) Establishment of territories and home ranges.

There are very few data available on home-range and territory characteristics for reintroduced felids. While lion and cheetah spatial patterns have been well-studied in established populations in numerous ecosystems (Van Ordsol *et al,* 1985; Stander, 1991; Caro, 1994; Hanby *et al,* 1995) they are not known from translocation or reintroduction scenarios. A reintroduction project such as at Phinda offers opportunities to explore aspects

of felid spatial patterns which would not be possible in established populations. There were no resident lions or cheetahs at Phinda prior to the release of the study subjects, so the movements and behaviour of released individuals were not constrained by the presence of conspecifics. In addition, available habitat was highly heterogeneous so that felids had a 'choice' of suitable habitats in which to settle. Finally, given that Phinda was entirely enclosed, ungulates were not able to migrate, so felids may not have experienced the same pressure to make large movements in order to forage successfully as occurs in other ecosystems (Mills, 1990; Caro, 1994; Hanby *et al,* 1995).

The second aim of the study was to attempt to explore the process of home-range establishment and patterns of habitat use by felids following reintroduction (Chapter 4). I examine differences in seasonal ranges and the presence of young cubs on female ranging behaviour. I also aimed to look at the impact of stochastic factors such as the deaths of companions and conspecifics on ranging patterns in reintroduced felids. Finally, the study aimed to establish management and technical considerations pertaining to lion and cheetah ranging patterns and habitat use which may assist future reintroduction efforts.

3) Population characteristics.

One critical factor in assessing the success of reintroduction efforts is the demography of reintroduced populations. In particular, reproduction, mortality and population growth are crucial to understanding population dynamics, particularly for populations undergoing the process of recolonisation (Kleiman *et al,* 1989; Stanley-Price, 1989). Furthermore, analyses and predictions about viable population sizes and the persistence of populations are typically produced using such demographic data (Lacy, 1987; Lacy & Clark, 1993). Few studies have been able to collect detailed data of this sort for reintroduced carnivores.

Therefore, a further aim of the present study was to collect information on the mortality and reproductive characteristics of reintroduced lions and cheetahs (Chapter 5). Specifically, the study aimed to:

1. document the post-release survival of reintroduced lions and cheetahs and attempt to determine important causes of mortality;
2. document patterns of reproduction of reintroduced lions and cheetahs;
3. use the above data as input parameters to model population viability estimations;
4. make methodological recommendations based on the data and population projections to enhance the success of large felid reintroduction efforts.

4) Feeding ecology.

Patterns of predation and foraging in lions and cheetahs have been well-studied in many parts of their range and determinants of such patterns are beginning to be well-understood (Caro, 1994; Packer & Ruttan, 1988; Packer *et al,* 1990, 1995). Some of these factors differed markedly at Phinda compared to most other well-studied populations. Reintroduced felids were faced with a high density and diversity of naïve prey species which had experienced low predation pressure prior to reintroduction (Hunter & Skinner, 1998). Furthermore, the lack of resident lions and cheetahs, and low densities of other major predators (Chapter 2) meant that competition for food resources was low. Additionally, some aspects of lion and cheetah population dynamics were unusual compared to established populations (Chapter 5). Lions prides were generally small so that competition for food within prides was potentially low. Pride size was likely to undergo an increase over the duration of the study once the small founding groups which were released, began breeding. This presented an opportunity to examine changes in prey selection related to increasing group size over time. Finally, patterns of predation for cheetahs are generally only well-known from very open habitat such as the population of the Serengeti plains. The *Acacia*-dominated woodland mosaic at Phinda presented an opportunity to examine cheetah feeding ecology in a very different environment to the 'classic' grassland habitat of cheetahs.

In this section of the study (Chapter 6), I aimed to examine lion and cheetah feeding ecology under these circumstances. Specifically, I attempted to explore the following questions:

1: Does lion foraging behaviour reflect the reduced requirements inherent in small pride size, and the abundance of smaller, easier-to-kill prey species at Phinda?

2: Does this behaviour change over time as pride size increased due to rapid reproduction and high survival of cubs?

3. What are the patterns of feeding ecology of cheetahs in woodland-dominated vegetation and can cheetahs successfully forage in habitats often assumed to be sub-optimal?

4: Does the high rate of survival of cheetah cubs place increased demands on mother cheetahs and if so, how do they respond?

Finally I also aimed to assess the importance of food resources for reintroduced carnivores in terms of project success and consider management issues related to predator-prey interactions following carnivore reintroduction.

5) Carnivore-herbivore relationships.

The effect of predation by large carnivores on populations of their prey species is a controversial subject. Predation is often assumed to regulate or even deplete herbivore populations and as a result, predators may be persecuted by hunters, game farmers and managers of some reserves (Keith, 1974; Bergerud, 1985; Skogland, 1991). However, studies which unequivocally demonstrate the impact of predation in large mammal communities are sparse. Previous work on large mammal predator-prey systems in Africa suggests that predation generally has little regulating effect on prey populations. Herbivore populations appear to periodically escape high predation pressure either by migratory movements (Sinclair *et al*, 1985; Fryxell & Sinclair, 1998; Mills & Shenk, 1992), or by being nomadic (Mills, 1992). However, the small size of Phinda and its enclosure within electrified fencing established conditions in which herbivores may have lacked refuges from predation. Accordingly, the potential for considerable impact by predation on herbivore populations at Phinda was substantial. This aspect of the present study aimed to document any impact on lion and cheetah prey populations in a small enclosed area where there was no refuge from predation (Chapter 7).

The study also aimed to examine the vigilance response of a naïve prey population to the introduction of their historical felid predators after an absence of those predators for many decades. This aspect of the study investigated whether the increase in predation pressure as a result of the re-introduction of lions and cheetahs would be reflected in increased vigilance and also, if vigilance increased over time in the months immediately following the re-introduction of lions and cheetahs. I also examined the relationship of group size, location in herd and the presence of juveniles to vigilance behaviour where re-introduced cats were present and where they were absent (Chapter 8).

The over-arching aim of this study was to attempt to establish biological and methodological considerations which may contribute to the success of these sorts of conservation efforts, the outcome of which has seldom been documented (Mills, 1991; Linnell *et al* 1997).