CHAPTER 3.

EARLY POST-RELEASE MOVEMENTS AND BEHAVIOUR OF REINTRODUCED LIONS AND CHEETAHS, AND TECHNICAL CONSIDERATIONS IN LARGE CARNIVORE RESTORATION.

Although re-introduction and translocation have been widely practised management techniques employed with large carnivores, post-release monitoring of such attempts in the past has been poor, particularly of African species. Where such monitoring has occurred, success has generally been low and frequently, the reasons for failure were not well understood. Such failures have led many authors to conclude that the factors affecting success are not well enough understood to justify relocation as a method for conserving and managing large carnivores (Panwar & Rodgers, 1986; Wemmer & Sunquist, 1988; Mills, 1991).

There may be a number of factors contributing to low project success. Many well-intentioned translocations have moved animals from a conflict situation with humans into a protected region (Cobb, 1981; Rogers, 1988). Typically, so-called "problem animals" are captured on the outskirts of a protected population and either returned to that population or translocated to another area and released. However, conservation areas, by virtue of their very status, may already contain saturated populations of the subject species. The presence of resident individuals at the release site is likely to have a significant effect on the establishment of translocated animals. Indeed, in many cases, it appears that the problem of dispersing individuals leaving parks or reserves arises because there is no room for them in the population (Maddock *et al,* 1996.)

Despite this, few projects have considered this factor. The pressure from the public for non-lethal methods of control aswell as a genuine desire on the part of local conservation or wildlife authorities to balance the problem generally dominates such concerns and translocation is often employed where it is unlikely to succeed. For example, of 10 livestock killing leopards translocated to Meru National Park in Kenya, only one eventually settled in the park after extensive movement outside. All the animals left the park within two weeks of release, almost certainly- at least to some extent- because of the presence of resident leopards and the lack of available habitat in which to settle (Hamilton, 1981). In the 11 years prior to this study, 96 leopards had been released in Meru but were not monitored and their fates largely unknown.

A further factor which appears in the literature frequently but has rarely been addressed is the tendency of translocated carnivores to return to the capture site. Large felids are strongly territorial (Kruuk, 1972; Bertram, 1973; Smuts, 1976, 1978;

Gittleman & Harvey, 1982; Caro & Collins, 1987) and a shift from their known territory to a strange area is likely to be one of the dominant stress factors in the re-introduction process. Most previous efforts involving large felids have been 'hard-releases' in which animals are freed at the release site as soon as possible after translocation. Experience from non-felids suggests that 'soft-release' methods incorporating a captivity period at the release site may improve project success (Linnell *et al,* 1997).

Intuitively, the period immediately following release will be crucial for establishment of translocated individuals (Chivers,1991; Ruth *et al,* 1993). Many carnivore translocations are characterised by large post-release movements, presumably as animals orient themselves and assess local conditions which may be important for survival, e.g. the presence of conspecifics, the location of water and food resources, location of suitable refuges for females to bear young, and so on. The early post-release period is often marked by high mortality as released individuals are exposed to increased risk of 'death by misadventure' due to exploratory movements and lack of knowledge of local conditions (Comly & Vaughan, 1995).

At Phinda, the opportunity arose to assess early post-release behaviour in a comparatively controlled environment where many of the apparent problems facing carnivore translocation had been addressed. The reserve lacked resident populations of either lions or cheetahs and also had low densities of potential competitors or predators such as leopards and spotted hyaenas. Further, the entire boundary was secured with electrified fencing (Chapter 2). Finally, translocated lions and cheetahs were held for extended periods in captivity at Phinda prior to being released.

In this chapter, I explore the role of these factors in early post-release movement and behaviour of re-introduced lions and cheetahs. Ultimately, all lions and cheetahs released at Phinda which survived the early post-release period established home ranges in the reserve (Chapter 4). Here, I attempt to assess the importance of the first 12 weeks following release in the process of re-establishment by released felids. Based on these observations, I include management and technical recommendations for translocation and reintroduction projects of large carnivores.

METHODS:

Details of the pre-release period and techniques were presented in Chapter 2. Following release of felids, I monitored their movements and behaviour by telemetry and direct observation as described in Chapter 2. Generally, telemetred cats were located at least once every three days for the entire duration of this study. In the first 12 weeks following release, all newly released cats were located at least every second day and daily where possible. Animals showed variable patterns of association following release (see Results) and data here is presented as groups (containing at least one telemetred animal) which remained together for 3 months immediately after release. Some individuals which separated from telemetred groups shortly after release were not radio-collared until later in the study and their early post-release behaviour is poorly known. Locations were recorded as described in Chapter 2. Direction of travel and, direction and distance from the release site were calculated from a 1:50,000 topographic map.

Angles of direction from the release site to the capture site (home) were calculated using reference maps of southern Africa generated by MAPPIT (geo-referenced mapping software). For lions, the precise location of their capture site was known but for cheetahs (which originated largely from sporadic captures by wildlife dealers in Namibia), their exact origin was rarely recorded. In this case, circular distribution statistics (Zar, 1984:441) were used to calculate the mean angle of direction from release sites to home using 'general' locations (i.e. as described by dealers) within the Otjiwarongo- Otavi region where the cheetahs were caught.

Released cats usually remained in the vicinity of the boma once freed so data for this analysis was included only once animals had made an initial movement (IM) away from the boma of at least 1km. Angles of direction from the release site of all locations in the first three months following release were calculated from location data. If cats were stationary for more than one location, such as when feeding on a kill or mating on consecutive days, only the first location was included in the analysis. These angles were tested for uniform distribution around 360° using a One-sample Test for Mean Angles (Zar, 1984:445). This test calculates the 95% confidence interval of the mean angle for a population of angles and establishes whether a specified value (in this case, the direction of the capture site) lies within the interval (Zar, 1984:445). In other words, as used here, it determines whether or not released lions and cheetahs showed consistent movement towards the direction of home.

Distance travelled per day was calculated from consecutive locations, not including locations when cats were stationary for more than one day. This measurement represents the minimum straight-line distance between locations, not the actual distance travelled by cats on the ground. While lions and cheetahs were often followed for much of their active period (see Chapter 2), it was logistically impossible to constantly record actual distance travelled of all released individuals. Distance from the release site and daily distance travelled were compared separately for each group for the first three months following release using a one-way ANOVA.

RESULTS.

Released lions and cheetahs remained within 1km of the release pen for up to a week before dispersing. Animals released together showed variable tendency to remain associated. All male cheetah coalitions remained together after release, despite some animals being unrelated and previously unfamiliar. Female cheetahs sometimes initially remained with male coalitions or other females with which they were held captive, but always dispersed individually within 3 weeks of release. For lions, males and females generally separated into discrete groups shortly after release. In Release 1, two adult lionesses LF1 and LF2 immediately split from five unfamiliar sub-adults following release. These 5 sub-adults (which came from the same pride, see Table 2, Chapter 2), remained together for two weeks after which two females (LF5 & LF6) separated, leaving two males with a female together (LM3, LM4 & LF7).

Mean distance from the boma in the first three months following release ranged from 2.0± 1.1km to 7.6 ± 3.2 km (Table 3). The maximum distance recorded from the boma in the three month period was 13.0 km for a single male cheetah CM14: however, this cat began moving widely following the death of its coalition partner one week after release (see Chapter 5) which may have contributed to large daily movements. Except for this animal's movements, cheetahs and lions were always within 10km from the release site in the first three months.

Group Composition.	Month 1	Month 2	Month 3	ANOVA result ($p < 0.05$)
Cheetahs				
I: CM7, CM8, CM9	3.5 ± 1.2	4.1 ± 1.6	4.3 ± 1.2	NS
II: CM13, CM14	7.6 ± 3.3	-		-
III: CM1, CM2	4.1 ± 2.5	5.3 ± 2.7	4.7 ± 2.9	NS
Lions				
IV: LF1, LF2	4.2 ± 1.9	5.2 ± 3.0	6.0 ± 2.0	F = 2.89, p = 0.05, df =2
V: LF8, LF9, LF10	2.2 ± 0.9	3.6 ± 1.7	-	F = 11.80, p = 0.001, df =1
VI: LM3, LM4, LF7	2.0 ± 1.1	4.4 ± 2.6	5.6 ± 2.1	F = 12.91, p= 0.000003, df = 2
VII: LM11,LM12,LM13	2.2 ± 1.2	3.2 ± 1.5	3.3 ± 1.4	F = 4.49, p= 0.01, df =2

Table 3: Mean ± SD distance (km) of released cats from boma. Hyphens indicate months where data collection ceased due to death of cats.

There was a general trend for animals to move more widely from the boma after the first month. For all lions groups, this trend was significant (Table 3): however, it was not significant for any cheetahs. The mean daily distance travelled by released felids ranged from 1.2 ± 0.7km to 3.4 ± 1.2 km. The greatest distance travelled in 24hrs for each species was 16.2km (cheetahs) and 11km (lions). Daily distance travelled generally did not differ between months: it increased significantly beyond the first month for two lion groups (Table 4).

GROUP	Month 1	Month 2	Month 3	ANOVA result ($p < 0.05$)
Cheetahs				
I: CM7, CM8, CM9	1.5 ± 0.5	2.7 ± 2.2	2.5 ± 0.9	NS
II: CM13, CM14	3.0 ± 4.3	-		-
III: CM1, CM2	2.0 ± 1.8	2.1 ± 1.5	2.7 ± 1.4	NS
Lions				
IV: LF1, LF2	3.1 ± 2.9	2.1 ± 1.3	2.6 ± 1.5	NS
V: LF8, LF9, LF10	1.2 ± 0.7	1.9 ± 1.2	-	$F = 5.45$, $p = 0.02$, $df = 1$
VI: LM3, LM4, LF7	1.4 ± 0.6	2.5 ± 1.5	2.1 ± 2.1	NS
VII: LM11,LM12,LM13	1.6 ± 0.9	3.4 ± 1.2	2.8 ± 1.4	$F = 9.91$, $p = 0.0002$, $df = 2$

Table 4: Mean ± SD daily distance (km) travelled by released cats.

Figures 6-8 show the direction of lion and cheetah locations from the boma. In three groups, the direction home was contained within the 95% confidence interval of their mean angle of movement for the first two months following release. This suggests that direction of movement for these three groups was consistently towards the capture site; that is, they exhibited homing behaviour (Table 5).

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

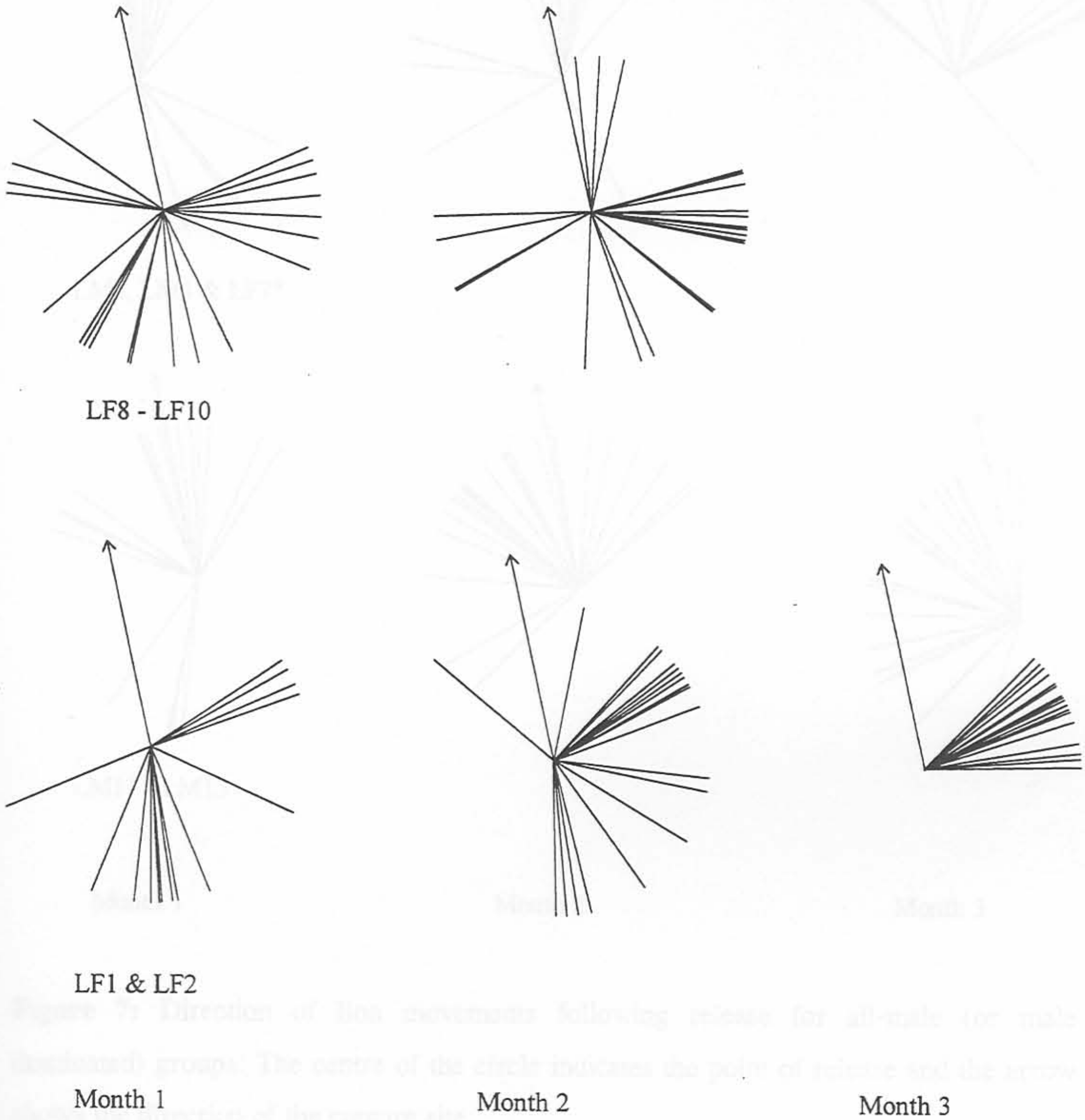

Figure 6. Direction of lion movements following release for all-female groups. The centre of the circle indicates the point of release and the arrow shows the direction of the capture site.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

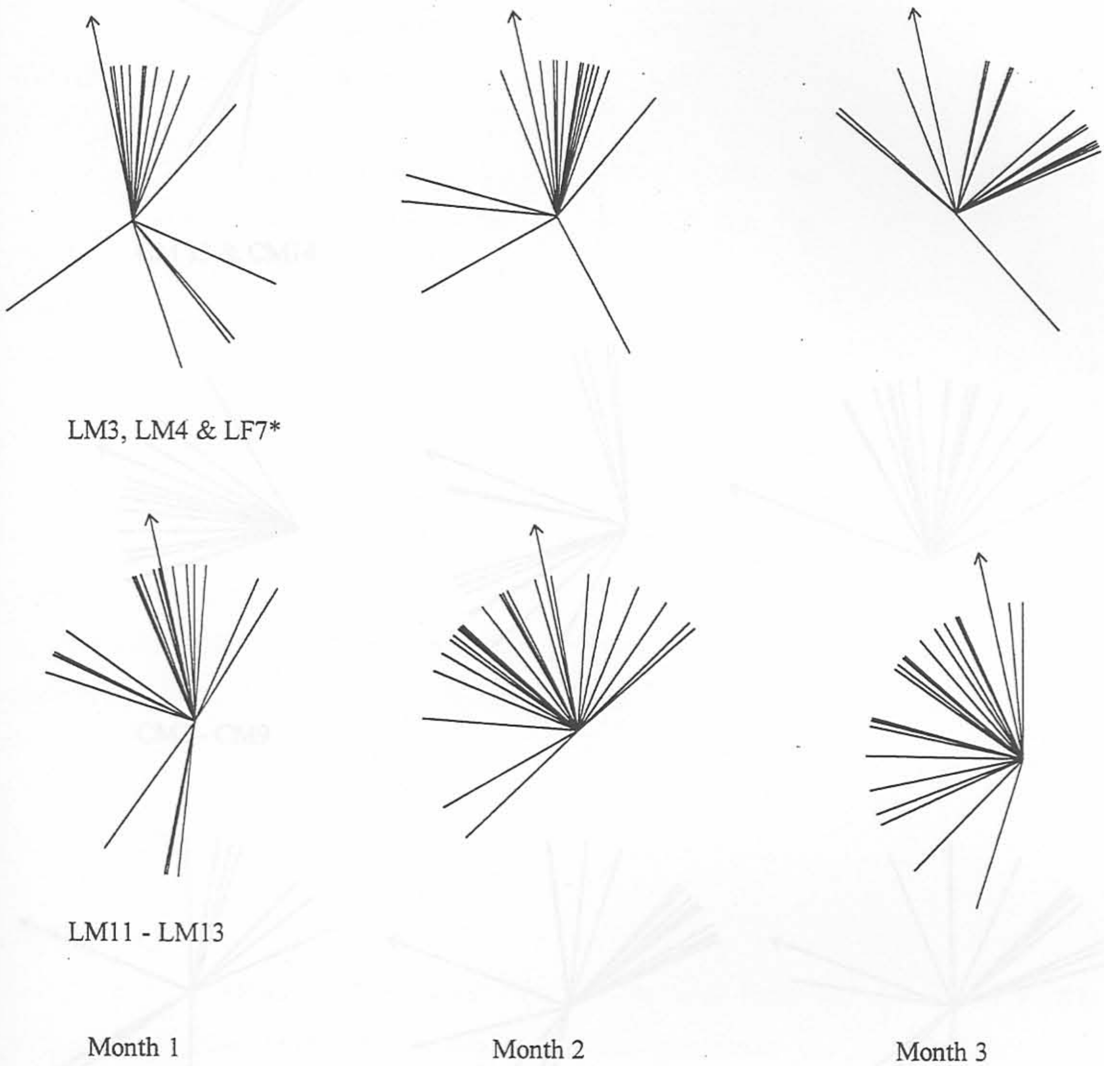

Figure 7: Direction of lion movements following release for all-male (or male dominated) groups. The centre of the circle indicates the point of release and the arrow shows the direction of the capture site.

*LM3 & LM3 were released with three lionesses, LF5 - LF7. LF5 and LF6 remained with the group for two weeks following release and then separated (see text).

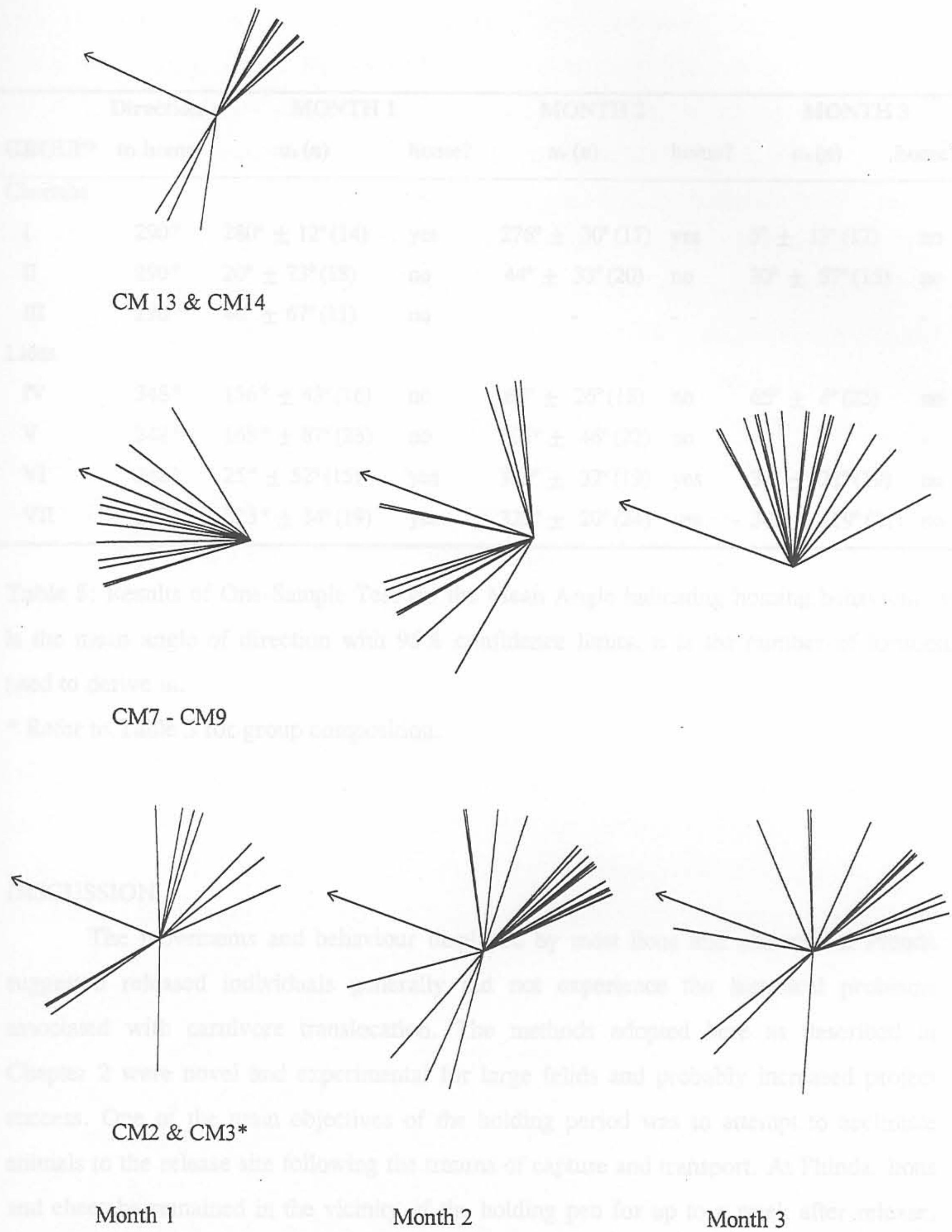

Figure 8: Direction of movements by cheetahs following release. The centre of the circle indicates the point of release and the arrow shows the direction of the capture site. *CM1 & CM2 were accompanied by four cheetah females CF3 - CF6 for the first month, during which the females separated individually from the group and remained solitary thereafter.

GROUP*	Direction to home	MONTH 1 u_a (n)	home?	MONTH 2 u_a (n)	home?	MONTH 3 u_a (n)	home?
Cheetahs							
I	290°	280° ± 12° (14)	yes	276° ± 30° (17)	yes	5° ± 13° (17)	no
II	290°	20° ± 73° (18)	no	44° ± 33° (20)	no	30° ± 57° (15)	no
III	290°	40° ± 67° (11)	no	-	-	-	-
Lions							
IV	348°	136° ± 43° (16)	no	63° ± 26° (18)	no	65° ± 4° (23)	no
V	348°	168° ± 87° (23)	no	105° ± 46° (22)	no	-	-
VI	348°	25° ± 52° (15)	yes	356° ± 32° (19)	yes	38° ± 21° (19)	no
VII	348°	323° ± 34° (19)	yes	329° ± 20° (24)	yes	302° ± 19° (21)	no

Table 5: Results of One-Sample Test for the Mean Angle indicating homing behaviour. u_a is the mean angle of direction with 95% confidence limits. *n* is the number of locations used to derive u_a.

* Refer to Table 3 for group composition.

DISCUSSION

The movements and behaviour displayed by most lions and cheetahs at Phinda suggested released individuals generally did not experience the historical problems associated with carnivore translocation. The methods adopted here as described in Chapter 2 were novel and experimental for large felids and probably increased project success. One of the main objectives of the holding period was to attempt to acclimate animals to the release site following the trauma of capture and transport. At Phinda, lions and cheetahs remained in the vicinity of the holding pen for up to a week after release, followed by dispersal to all areas of the reserve. All animals remained in the reserve and established enduring home ranges (Chapter 4) or died at Phinda. Lion prides and male cheetah coalitions established stable territories of 50-100km^2 which were demarcated and defended as in established populations (Hunter & Skinner, 1995). In contrast, female cheetahs, which are apparently non-territorial (Caro, 1994), used the entire reserve (Chapter 4).

One cheetah group and two lion groups showed evidence of homing behaviour, in all cases, for the first two months after release. All the groups were male coalitions or male-dominated. In the case of lions, the groups were composed largely of sub-adult males which are generally the main dispersing cohort in established lion populations (Schaller, 1972; Hanby *et al,* 1995). The cheetah coalition which showed homing behaviour also comprised young males, though they were adults approximately three to four years old. In contrast, young animals of dispersal age in translocated black bears and pumas displayed the weakest homing behaviour (Rogers, 1986; Ruth *et al,* 1993). This suggests that, despite the captivity period, some animals may still retain an urge to home for at least for two months following release. The male lions released at Phinda were mostly captured from stable prides, in all cases, before they were 18mo which is younger than the age at which they normally disperse (Pusey & Packer, 1987). Although these animals foraged successfully and all survived for at least one year after release (Chapter 5), slightly older animals may be better suited to translocation.

Nonetheless, relative to other projects, none of the Phinda animals showed persistent patterns of homing behaviour. Despite their early movements being oriented to home, young male lions and cheetahs at Phinda did not wander more extensively than adults (Tables 3 and 4) and in no cases, did they remain at fencelines for extended periods. Many translocated carnivores demonstrate a marked ability to return to a capture site hundreds of kilometres away, or failing that, make wide post-release movements in the direction of home (Linnell *et al,* 1997). Data on felids is sparse but a few well-documented cases illustrate this tendency. Of 13 hard-released mountain lions translocated an average of 477km, 10 that survived beyond 3.5 months of release all displayed consistent, large movements towards the direction of home (Ruth *et al,* 1993). Four mountain lions held for a week prior to release also made early post-release movements towards home but eventually established home ranges within 32 km of the release site (Belden & Hagedorn, 1993).

As Moore and Smith (1990) indicate in a discussion on re-introduction of the red wolf, a pre-release holding period may be an important factor in reducing the tendency to home. The captivity stage appears to acclimate animals to changes in their environmental and locational conditions, thereby enabling acceptance of the new locality more rapidly. As a result, there may be greater motivation to shift geographical fidelity and reduce homing behaviour. This was generally the case in the Phinda animals. Having said this, these observations need to be interpreted with caution. Other factors such as the location of herbivore aggregations or the suitability of habitat may have influenced the initial movement patterns of cats. I do not have the data to eliminate these potential factors and therefore cannot say with certainty that the observed 'homing' actually indicated an inclination to return to the capture site.

An essential aspect of encouraging site fidelity in released felids was exposing them to electrified fencing prior to release to discourage breaches of the reserve's boundary fence. Although I obviously could not ascertain the movements of animals if the fence was absent, there is little doubt they would have moved beyond the boundary of the reserve if it was not secure. Nonetheless, lions and cheetahs could easily cross this fence if inclined and I observed several other species breaking through it (i.e.impala, nyala, kudu, zebra), going under it (i.e. hyaena, leopard, warthog, wild dog) and climbing over it (i.e. leopard). While cats were in captivity, contact with the boma's electrified fence occurred during the first 2-3 days of their captivity, after which the fence was avoided. Since their release, no lions or cheetahs have been recorded actively attempting to either scale or dig under the boundary fence. "Passive" escapes, i.e. escape through holes in the fence created by other species or by crossing electrified cattle grids at unfenced entry gates, occurred on eight occasions by cheetahs and six occasions by lions. These individuals returned to the reserve of their own volition (seven occasions), were recovered by darting (five occasions) or were not recovered (two occasions, see Chapter 5).

Other observations suggest that avoidance behaviour of the fence assists in discouraging break-outs, despite considerable incentive. Cheetahs and lions regularly sat at the fence observing wild and domestic ungulates on adjacent land. On five occasions, I observed domestic cattle on neighbouring property approach lions resting next to the fence to within 5-30 metres. The lions displayed intense interest in the cattle, stalking them to the fenceline and then losing interest when the cattle moved away. Once, two lionesses reacted highly aggressively to dogs in a vehicle driving alongside the fenceline on a neighbouring property. The lionesses chased the vehicle for 1600m alongside the fence until it turned away. They ran repeatedly up and down the fence for a further 20 minutes before losing interest. In another incident, hunting lions pursued a zebra into the fence which it broke through, leaving a 3m break. Despite the hole, the lions discontinued their chase at the fenceline, watching the zebra flee on the other side.

Although carnivores are notorious for ignoring fences (Linnell *et al,* 1996; Mizutani & Jewell, 1998), a period of captivity during which they are exposed to electrified fencing appears to be valuable in restricting post-release movements. Clearly, this is only of use where the resources exist to fence the release site. South Africa is unusual in that most conservation areas are fenced and indeed, conservation authorities demand it to permit to release of large cats. In other regions where the restoration of carnivores is being attempted, the use of fencing should be considered. For example, a proposal to establish a second population of the Asiatic lion which presently only occurs

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

in a single location in the Gir Forest is considering temporary fencing for the early post-release stages based on the South African experience (Chellam, *pers. comm.*[1])

Unfamiliar animals socialised during captivity often remained together following release, in contrast to observations from other social carnivores, particularly wolves (Fritts, 1992). Upon release, two unrelated and previously unfamiliar lionesses remained together for 23 months until the death of one female. Cubs born to these lionesses were treated by the other female with affiliative behaviours typical of related animals, namely allosuckling, grooming and play. In another release, an adult lioness remained with two unfamiliar sub-adult females for three months, at which time they were responsible for the death of a human and were destroyed (see Chapter 5). A trio of male lions comprising 2 brothers, LM11 and LM12, and an unrelated animal, LM13 remained together. Three male cheetah coalitions comprising at least one unfamiliar animal remained together following release. Two cases were unrelated male pairs who stayed together until the death of one animal (36 months and 1 week after release respectively). In another case, two males were brothers while the third animal was unrelated and unfamiliar. This trio remained together after their release until the unrelated male was killed in a wire snare 4 months later. In all cases, individuals displayed very frequent affiliative behaviour such as mutual grooming and play during their association.

In social carnivores, a lack of social stability in a population results in increased mortality and movement (Caro & Collins, 1987; Orford *et al*, 1988, Stander, 1990). These are particularly undesirable characteristics for re-introduced populations. However, cohesive family groups or coalitions are rarely available for translocation in Africa. Additionally, the need exists to manage individuals in conflict with humans. For example, lions leaving the boundaries of protected areas and moving into farming areas are mostly lone individuals or small groups (Anderson, 1981; Venter & Whateley, 1984; Stander, 1990), Similarly, in Namibia and Zimbabwe, opportunistic capture of "problem" cheetahs by livestock and game farmers frequently results in single animals becoming available, most of them males (Marker-Kraus *et al*, 1996; Zank & DuToit, 1996). Acquisition of such animals as they become a problem and a period of captivity appears to be of use in establishing socialised groups better suited for re-introduction purposes. In the case of highly aggressive species such as lions, use of long-acting tranquillisers (as described in Chapter 2) may facilitate this process.

The impact of stochastic events in the early post-release period is difficult to quantify but probably has a marked effect on ranging patterns of re-introduced felids. One of a pair of male cheetahs, CM13, was killed a week after release. The remaining

[1] Chellam, R. Wildlife Institute of India, PO Box 18, Chandrabani, Dehra Dun 248 001, India.

animal CM14 wandered widely covering an average of 10km ± 3.5 km per day until he entered the occupied territory of another cheetah coalition and was killed (Hunter & Skinner, 1995: Chapter 5). Interestingly, this animal had encountered the same coalition prior to the death of his companion without incident. The two pairs sat watching each other about 60m apart for nine hours after which they moved off in separate directions. In a reintroduction scenario, individuals which experience significant disturbance shortly after release and display extensive movement might be better off if recaptured. In the case of male cheetahs, such individuals could be exposed to a further pre-release captivity period with another male or males to attempt to forge a coalition which would probably have a greater chance of surviving and establishing a territory.

Sample size was too small to compare early releases (i.e. those where no other conspecifics were present) with later releases which potentially had to contend with the established individuals of prior releases. However the only cheetah coalition (Group III) which encountered residents within the first three months following release moved the greatest distance from the boma and the greatest daily distance for all male cheetah groups following the encounter (Tables 3 and 4). This suggests that the presence of resident cats may affect the likelihood of animals remaining near the release site which earlier studies have suggested (Hamilton, 1981). Conversely, Fritts and co-workers found that the presence of resident wolves at the release site did not appear to affect post-release behaviour of translocated animals (Fritts *et al,* 1984).

The strategy of locating release points in different places at the release area may have reduced the potential for conflict between reintroduced individuals. Animals tended to remain near the release boma and there were only two incidents of animals from later releases encountering previously released conspecifics in the first three months. In one case involving two coalitions of males cheetahs (described above), both coalitions had been housed in the same boma. In the other case, two groups of lionesses encountered one another when LF5 & LF7 ('early release') moved far from their normal range and encountered LF8, LF9 and LF10 ('late release') The latter animals chased the pair off. The release bomas at Phinda were located only 16 km apart, which a lion or cheetah could easily traverse in 24 hours. Experience from this study suggests that, where possible, multiple release points should be established in a restoration effort to enhance success.

Clearly, the problems facing reintroduction projects of large felids are considerable. Aside from ecological and biological considerations, methodology and technical elements may contribute significantly to a project's outcome (Reading & Clark, 1996). Experience from the current research suggests the importance of the latter should not be underestimated and, as in the case of the planning of Phinda, considerable resources should be allocated to this element. It remains to be seen whether these techniques would have similar results in other carnivore species. Preliminary observations from other projects in South Africa suggests that other social species such as wild dogs and spotted hyaena may benefit from these considerations (Hofmeyr, *pers. comm*[2]). It would be of interest to apply these techniques to endangered carnivores in other regions. Proposals for the reintroduction of the Asiatic lion and the Asiatic cheetah in India and the Middle East (Nowell & Jackson, 1996) may present the opportunity to apply this knowledge elsewhere.

---

[2] Hofmeyr, M. Madikwe Game Reserve, North West Parks Board, PO Box 4124, Rustenburg, 0300, South Africa.