CHAPTER 5

IMPACT OF LEOPARD TRANSLOCATIONS ON LEVELS OF CONFLICT IN A HUMAN-DOMINATED LANDSCAPE IN MAHARASHTRA.

Site of leopard attack on a boy in Junnar, Pune district.

1 This paper has been published as Athreya, V., Odden, M., Linnell, J. D. C. and K. U. Karanth. 2011. Translocation as a Tool for Mitigating Conflict with Leopards in Human-Dominated Landscapes of India. Conservation Biology 25:133–141.
5.1. INTRODUCTION

Large cats and humans have always shared an uneasy relationship (Loveridge et al. 2010a). Humans are the single largest cause for large cat mortality due to direct hunting, habitat destruction, hunting of prey and on the other hand, large cats affect human lives and livelihoods due to livestock depredation and attacks on humans (Inskip & Zimmermann 2009; Loveridge et al. 2010a). When large cats and human space use overlaps, there is a potential for conflict which can be prevented by the creation of protected areas (Treves & Karanth 2003). However such conservation contexts are not always practical because large cats range widely making it inevitable that they will use human-dominated landscapes, and in such instance, the abundance of domestic animals outside protected areas could form a potential prey base (Athreya et al. 2011; Meena et al. 2011; Linnell et al. 2012).

Among the large cats, the leopard is a particularly adaptable species that feeds on a wide variety of prey (Hunter et al. In press) including medium sized livestock and domestic dogs (Hamilton 1981; Seidensticker et al. 1990; Daniel 2009; Hunter et al. In press) thereby successfully persisting in human-dominated landscapes. Populations of jaguars in the Pantanal, Brazil (Schaller 1983; Polisar et al. 2003; Rabinowitz 2005), tigers in the Russian Far East (Goodrich et al. 2011) and mountain lions in America (Beier et al. 2010) are known to occur in human-use landscapes. However, except for some mountain lion populations in urbanized areas in North America, all the above mentioned landscapes support very low density of humans. In contrast, some populations of large cats in Africa and India persist in areas with high human population densities but these systems have not been studied in detail. In India even though the leopard (Athreya et al. 2006; Daniel 2009) occurs both inside and outside protected areas, its ecology and interactions with humans has been poorly understood.

Globally, the most common management response to the presence of large, potentially dangerous carnivores outside protected areas involves either killing, or capture and translocation of the animal (Linnell et al. 1997; Treves & Karanth...
In India, lethal control is not favored by managers (Karanth & Gopal 2005) largely due to cultural and legal reasons (Anon 1972). More often leopards (Athreya et al. 2006), lions (Saberwal et al. 1994) and even tigers (Patil et al. 2011) are captured and translocated rather than killed. However, such translocations do not take into account the territorial nature, site fidelity or the consequent disruption in their social interactions, which are often cited as reasons why this strategy is not recommended for dealing with large carnivores (Linnell et al. 1997). Translocation is believed to settle the large cat ‘back’ in the wilderness and reduce conflict at the site where it was captured. However, the impact of such interventions is not known because post-monitoring of the translocated individuals is usually not carried out.

In this chapter, historical data from the forest department of leopard captures, releases and leopard attacks on humans from Junnar, Pune district, Maharashtra was analysed to assess the effect of a large-scale leopard translocation programme on the subsequent levels of conflict. In the year starting February 2001, a large number of leopards (28 in 2 years) were trapped in the human-dominated agricultural areas and released in adjoining forests (< 60 km). From January 2002, releases into the adjoining forests were halted and the captured leopards were mainly translocated to far-off protected areas (> 200 km) in different parts of the state. Information from official records and directly collected data are used to examine temporal changes in the frequency of leopard attacks on humans, rates of consequent human fatalities as well as spatial distribution patterns of attack sites in relation to the translocation interventions. Finally the conflict patterns in Junnar are compared to that in the human-dominated landscape in Akole, Ahmednagar district (the current study site), where such translocations are minimal. Based on these analyses the possible role of leopard translocations in potentially aggravating attacks by large cats on people is discussed and complementary and alternative conservation approaches are provided.
5.2. METHODS

5.2.1. STUDY AREA

The Junnar Forest Division (FD, 18°36'46.77" – 19°25'17.18"N and 73°29'08.78" – 74°20'34.02"E) lies in the north western corner of Pune district, adjoining the Thane and Ahmednagar districts, in the state of Maharashtra (Figure 5.1). The area is administered by the territorial wing of the Maharashtra State Forest Department and the area under consideration in this study is divided into the 3 sub-districts of Junnar, Ambegaon and Khed (Figure 5.1), covering a total area of 3828 km$^2$. The density of people across the three sub-districts was 239/km$^2$ in 2001 (District Environmental Atlas of Pune 2001). In addition to managing the government owned forests, the ownership and responsibility for all wildlife in the district vests with the Forest Department, under the Wildlife Protection Act of 1972, even when such wildlife occurs on private land or other land uses.

The domestic animals in this region include livestock such as cattle, water buffalo, sheep, goats, pigs as well as dogs and cats. Large numbers of feral or semi-feral dogs and pigs are present but mainly in and around towns in the region. The density of medium sized livestock (goats, sheep) was 51/km$^2$ (District Environmental Atlas of Pune 2001; Table 5.1).


<table>
<thead>
<tr>
<th>Taluka</th>
<th>Area (km$^2$)</th>
<th>2001 human population density/km$^2$</th>
<th>Goat population</th>
<th>Sheep population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khed</td>
<td>1400</td>
<td>245</td>
<td>46727</td>
<td>9199</td>
</tr>
<tr>
<td>Ambegaon</td>
<td>1043</td>
<td>205</td>
<td>51497</td>
<td>13076</td>
</tr>
<tr>
<td>Junnar</td>
<td>1385</td>
<td>267</td>
<td>67423</td>
<td>7006</td>
</tr>
<tr>
<td>Total</td>
<td>3828</td>
<td>239</td>
<td>165647</td>
<td>29281</td>
</tr>
</tbody>
</table>

The Junnar study area receives an annual rainfall of ~600 mm (http://pune.nic.in). Historically it supported dry deciduous vegetation of the Acacia-Anogeissus type (Gaussen et al. 1965; Champion & Seth 1968) interspersed with
cultivation of dryland crops such as Jowar (Sorghum bicolor), Bajra (Pennisetum glaucum) and Ragi/Nachni (Eleusine coracana).

Seven major irrigation river projects were started in the region from 1977 (National Registrar of Large Dams 2009) changing the agricultural land-use in the valleys to cash-crop which is now dominated by fields of sugarcane, grapes, onions, maize, banana, guava plantations. The tree cover mainly consists of those situated near houses or at the edges of fields, and consist of mango (Mangifera indica), babul (Acacia nilotica), neem (Azadirachta indica), Ziziphus mauritiana and Thespesia populnea. The hills that abut these valleys are now largely devoid of trees and support a deciduous scrub degraded by overgrazing and lopping, or, plantations of exotic species such as Gliricidia sepium and Eucalyptus spp. raised by the Forest Department. Wild herbivores have been virtually extirpated by hunting and habitat degradation. However, a resident population of wild leopards has persisted in the area for more than a decade.

The only remaining intact natural forests in the region are the sub-tropical montane broad-leaved types in the adjoining Western Ghats. Bhimashankar Wildlife Sanctuary (Area 130.78 km², 19°05′14.67″N, 73°34′17.96″E) supports the largest expanse of such natural forests in the region. Malshej Ghat (19°20′27.77″N, 73°47′41.98″E) is a small forested patch no more than 30 km² that lies at the tri-junction of Junnar, Ahmednagar and Thane Forest Divisions (Figure 5.1). These areas are connected by roads and are less densely populated by people making them preferred release sites for “problem” leopards trapped in the human-dominated areas of Junnar.

For the purposes of analysis two distinct spatial units based on the location of the above two release sites were considered; the ‘northern region’ consists of Junnar sub-district, and is associated with the Malshej ghat release site, whereas the ‘southern region’ consists of the Ambegaon and Khed sub-districts and are associated with the Bhimashankar Wildlife Sanctuary release site.
Figure 5.1. Junnar Forest Division in Pune District, Maharashtra. The two release sites are in the north-west (Malshej Ghat) and in the south-west (Bhimashankar WLS). The leopard captures occurred in the same region where human attacks followed. Year-wise locations of human attacks are provided in the figure.

5.2.2. ASSESSING CONFLICT LEVELS

Records of leopard attacks on humans and livestock, and of leopard translocation events (since 1993) were obtained from the Junnar Forest Division, Pune Forest Circle. Ninety-seven sites of 103 leopard trappings carried out between February 2001- December 2003 were visited and GPS locations obtained. Seventy-eight of 83 leopard attacks on humans that had occurred since 1993 were sample. GPS locations were noted along with information on the date of attack, age and sex of the victim, survival, and extent and nature of injuries during interviews with the
affected families. Furthermore, location data and other information on 537 leopard attacks on livestock that had occurred between October 1999 - July 2003 were also obtained by visiting the sites based on the records.

The effects of translocation on the frequency of attacks on humans, and whether the attacks resulted in fatality, were evaluated by comparing attacks before and after the translocation campaign. The observed number of attacks on humans and livestock in the periods before and after the start of translocation with the expected number of attacks was also compared.

Furthermore, differences in the age, and fatality rate of the humans attacked by leopards between the two periods were examined. The effect of the different types of translocation on the temporal distribution of the attacks and the survival of the humans attacked was assessed. The different types of translocation were (i) short-distance, in which leopards were removed from the human-dominated areas in Junnar and released in adjoining forested sites < 60 km away, (ii) long-distance, in which leopards were moved from Junnar to districts >200 km away and (iii) release of leopards from other districts to forested sites adjoining Junnar (captured 100 – 200 km away). Attack frequency was defined as the natural logarithm of the number of days since the previous attack. Thus, attacks separated by fewer days indicated a higher attack frequency.

Of the 86 leopards captured in the study area, 28 were released in the first two years in the 2 release sites adjoining the Junnar Forest Division (average translocation distance of 39.5 km [SD 9.7]) km. In addition, 11 leopards from neighboring districts were released in the 2 release sites. The different types of translocations are likely to have affected the subsequent levels of human-leopard conflict differently and therefore, the number of translocations in each of the three categories, which had occurred prior to each attack were used as predictor variables for modeling the temporal distribution of attack frequency. Linear regression was used to model the temporal distribution of attack frequency and logistic regression was used to model the survival of victims that were attacked.
by leopards. In these models all the combinations of the three predictors, excluding interaction terms, were compared and also the calendar date was included in a separate model.

5.2.3. ANALYSES

Regression analysis was used to assess how the different categories of translocations (the predictor variables) affected the following:

(i) Attack frequency (defined as the natural log of the number of days since the previous attack) on humans was the response variable and was modeled using linear regression. Therefore, higher attack frequency on humans meant fewer days occurred between attacks on humans.

(ii) The spatial extent of attacks on humans. Logistic regression model was used to test if translocation were associated with increased frequency of attacks on humans near release sites. The binary response variable was the region of the attack (northern near Malshej Ghat release site or southern near Bhimashankar Wildlife Sanctuary). For instance, in the case of the northern attacks site, the predictor variable was the number of leopard (even from outside the district) released in Malshej Ghats prior to each attack, minus leopard releases into Bhimashankar prior to each attack.

(iii) Lastly the survival of victims (alive or dead) following leopard attacks was modeled using logistic regression.

The inferences were based on model selection using the information theoretic approach (Burnham & Anderson 2002). The best model was chosen based on the Akaike Information Criterion (AIC) and with model with the smallest AIC was regarded as the best unknown "true" model.

5.3. RESULTS

5.3.1. ATTACK FREQUENCY

The large-scale leopard translocation campaign in the Junnar Forest Division was initiated as a response to two leopard attacks on humans during February and March 2001. No leopard attacks on humans had occurred for one year prior to
these events. Following the large-scale translocation programme, the frequency of
attacks on humans increased markedly in the study area. In the eight years
between 1993 and 2001, 33 leopard attacks on humans were reported whereas 44
took place during the three years of the translocation period (Figure 5.2). Hence,
the average annual number of leopard attacks on humans each year increased
from four to 17 following the large scale leopard translocation programme. The
observed frequencies of attacks on humans before and after the start of leopard
translocation differed significantly from the expected even distribution of attacks
($\chi^2 = 27.4, df = 1, P < 0.0001$). Leopard attacks on livestock also increased. In the
year prior to the translocation (February 2000 to January 2001) 106 livestock
attacks were reported. During the translocation period across three years, the
livestock attacks increase to an average of 166/year and this difference was
significant ($\chi^2 = 7.7, P = 0.006$). Hence, a 56% increase was seen in the rate of
livestock attacks, whereas rate of human attacks increased by 325%.

The frequency of attacks changed over time, even during the translocation
period. It increased during the first year and reached a peak during the second
year. This period coincided with releases of previously caught leopards into the
forest areas (Figure 5.4a and 5.4b). The attack frequency decreased in the third
year after a large number of leopards had been captured and removed for release
(> 40) in other parts of the state (Figure 5.4b).

The linear models of attack frequency illustrate the relative influence of short-
distance and long-distance translocations. All of the three better fit models
included the cumulative number of leopards that were captured from the region
and moved far away from the area (Table 5.2a, M1-3). The highest ranking model
also included the cumulative number of leopards captured and released in the
region. The release distance parameter had contrasting effects; the attack
frequency decreased with increased removals of leopards for release to distant
site), whereas attack frequency on humans increased with increased releases of
locally caught leopards into adjoining forests.
Figure 5.2. Comparison of lethal and non-lethal attacks on humans before and during a large scale translocation programme in the Junnar Forest Division, Maharashtra, India.

Figure 5.3. A cub captured in Junnar along with its siblings which were then placed in the bait cage to trap the mother. The mother and cubs were released in the southern release site of Bhimashankar.
Table 5.2. Most parsimonious models (AICc < 2) relating attack frequency and location of leopard attacks on humans, and fatality rates of victims, in the Junnar district of central Maharashtra, India, during a period of intensive leopard translocation programme (2001 – 2003).

<table>
<thead>
<tr>
<th>Attack frequency^a</th>
<th>Model terms and parameter estimates (SE)</th>
<th>AICc</th>
<th>ΔAICc</th>
<th>W^b</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>2.616(0.459) +0.040(0.014)LDT -0.047(0.025)SDT^c</td>
<td>163.107</td>
<td>0.000</td>
<td>0.312</td>
</tr>
<tr>
<td>M2</td>
<td>2.475(0.433) +0.046(0.018)LDT -0.130(0.081)INTR^d</td>
<td>163.901</td>
<td>0.794</td>
<td>0.210</td>
</tr>
<tr>
<td>M3</td>
<td>1.900(0.248)+0.023(0.011)LDT</td>
<td>164.183</td>
<td>1.076</td>
<td>0.182</td>
</tr>
<tr>
<td>NULL^f</td>
<td></td>
<td>166.702</td>
<td>3.594</td>
<td>0.052</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attack location^e</th>
<th>Model terms and parameter estimates (SE)</th>
<th>AICc</th>
<th>ΔAICc</th>
<th>W^b</th>
</tr>
</thead>
<tbody>
<tr>
<td>M4</td>
<td>-0.841(0.515) +0.152(0.055)REL^g</td>
<td>61.359</td>
<td>0.000</td>
<td>0.744</td>
</tr>
<tr>
<td>NULL^f</td>
<td></td>
<td>67.877</td>
<td>6.518</td>
<td>0.029</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mortality of victims^h</th>
<th>Model terms and parameter estimates (SE)</th>
<th>AICc</th>
<th>ΔAICc</th>
<th>W^b</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5</td>
<td>-4.617(1.386) -0.063(0.041)LDT +0.651(0.290)INTR</td>
<td>57.854</td>
<td>0.000</td>
<td>0.317</td>
</tr>
<tr>
<td>M6</td>
<td>-2.786(0.990) +0.291(0.111)INTR</td>
<td>58.357</td>
<td>0.503</td>
<td>0.246</td>
</tr>
<tr>
<td>M7</td>
<td>-4.441(1.859) -0.085(0.048)LDT +0.138(0.108)SDT +1.078(0.464)INTR</td>
<td>58.543</td>
<td>0.689</td>
<td>0.224</td>
</tr>
<tr>
<td>NULL^f</td>
<td></td>
<td>65.597</td>
<td>7.743</td>
<td>0.007</td>
</tr>
</tbody>
</table>

^a The natural logarithm of the number of days since the previous attack, linear regression
^b Akaike weight
^c The cumulative number of leopards captured and moved to other districts far away
^d The cumulative number of leopards captured and moved within the study area
^e The cumulative number of leopards introduced to the study area from remote districts
^f Null model
^g Whether the attack occurred in the northern or the southern section of the study area, logistic regression
^h The cumulative numbers of leopards translocated to the northern section minus leopards translocated to the south
^i Alive or deceased, logistic regression

5.3.2. SPATIAL PATTERN OF LEOPARD ATTACKS ON HUMANS

During the first year of translocation (2001), attacks on humans escalated in the southern region (n=13), while the attack rate in the northern region was lower (n=6). By the end of June 2001, five leopards had been introduced in the southern region from other areas, but only one equivalent release had occurred in the northern part. Thereafter the pattern changed, as only one release took place in the southern region, while 18 leopards were released in the north. In the following year (2002), attacks increased markedly in the north (n = 16), and decreased in the south (n = 6). Logistic regression model showed that the relative number of past releases in each region was the best predictor of whether the
attacks on humans occurred in the northern or the southern region (Table 5.2b - M4).

Figure 5.4. a) Number of leopard attacks on humans in the Junnar Forest Division and (b) the cumulative number of leopards captured in Junnar and released short distance (mean [SD] = 39.5 km[97.]) and released long distance (> 200 km in other parts of Maharashtra).

5.3.3. MORTALITY OF VICTIMS DUE TO LEOPARD ATTACKS

The average age of people attacked prior to the translocation period was 33 ± 5 (SE) years (n = 16) of which only 25% were less than 14 years old. Following the initiation of the translocation campaign, the average age of the victims decreased to 22 ± 3 (SE) years (n = 45). During this period, 51% of the victims were less than 14 years old. The log-transformed age of the victims was significantly lower after the start of the translocation than it was before (t = 2.153, DF = 59, P = 0.035).
Eighteen percent of leopard attacks on people were fatal in the eight years before the translocation period, and the proportion doubled to 36% in the following large-scale translocation campaign. The proportion of lethal attacks differed significantly between the two periods ($\chi^2 = 12.0, \text{df} = 1, P < 0.001; \text{Table 5.5}$). The most parsimonious model of victim survival during the translocation period included two terms; cumulative numbers of leopards introduced from other districts to the forested sites adjoining Junnar and the cumulative number of leopards captured in Junnar and released far away (Table 5.2b - M4). Introducing leopards into the region increased the probability that an attack would be lethal (Figure 5.5), and removing animals from the study area lead to a decrease of fatality rates.

Figure 5.5. The number of lethal and non-lethal attacks by leopards on humans in Junnar Forest Division during the large scale translocation programme. The leopards released is the cumulative number of leopards trapped within and outside Junnar district and released in Junnar.
5.4. DISCUSSION

Translocation has been used in many parts of the world as an alternative to lethal control to manage various potentially dangerous species; gila monsters, snakes, eagles, mustelids, felids, canids, ursids (Linnell et al. 1997; Craven et al. 1998; Hardy et al. 2001; Treves and Karanth 2003; Sullivan et al. 2004; Letty et al. 2007). The overarching conclusion in all the post translocation studies assessed so far is that this seemingly humane procedure can severely compromise animal welfare, because translocated individuals face higher mortality probably during their extensive post-release movements. Furthermore, the removal does not appear to decrease the conflict levels at the site of removal over the long term (Stander 1990; Robinson et al. 2008; Cooley et al. 2009).

In this study, an additional serious effect of releases of translocated large cats was seen – a four-fold increase of attacks on humans near the release site. This unanticipated outcome may be partially explained based on the biology of leopards. Following the large scale trapping initiative that was started in 2001, a total of 39 leopards were released into two forested sites of 30 km² and 130 km² in western Junnar, not more than 60 km from their site of capture. The results indicate that the leopards probably did not stay in the release areas following the short distance translocations. For instance, in Kenya, translocated leopards moved 6.5 to 20.7 km daily (Hamilton 1981) and five out of 10 leopard released in the 870 km² Meru National Park left the area within two days and the rest within two weeks (Hamilton 1981).

In the case of Junnar, the spatio-temporal patterns of leopard translocations and human attacks indicated that the animals moved away from the forested release sites and into areas with high human population densities. Within a week of the releases the attack frequency increased in the human-use areas adjoining the release sites and the spatial shift in the distribution of human attack locations coincided with a shift in the locations of leopard releases. Later, when a large number of leopards were removed from the area, attack rates decreased. The increases, both in attack rates and in victim mortality during the translocation
period indicate that the leopards changed behavior and started attacking people. In the year prior to the large scale translocation programme, no human attacks were reported in the same areas.

Because the release sites in Junnar already contained resident leopards (Maharashtra Forest Department records), the introduction of a large number of new leopards may have disrupted a previously stable social and spatial organization pattern and as well as behavior of individual affected leopards. Interestingly, the increase in post-release livestock attacks in the human-dominated areas was not proportional to the increase in number of attacks on humans indicating that increase in attacks on humans was not likely due to a sudden increase in leopard density. A behavioral (functional) rather than a numerical response is more likely to have determined the patterns of conflict.

Existing theoretical and empirical data support the notion that large carnivore translocation procedures may trigger negative behavioural response in individuals (Letty et al. 2007; Teixeira et al. 2007). Translocation involves several additive stress-inducing components; the capture, close interaction with humans while in captivity, transport, potential injury, and the release into an unfamiliar area with signs left by established and territorial conspecifics (Letty et al. 2007; Teixeira et al. 2007). Among captive tigers, cheetahs (*Acinonyx jubatus*) and clouded leopards (*Neofelis nebulosa*), pronounced increases in levels of stress lasted for several days following transportation between enclosures (Wielebnowski et al. 2002; Dembiec et al. 2004; Wells et al. 2004). Stress and aggressive behavior are closely linked entities, and reactions to stress-inducing situations could vary among individual animals (Grandin 1997). Consequently, potentially such unintended negative effects of translocations may increase rather than mitigate carnivore attacks on humans in many contexts.

Another, non-exclusive, explanation for increased human attacks may lie in the fact that leopards moving through unfamiliar terrain all of which contain high density of humans are more likely to encounter humans, whose proximity they
actively avoid in areas they are familiar with even in heavily human-dominated landscapes. For example, not knowing the distribution and the connectivity patterns among patches of cover in the landscape could increase the risk of accidental but dangerous encounters with humans.

Some of the captured leopards from Junnar were translocated more than 200 km away to protected areas in northern (Yaval Wildlife Sanctuary) and southern (Radhanagari Wildlife Sanctuary) Maharashtra. No attacks on people by leopards had been reported in these areas since historical times despite the presence of wild leopards. However, following the release of Junnar leopards, humans in those areas were attacked by leopards for the first time in history. Based on micro-chip identification tags implanted earlier during capture, two of the leopards that were re-captured near the release sites following human attacks were seen to be from Junnar (A. Belsare & V. A. Unpublished data). Similar attacks on people near the release site by translocated leopards have been reported by Hamilton (1981) in Kenya.

The results of this study find that translocation increased the overall level of conflict rather than eliminating it, demonstrating its limitations as a tool for conflict reduction in carnivore management (Griffith et al. 1989; Linnell et al. 1997; Fischer & Lindenmayer 2000; Bradley et al. 2005). This is particularly so in India where human population density is very high and most protected areas which are often used as release sites already support resident populations of large carnivores.

The other practised post-conflict alternatives to translocations, are permanent removal of leopards either by lethal control or holding in captivity. Housing wild caught animals in captivity poses a wide range of economic, logistic, and animal welfare issues. Studies on removal of large carnivores in response to problem animal management find lethal control to have rather limited effects, if any, on conflicts (Herfindal et al. 2005; Harper et al. 2008). In fact, removal may increase conflicts due to social disruption, and it may be ineffective for reducing
population densities because transient individuals immediately arrive to occupy the vacant territories (Lindzey et al. 1992; Cooley et al. 2009; Loveridge et al. 2010b). Of course persistent removals will result in the extirpation of large felids and will reduce conflict. This situation characterizes many landscapes in India and the rest of southeast Asia as far lions, tigers and even leopards are concerned. However, that option clearly cannot be defined as a conservation intervention.

There is also a lack of knowledge of whether conflicts with humans are associated with specific individual leopards, or animals in certain age and sex classes, rather than the population as a whole (Linnell et al. 1999, Odden et al. 2002). This makes it impossible to target removals of any specific age-sex class of leopard (be it by lethal or non-lethal means) to mitigate conflict. In the absence of better-informed, practical, reactive responses to conflict, long term conservation strategies for leopards must also focus on proactive methods. These must include ones that promote greater social acceptance of their presence in human-dominated landscapes, even as we try to minimize levels of conflict (Linnell et al. 1997, Mclellan 1998).

In conclusion, translocation as a response to problem carnivores does not appear to be a viable option. The challenges include facets of carnivore ecology such as territoriality, homing behaviour and extensive post release movements. In a densely populated country like India, with intact forests covering less than 10% of land and concentrated in a few regions, the release of potentially dangerous big cats may in fact increase the overall danger to human life and also adversely affect tolerance of people who have traditionally displayed acceptance of these species in their space. Lethal control is an approach commonly practiced in other parts of the world, usually with much lower human densities but there is evidence to show that in case of high quality habitats, removals could also lead to an increase in resident numbers due to immigration and increase conflict at site of removal (Cooley et al. 2009).
In the case of Junnar, prior to the intervention, conflict levels were very low even though the leopards were living in high human density landscapes and the situation resembled the conflict levels seen at the Akole study site (Chapter 2,3,4) where relatively high density of leopards share the same space with very high density of humans without any fatal attacks and with low levels of livestock depredation. Thus what seems as an easy recourse such as killing, and trapping of large felids for translocation might actually worsen conflict, both in relation to attacks on livestock (Robinson et al. 2008; Cooley et al. 2009) and attacks on humans. Based on the results, it is hypothesized that if interventions are terminated in high human density landscapes, rates of attacks on humans may decline. This idea can be tested by experimentally eliminating interventions in areas where at present attacks on humans are common, such as the state of Uttarakhand.

It is extremely important that whatever conflict management option is planned to deal with potentially dangerous wild animals in a high human density country like India, it should be well planned, has to be monitored and assessed, so that the welfare of both, humans and wild animals is not compromised.