

Title: Leopards in human-dominated areas: a spillover from sustained translocations into nearby forests?

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Abstract: In the past decade, parts of many Indian states have reported an increase in leopard (*Panthera pardus fusca*) populations outside forests accompanied by large numbers of attacks on people. This high density was attributed to declining natural habitats and prey species, and the increased survival of leopards in croplands where they preyed on tended and feral domestic animals. That leopard cubs were frequently found in agricultural fields was thought to also indicate rising leopard populations. We use data from our human-leopard conflict study in Junnar, Maharashtra along with information from three other conflict sites in India to propose that the reason for this increase in leopard population and conflict is related to the sustained translocations of 'problem' leopards into nearby forests. That sustained releases could lead to population increases was never considered before, even though translocation is known to be a procedure aimed at increasing populations of species at or close to the site of release. Although scientists do not recommend translocations as a management strategy used in response to problem carnivores, it is currently the legally recommended method of dealing with 'problem' large cats in India. Such faulty policies will only further condemn the conservation of this species, which is hunted in large numbers for the illegal wildlife trade.

Keywords: translocation, *Panthera pardus fusca*, conflict, population increase, India

Introduction

India has a history of human-large cat conflict (Seidensticker and Lumpkin, 1991) but increasingly, it is the leopard *Panthera pardus fusca* which is most often implicated in attacks on people (Athreya et al., 2004). Leopards have always lived on the fringes of human habitation (Prater, 1948; Gee, 1964; Santiapillai et al., 1982; Tikader, 1983; Daniel, 1996; Johnsingh, 1992; WWF-India, 1997) especially in India where the interface between forests and rural inhabitations is a continuum. This is possibly because leopards are a highly adaptable species capable of eating a wide variety of prey and are not dependant on free water like their larger cousins, the tiger (Prater, 1948; Bertram, 1982; Daniel, 1996; Edgaonkar and Ravi, 1997; Stander et al., 1997; Mukherjee and Mishra 2001; Kulkarni et al, 2004).

In the event of a leopard problem (which can vary from just a sighting near a village to livestock predation and attack on a person), the most common management strategy followed throughout India is the setting up of baited traps, capture of an individual (not necessarily the problem causing individual) and its subsequent translocation into the nearest 'suitable' natural habitat. This is also recommended by the Indian Wild Life Protection Act (Anon, 1972) through an amendment made in 2002. However, this strategy is not recommended by scientists for managing 'problem' animals (Linnell et al., 1997; Fischer and Lindenmeyer, 2000; Sullivan, 2004) because of the strong homing instincts exhibited by a wide range of carnivore families and the potential for movement of conflict with the individuals. A recent study of the conflict in Maharashtra by Athreya et al., (2004) has provided strong evidence of the same. Various Indian scientists and managers have also cautioned against this strategy for the above reasons as well as the potential disruption that introduction of new individuals could have in the existing social set up of these highly territorial species (Saberwal et al., 1994; Karanth and Sunquist, 1995; WWF-India, 1997; Edgaonkar and Ravi, 1997; Karanth and Sunquist, 2000).

The Indian states we will discuss in this paper, Maharashtra, N. Bengal and Gujarat, have reported high human - leopard conflict levels for at least a decade (WWF-India, 1997; Chauhan and Goyal, 2000; Vijayan and Pati, 2001; Athreya et al., 2004; Pati et al., 2004). These areas also

report high densities of leopards in human dominated areas and the principal reason put forward, essentially without evidence, is the decreasing natural habitat that compels the highly resilient leopard to move into human-modified habitats like tall crops, orchards (Gujarat), tea gardens (N. Bengal) and sugarcane fields (Junnar Forest Division). Within these human-modified habitats, which provide good cover, it is thought that livestock and feral domestic animals provide an abundant supply of food in contrast to the depleting wild prey base (WWF-India, 1997; Chauhan and Goyal, 2000; Vijayan and Pati, 2001; Field Director Buxa Tiger Reserve, personal communication).

We question this heuristic explanation and suggest that, ironically, far from being the panacea for managing conflict situations, the policy of translocation has resulted in an increase leopard populations colonizing the nearest suitable habitat such as sugarcane fields and tea-gardens thereby increasing conflict potential. Finally we suggest that increased leopard populations reported from Sanjay Gandhi National Park, Mumbai, Maharashtra, and affected areas in Uttaranchal as well as Baria Forest Division, Gujarat are likely to have a very similar cause.

Methods

The human-leopard conflict study in Junnar Forest Division (Athreya et al., 2004) first quantified the extent to which translocation has been used as a management strategy to handle problem felids in India. In this paper we use data from Junnar and other sites which report a history of conflict for which data is available and view it in the context of translocation of leopards into or near these sites.

Data on leopard densities and conflict were collated for Junnar Forest Division, Sanjay Gandhi National Park, Mumbai, Maharashtra; the Terai, W. Duars and E. Duars regions of N. Bengal and areas around Gir National Park, Gujarat. The sources of information were Maharashtra, N. Bengal and Gujarat Forest Department records, Edgaonkar and Ravi (1997),

WWF – India (1997), Vijayan and Pati (2001), Khan et al., (2003), Athreya et al., (2004) and Pati et al., (2004). Leopard densities for all sites except N. Bengal have been estimated from actual number of animals trapped. In the case of N. Bengal data the information is obtained from the Forest Department census figures and an idea of the numbers of leopards living outside the forested areas is obtained from the number of cubs captured from tea-gardens and leopards found dead. Further information was also obtained from interviews with scientists and, past and present managers who had worked in these conflict areas (Field Director, Buxa Tiger Reserve; Deputy Chief Conservator of Forests, Junnar) to obtain a better understanding of the conflict patterns in various human – leopard conflict areas of our country. Finally we corroborated our analysis with information from past scientific studies on translocated large cats.

Results

Maharashtra

The two regions which have reported high numbers of human casualties due to leopard attacks in Maharashtra are Junnar Forest Division, Pune district, and Sanjay Gandhi National Park, Mumbai (Table 1).

The Maharashtra Forest Department leopard census showed an increase from 20 animals in 1997 to 57 in 2001 in Junnar Forest Division. Livestock predation and attacks on people have been reported in this region since 1993 albeit at very low levels. It was only post-2001 that the conflict escalated sharply. The 4360 km² of Junnar Forest Division is predominantly human-dominated and land cover analysis indicates no significant changes between 1992 and 2000. At the height of the conflict approximately 1600 km² of this area was affected (Athreya et al., 2004). Fifty-one people were attacked between 2001 and 2003 of which 18 died (Junnar Forest Division records). Athreya et al., (2004) estimated a minimum population of 75 adult leopards based on the number of individuals translocated, kept in captivity and found dead, in this region between 2002 and 2003.

It has to be stressed that all the natural forests in Junnar Forest Division are confined to a narrow strip on the western edge along the ridge of the W. Ghats while the rest of the division is totally devoid of any natural cover. The hotspot of the conflict was the irrigated valley of Narayangaon lying close to the eastern edge of the division and farthest from the forested Ghats. Forty two leopards were removed from the 390 km² of the Narayangaon range either due to death, permanent captivity or far-off translocations (Athreya et al., 2004). The rise in conflict was attributed to the ideal cover provided by sugarcane fields leading to increased leopard populations.

Sanjay Gandhi National Park is a forested island amidst the booming metropolis of Mumbai and is the only site in India which reports sustained human-leopard conflict from within the boundary of a protected area (Maharashtra Forest Department records, cited in Edgaonkar and Ravi, 1997). The leopard population in Sanjay Gandhi National Park increased from about a handful of individuals in the early 1970's (J.C. Daniel, personal communication) to 35 in 1988 and 40 in 1996 (Maharashtra Forest Department records). Attacks on people have been reported since 1986 albeit in very low numbers (Maharashtra Forest Department records, cited in Edgaonkar and Ravi, 1997). Between March 2002 and March 2004 24 attacks on people were reported of which 6 occurred within the boundary of the Park (Maharashtra Forest Department records). In 2004 the number of attacks increased with 13 attacks reported only in the month of June 2004 of which 10 people died (Maharashtra Forest Department records). After this, more than 30 leopards were trapped indicating a minimum density of 1 leopard per 3 km², and very likely much more. Clearly any explanation for this extraordinary spurt in attacks has to involve a sudden trigger and not gradual processes like encroachments and reduction of wild prey base. The most common strategy of dealing with the leopard 'problem' in Sanjay Gandhi National Park has been their capture in baited traps and subsequent translocation into certain areas of Sanjay Gandhi National Park as well as adjacent forests (E.g., Tansa WLS which is about 150 km to the north-east of Sanjay Gandhi National Park; see Edgaonkar and Ravi 1997). Between July 2002 and December 2003, 26 leopards were trapped, most of them outside the forest, of which 21

were translocated back inside the forest. The data available from Edgaonkar and Ravi (1997) indicates that this strategy has been in use for close to a decade now.

N. Bengal

One hundred and twenty one people were attacked in this region between 1990 and 1997 (WWF - India 1997), of which 10 died (Table 1). Forest Department records until 2002 report the death of 18 people due to leopard related incidents. Of the 3 regions in Jalpaiguri district- Terai, E. Duars and W. Duars- the W. Duars has experienced the most conflict. Forest Department data reports that 13 people have died in the W. Duars between 1990 - 2002 while the Terai and E. Duars reported 0 and 5 respectively. Based on leopard attacks on people and livestock as well as the number of cubs found, the WWF-India report (1997) identified 24 conflict hot-spots in the region. Fifteen of these lie in the W. Duars and within 15 km of Gorumara National Park and Chapramari Wildlife Sanctuary. The remaining nine occur in the E. Duars at the fringes of Jaldapara Wildlife Sanctuary and Buxa Tiger Reserve. The census figures for 1999 report 159 leopards in the forest areas with a density of 1 per 10.85 km² (<http://www.wb.nic.in/dist/jalpai.html>). There are reports of large number of leopards deaths due to conflict related incidents in this region, with 5 deaths reported in the Terai region between 1993 - 1996, 20 in W. Duars between 1990 and 1997 and 14 in the E. Duars between 1990 and 1996 (WWF - India, 1997). Of these 39 deaths, 25 were caused by people (either mob related or poisoning or shot at).

Gir National Park, Gujarat

The Gir National Park is a forested island home to the Asiatic Lion and the leopard. However, both these large cats are increasingly reported in conflict incidents on the periphery of the Park (Vijayan and Pati, 2001). Gir National Park reports very high densities of both, the Asiatic Lion (at one per 5 - 7 km²) and of the leopard (one per 7 km²) (Vijayan and Pati, 2001, Table 1). A study carried out in one of the areas affected by human-leopard conflict (Talala sub-district/taluka) adjacent to the National Park reported 27 leopard attacks on people between

1990 and 1999 of which four were fatal (Vijayan and Pati, 2001). However, the common management strategy in dealing with leopards and lions that are found outside of the Park is their capture and release within the National Park (Saberwal et al., 1994; Vijayan and Pati, 2001; Khan et al., 2003). An average of 50 leopards are translocated into the National Park each year (Vijayan and Pati, 2001; Khan et al., 2003). Thirty two leopards were rescued and 12 found dead between 1990 and 1998 from the Talala sub-district alone. Eleven lions were rescued and 11 found dead due to poisoning, or falling into wells (Vijayan and Pati, 2001) in the same period.

Discussion

The leopard occurs throughout India and had always been reported from areas bordering human habitation (Prater, 1948; Daniel, 1996; Seidensticker and Lumpkin, 1991), but severe conflict is reported only from some pockets across the country. Leopards occur in tea-gardens of Assam and south India but no conflict comparable to that in N. Bengal has been reported. Sugarcane occurs in many parts of Maharashtra with far more extensive tracts in the southern areas of Kolhapur and Karad, situated at the same distance from the Western Ghats as in Junnar, but without comparable conflict levels (Athreya et al., 2004). Even within each of the forest divisions reporting human-leopard conflict, the problem is confined to a small sub-region. For example, in Junnar, the conflict that started in 2001 was concentrated in the Narayangaon valley; in Sanjay Gandhi National Park the hot spots of the conflict in 2004 were close to the Ghodbhandar and Film City areas; in Gir it is the sub-districts/talukas of Visavadar, Malia and Talala (Saberwal et al., 1994); in N. Bengal most of the hot-spots identified by WWF-India (1997) were in the W. Duars, a few in the E. Duars with none in the Terai region.

The theories commonly put forth to explain human-leopard conflict are loss of natural habitat and wild prey and the subsequent movement of leopards to 'ideal' irrigated areas and its associated domestic animals. An important aspect that was not considered is the sustained translocation of leopards in/close to these sites for at least a decade. The Junnar study by

Athreya et al., (2004) looked into the patterns of conflict on a landscape level and they found that the conflict was not present close to the sites of release, but commenced about 15 km away with the hot-spot of conflict ranging 40 - 60 km away from the site of release (Athreya et al., 2004). A translocation exercise in Kenya in the late 1970's provides an insight into why this might be. Radio telemetric studies on eight leopards translocated more than 200 km in response to livestock predation into a National Park found that they immediately moved away a distance of 25 km from the release site (Cobb, 1981). It is likely that a hard release into an alien area makes these highly territorial animals leave the area in the direction of home, a phenomena seen across carnivore species (Linnell et al., 1997). In all the conflict sites discussed in this paper, except Sanjay Gandhi National Park, the areas with highest vegetation density immediately out of the forested release sites are human-modified crop lands. A sustained release of leopards into these few release sites over many years is likely to have lead to the high leopard numbers seen in irrigated fields, tea-gardens and even in the single protected area of Sanjay Gandhi National Park.

Moreover, natural leopard populations are already present at these forested sites of release. For example, in 2001, 11 leopards trapped in the Junnar Forest Division were released close to the Bhimashankar Wildlife Sanctuary. Census figures for the Wildlife Sanctuary (Maharashtra Forest Department records, Kulkarni et al., 2004) reported 10 leopards. In the absence of any leopard-free forests in the surrounding area and in their attempt to leave the site they would naturally move down the river valleys which contain the highest vegetation density in the form of irrigated fields. Indeed, high levels of conflict were reported for the first time in five years in these areas following the translocations (Athreya et al., 2004).

Translocation is the most common management strategy used in our country in response to any problem associated with the large cats (lions, tigers and leopards), and is recommended by law. Translocation as the preferred method of dealing with 'problem' Schedule I species was introduced as late as 2002 as an amendment to the Wild Life Protection Act (Anon 1972). However, translocation is meant to establish or increase the presence of a species near the site of

release (IUCN, 1987) and has rightly been recommended in the case of the Asiatic Lions for founding a second home outside Gujarat (Chellam et al., 1994). The Florida panther study provides an idea of how large cat populations increase following translocation (Ellis et al., 1999). Eight females released in 1995 increased to 21 individuals by 1999. Furthermore, translocation is **not** recommended for problem carnivores due to reasons rooted in their biology (such as very strong territoriality and consequent post-release movements, movement of the conflict with the individual, social disruption of existing leopard populations at site of capture as well as release, introduction of pathogens to the new sites of release, etc.; *see* Rabinowitz and Nottingham, 1986; Linnell et al., 1996; 1997; Khan et al., 2003; Treves and Karanth, 2003; Athreya et al., 2004). Furthermore, from our results, it appears that population increases can also occur close to the release site and in the absence of forested areas devoid of conspecifics, the animals will colonize adjoining human-modified habitats such as crop fields and tea-gardens.

The state of Uttaranchal has had a history of human-leopard conflict with close to 140 people succumbing to leopard attacks between 1988 and 2000 while 93 leopards were killed in the same period (UA Forest Department records in Chauhan and Goyal, 2000). Rajaji and Corbett National Parks are reported to be sites of release for leopards trapped in the state. An analysis of the capture and release sites, and dates overlaid on maps of vegetation density and river systems could test our prediction that sustained translocations into the nearby forested areas have created the hyper-dense leopard populations of 3 - 4 per 10 km² reported in the Pauri region (Chauhan and Goyal, Unpublished). That Pauri is not in the immediate vicinity of the forested sites (about 40 km away) may not be an issue. Even in Junnar, the conflict area, Narayangaon, and the release site, Malshej, are 40 km apart with few attacks reported in the intervening area. In the complete absence of post-release monitoring of such large numbers of translocated leopards, we do not have any information on how these animals use the new areas of release and of their movements across the landscape in their attempt to head back home. A leopardess trapped in Junnar and released in the forests of the MP - Maharashtra border and marked with a transponder chip, moved 90 kms in the direction of Junnar and in the process was responsible for

6 human fatalities and a similar number of injuries (Belsare and Athreya Unpublished). In keeping with the known biology of the species, her route was along the river valleys in human dominated areas just as we inferred for the Malshej-Narayangaon leopards (Athreya et al., 2004).

Information from felid biology explains why problems even at the site of capture do not decline following large removals of leopards. Sub adult felids are known to incur high mortality rates due to poorer hunting success and/or due to killings by resident males (Cramer and Portier, 2001). The removal of 12 mountain lions (similar in size to leopards) in Utah, USA, following livestock depredations did not change conflict levels because 17 *different*, and younger individuals moved in to occupy the vacant territories (Linnell et al., 1996). If landscape features do not allow translocated individuals to home all the way back to their territories, their vacant territories will be filled up by younger individuals while the survival of the translocated mature individual close to the new site will indeed increase the overall leopard population over a period of time. Furthermore, landscape features just outside of the release sites are likely to determine the extent to which the newly released animals can use them. Availability of prey is not an issue for leopards living in human dominated areas due to the abundance of feral dogs and domestic livestock. It is well known that domestic dogs are commonly taken by leopards (Mukherjee and Mishra, 2001; Edgaonkar and Ravy Chellam, 2002). Leopards that are most frequently trapped in India are from outside natural habitats. Following their release into forested sites it is likely that they will move towards human settlements thereby perpetuating conflict and this has indeed been seen to be true (Khan et al., 2003; Athreya et al., Unpublished).

In conclusion, the consistent pattern of high leopard density seen in various areas reporting human-leopard conflict (many parts of Maharashtra, N. Bengal, Gujarat, Uttaranchal) is likely to be due to their proximity to 'preferred' release sites of leopards, effectively re-stocking the area with leopards. Habitats such as tea-gardens in N. Bengal, sugarcane in Junnar, orchards around Gir will provide the next best habitat for colonization for the released animals and their progeny. Therefore, when analyzing human-carnivore conflict patterns it is also important to take into account the numbers of animals that were/are trapped and released and the proximity

of these sites to where the conflict ranges. For instance, Himachal Pradesh reported 70 leopard trappings between 1997 and 2003 (*In Athreya et al., 2004*), and does report conflict but we could not access data on the fate of these captured animals. The Baria forest Division in Gujarat reported 121 attacks on people by leopards in 2000 (Gujarat Forest Department records in Athreya et al 2004). Releases of leopards are also reported close to Baria Division, but we lack factual data to discuss the issue. Translocation of problem leopards was also carried out into Meru National Park, Kenya where for 11 years until 1979, 108 leopards were released (Cobb, 1981). It would be interesting to enquire if the areas outside of the release site reported increased leopard numbers in those years.

On the lines of Linnell et al., (1997), we also recommend that translocation of any problem carnivore not be carried out. With our faulty methods of dealing with leopards, a species capable of living close to human settlements, we have only perpetuated conflict and increased it to alarming levels in the recent years. It is of serious concern that the amendment to Section 11 of the Wild Life Protection Act was made a full five years following a scientific review (Linnell et al., 1997) which advised against such a management strategy. It is imperative that past studies and the biology of species as well as experiences of managers be considered when changing or making policy decisions.

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Table 1. Leopard densities and numbers translocated into adjacent forests in four conflict sites in India.

	<i>Jumna</i> ^b	<i>Sanjay Gandhi National Park</i> ^c	<i>N. Bengal</i> ^d	<i>Gir</i> ^e
Leopard densities	1 per 25 km ²	1 per 3 km ²	1 per 10 km ²	1 per 7 km ²
Habitat of conflict	Sugarcane fields	In and around protected area	Tea gardens	Sugarcane fields and mango orchards
No. people attacked (period)	51 (2001 - 2003)	13 (June 2004)	121 (1990 - 1997)	27 (1990 - 1999)
Nearby sites of release (no. of leopards released, period)	Malshej Ghats (25, 2001),	Bhootbangla Parisar (16, 2002 - 2003),	Gorumara National Park + Chapramari Wildlife Sanctuary (20, 1992 - 1997).	Gir National Park (38, 2001 - 2002)
			Buxa Tiger Reserve + Jaldapara Wildlife Sanctuary (7, 1992 - 1997).	
	Bhimashankar Wildlife Sanctuary (11, 2001)	Nagla Block (5, 2002 - 2003)	29 more were trapped but data is present on release.	
Distance of above site from site of conflict	< 60 km	< 20 km	< 20 km	< 50 km

^b Data from Athreya et al., 2004

^c Data from Forest Department Records

^d Data from WWF-India 1997 and Field Director, Buxa Tiger reserve, personal communication.

^e Data from Vijayan and Pati 2001; Pati et al., 2004.