Summary

Can tigers survive in human-dominated landscapes?
Understanding Human-Tiger Coexistence in the Buffer Zone of Panna Tiger Reserve, Madhya Pradesh, India.

The tiger (*Panthera tigris*) is one of the world's most iconic carnivores for conservation. This status is because tiger populations throughout their range have reduced and continue to decline despite continued global efforts to save them. In 2010 the Global Tiger Initiative (GTI) meeting that took place in St. Petersburg, Russia, the governments of all 13 tiger range countries pledged to invest resources and contribute to doubling tiger numbers by 2022. This global effort may be the last chance to save the species from extinction.

The forests of India support nearly 60% of all the tigers in the world. However, India also has a large economically deprived rural population, and people rely heavily on the forests and forest resources for their survival and livelihoods. Conserving the tiger in India has vast benefits for these rural communities. If tigers, as keystone predators and focal species are conserved, such conservation will ensure forest protection and ecosystem functioning. Secure ecosystems will, in turn, protect many other species and also provide ecosystem services to the people living in the area. Following this line of reasoning, the Indian government has committed resources and created 48 tiger reserves, which are the critical source habitats for tigers in India. However, the Indian tiger conservation strategy, based on the metapopulation concept, is reliant on connecting various isolated protected areas capable of supporting only small numbers of tigers with the adjoining multiple use forests and private lands. If successfully implemented, the connected tiger landscape will adequately support a genetically diverse and ecologically viable population of wild tigers and also keep the ecosystem functioning of the landscape intact. The most significant challenge in realising this new vast landscape for tigers is to integrate the areas used by people into the landscape

and create one coexistence landscape suitable for both people and tigers. I was motivated by the immediate and foreseeable challenges in realising a coexistence landscape and conceived this study.

There are many sceptics within tiger conservation groups and government managers who believe that promoting large carnivores in human use areas will lead to conflicts with people. Their scepticism is based on the fact that tigers, when they move in shared landscapes, are capable of attacking people and killing livestock. As a response, people will conflict and respond by killing tigers or opposing coexistence plans. Addressing conflicts is, therefore, one of the primary objectives of Global Tiger Recovery program, a global initiative to increase tiger numbers. There are also those who support the idea to promote tiger conservation outside protected areas. However, I feel that currently human-tiger coexistence prospects in India are poorly understood. My thinking is based on the fact that there is a scarcity of systematic studies on human-tiger coexistence scenarios. Most published information on human-tiger coexistence are intellectualised scenarios and assumptions of tiger behaviour from studies conducted in protected areas. In protected areas of India, human presence and activity are restricted, and therefore the full-scale human influence on the tiger habitat and tiger response to such influence are underrepresented. Further, historically and to the present tiger conservation efforts in India have mostly focussed protected areas and their management and have rarely aimed outside the protected areas or involved local people. So apart from human injuries and livestock losses other facets of the relationship people may have with tigers is poorly understood.

Rural citizens in India have always lived alongside wildlife and have developed ways to cope with the threats and dangers large carnivores like tigers pose. If people could not deal with dangerous animals, they would have killed all threatening wildlife species by now. However, that is not the case, and wildlife continues to survive alongside people in many parts of India. Firstly, not having a clear understanding of people's ability to coexist with the tiger may mislead conservationists and managers to take a position that people's presence and activities will pose a persistent threat to tigers and its future survival in such lands, and oppose coexistence plans. Secondly, it is irresponsible to blindly promote tiger conservation in human-dominated lands without an in-depth understanding of local people's ability to cope. Thirdly, reliable information on tiger space use, diets or any other facet of their behaviour in human-dominated landscapes is scarce. These knowledge gaps on people, tiger's and their abilities to co-adapt and coexist make up my study. Chapter's two to five

describe each of the four investigations I conducted and chapter six provides a synthesises to the central question of my study, "Can tigers survive in the human-dominated landscapes?".

In chapter 2, an analysis of a unique situation of livestock pastoralists displaying unusually high tolerance towards large carnivores despite frequent predation incidents is presented. Firstly, I used ethnography to describe people's religious beliefs and local practices, and next, I analysed how these factors shaped the relations people had with tigers. Respondent interviews and personal observations allowed collection of detailed information, which were then qualitatively analysed. The findings revealed that residents had strong beliefs in forest spirits. They made pacts with their spirit protectors and firmly adhered to community norms that promoted risk-avoidance behaviours. These interconnected factors provided people with the psychological and practical advantages to cope with large carnivores and decreased negative interactions. Further, widely prevalent age-old livestock husbandry practices like dumping cow carcasses near village fringes and abandoning unwanted cattle into the forests to roam free provided readily available food for several large carnivores in the region. The vast scale of these cultural practices in the area and the traditional conservation ethic exhibited by local people, positively influence the presence of large carnivores including the tiger.

In Chapter 3, I showed how despite having seemingly excellent local knowledge on carnivores and using preventive strategies, resident livestock owners of Panna Tiger Reserve, India experience high livestock losses to large carnivores. The underlying reasons behind such uncontrollable losses were examined. Through informant interviews and observations I collected quantitative and qualitative data on local knowledge, livestock husbandry and residents perceptions of factors influencing losses. I used Generalised Linear Models (GLM) and qualitative data from informant interviews to analyse and explain factors affecting losses. The findings do support the assumption that good knowledge of carnivores and the use of preventive strategies lowered losses but did not eliminate them entirely. Socio-political factors surrounding livestock, for example, prohibitions on the sale of cows to abattoirs and lack of exclusive land use rights in the buffer zone created obstacles for resident people living in the buffer zone to remove feral and free-roaming cattle of non-residents from the forests. Further, it compelled residents to graze their valuable stock in the same areas, which made their valuable livestock more vulnerable to predation by large carnivores. At the same time, residents also found it difficult to oppose the socio-political prohibitions on cows and buffalos and contradict the practices of non-residents. This case study shows that some

communities have the local knowledge, and they invest in preventive measures. However, sometimes, the external socio-political influences and unfavourable land use rights create barriers for local people to manage their livestock well.

In chapter 4, I show the effects of tiger-specific (sex, age group), environmental (seasons, photoperiod) and anthropogenic (human use regimes) factors on the movements and spatial distribution of tigers using the human-dominated buffer zone of the Panna Tiger Reserve. Generalised Linear Mixed Models (GLM) were used to test the significance of the relationships between the covariates influencing tiger presence. The findings show that tiger-specific factors like age group, sex and environmental factors like seasons and day and night significantly explained the observed variations in tiger use of the human-dominated buffer zone. For instance, sub-adult tigers spent 40% of their time in the human-use areas, compared to 10% spent by adult tigers. When in human-use areas, sub-adult tigers approached areas near villages and spent 30% less time in areas close to water than adult tigers. Our study concludes that tigers try and adapt to human use, but the degree of adaptation is linked to experience (nativity hypothesis), meaning younger tigers may show minor adaptation than adults to human influences. If human activities, including livestock practices and people's land use remain poorly regulated in a landscape, such activities may negatively impact some tigers for example, through increased livestock predation leading to conflicts. Next, they may also restrict tigers from exploiting the resources like water bodies in the landscape.

In chapter 5, open access livestock grazing, which is a common practice in the multiple-use forests of India and its compatibility with the reintroduction of tigers is discussed. Here, I focus on the diet of tigers in livestock-dominated areas. The hypothesis was that the presence of feral cattle, along with open-access grazing practices in multiple-use forests, would increase the incidence of predation on livestock by tigers, even when wild prey is available. Generalised Linear Models (GLM) were used to test whether predation of livestock versus wild animals was influenced by (1) the sex and age class of tigers, (2) season, and (3) the distance of prey from the core-zone boundary of the reserve. Overall, sub-adult tigers and adult male tigers killed more livestock than wild prey, even when wild prey was available. In the winter and rainy seasons, livestock was killed by tigers in higher numbers in the buffer zone than in summers. This difference may be explained by the seasonally changing livestock movement patterns in the area. Further, with increasing distance from the core-zone boundary, all tigers killed more livestock, possibly because livestock were more readily available than wild prey. The findings of my study show that

open-access and poorly regulated livestock grazing is not currently compatible with large carnivore conservation in the same landscape. Such practices lead to an increase in adverse tiger-human-livestock interactions. In conclusion, I suggest that it may benefit tigers and people if people corralled valuable cattle, leaving feral and unwanted livestock for tigers. This simple strategy would help both local inhabitants and tiger conservation in multiple-use forests of India.

The overall conclusion of my study is that in many rural communities of India people have developed ways to co-adapt and coexist with large carnivores such as tigers. My study demonstrates that the observed adaptation is two directional with tigers also showing natural adaptability to adapt to the human use of the landscape. These findings on the natural ability of people and tigers to co-adapt are new. Based on these new findings, the argument that tigers and people will readily conflict when they interact is not supported. People's ability to cope with large carnivores may not be restricted to my study area alone and may be more common in India than previously thought. Therefore the findings of this study are also relevant to other tiger supporting landscapes of India.

In my study, I demonstrated how local people could cooperate in situations of crisis and support tiger conservation. I believe that similar willingness to support tiger conservation would also be found in other parts of India. On the other hand, some circumstances can undermine the ability of people to adapt. For instance, external socio-political pressure preventing the removal of unwanted cows from the landscape created barriers for local herders to manage their stocks well. In such situations, where local people cannot act, they may need the support of the reserve management and conservation organisations.

Tigers, in response to human presence and activity, exhibited avoidance behaviour, spatial and temporal shifts in their activity patterns and successfully found prey. The few exceptions were the younger tigers that found it more challenging to adapt to human use areas in comparison to the mature adults and may become vulnerable. Interestingly, with age, they changed and avoided human-use areas like other adult tigers. These findings on young tigers are new. Because young tigers are naturally more risk-taking, they require continuous monitoring while in human-use areas till they grow up. Second, when livestock was freely available in the landscape, tigers readily killed them. Such killing should not be seen as negative because the tigers, during our study period, did not show any signs of being problem animals such as prolific cattle killers or man-eaters. Further, the availability of livestock was

because of prevailing local practices and predation by tigers did not lead to conflicts. Tigers feeding on unproductive male animals and abandoned livestock were favouring people. Those who lost valuable animals also knew the circumstances responsible for their losses. These include the presence of feral cattle in the landscape, prohibitions on the removal and sale of cows and buffalos and lack of land use rights. Additionally, people suffered more significant losses from disease and theft. So, local people did not consider predation on its own as the most significant issue.

Based on my research, I conclude that people living in the rural areas of India practice religions, embrace cultural values and carry out age-old practices that promote a tolerant conservation ethic. Their way of life, with or without their conscious actions allows them to share their landscape and the resources in it with the wild animals that also inhabit the landscape. Next, the national pride that a considerable part of world's tigers survives in India will continue to motive Indian politicians, government managers and urbanites to support tiger conservation efforts in India. Tiger conservation efforts outside protected areas can produce both positive and negative social impacts for local communities and resource users. For this reason, it is necessary to understand and adaptively manage the social impacts of tiger conservation over time. Such focused intervention will improve social outcomes, improve local support and increase the overall effectiveness of tiger conservation efforts.

If India fails to protect the tiger, it is clear that not only the natural landscape but also the human landscape will be more impoverished. However, there is enough evidence for optimism that tigers and people can contextually coexist. The coexistence that I showed in my study is naturally occurring, and traditional institutions, age-old beliefs and community norms ensure the adherence to facets governing coexistence. Further, there is evidence of sustainability within the observed local practices. If modern-day tiger conservationists can skilfully integrate some of the encouraging old-ways of rural people who have always coexisted with the tiger, I believe that modern India despite its vast population and challenges can successfully ensure the survival of the tiger.