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## Research and Conservation Initiatives on Bengal Tiger (*Panthera tigris tigris*) in Nepal: The Past, Present and Future

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### ABSTRACT

Tiger conservation efforts in Nepal go back to a long history *i.e.*, paradigm shift in conservation from species during twentieth century to the landscape level conservation in twenty first century. Despite of substantial conservation efforts, tiger range and their numbers have declined and confined to a few small pockets of Terai region. This study examined the situation of tiger conservation in the lowland protected areas of Nepal. Studies show the vulnerability due to increasing tiger-human conflict and people's negative attitude towards tiger conservation in the protected areas. Government Acts and legislation for tiger conservation are favorable literally but the implementation level of these seems to be problematic. There is still a dilemma over buffer zone management as human-tiger conflict has been increased more after buffer zone program in the tiger range protected areas. However, community based "Tiger Watchers" and other guarding systems have been successful in minimizing the tiger-human conflict in some areas. Furthermore, the studies show lack of sufficient compensation for losses of livestock or human life of the local community that need more attention from the top to bottom level. Earlier studies show lacking of balance of prey base- small to large sized prey in the protected areas. The numbers of large sized prey have been declined in most of the protected areas. The availability of all sized prey base could enhance coexistence of tiger and other sympatric carnivores. Therefore, the integrated management of ecological and social factors would be the efficient approach for sustainable tiger conservation in Nepal.

## INTRODUCTION

The tiger is the largest of the cats and is one of the world's most magnificent animals (Sunquist 2010). Of eight sub-species of the tiger Bengal tiger *Panthera tigris tigris*, Caspian tiger *P. t. virgata*, Amur tiger *P. t. altaica*, Javan tiger *P. t. sondaica*, South China tiger *P. t. amoyensis*, Bali tiger *P. t. balica*, Sumatran tiger *P. t. sumatrae*, and Indo-Chinese tiger *P. t. corbetti*, the Bengal tiger occurs primarily throughout India, with smaller populations in the southern lowland Nepal, Bangladesh, Bhutan, and western Myanmar. Of these eight sub-species, three have become extinct since 1950s (Caspian, Javan and Bali tigers), two are virtually extinct (South China and Indo-Chinese tigers), and from the 100,000-150,000 tigers that might have existed 150 years ago, we are left with 5,000-7,000 animals today. At present, more tigers exist in captivity than in the wild (Khan 2004). The Bengal tiger is found only in southern, south-eastern and eastern parts of Asia. However, its range has been greatly reduced in recent times as their distribution once extended across Asia from eastern Turkey to the Sea of Okhotsk. Now tigers survive only in scattered populations from Nepal, India to Vietnam, and in Sumatra, China, and the Russian Far East (Nowell & Jackson 1996). By 2014, there were 2226 individuals of tiger in India, 440 in Bangladesh, 300 in Nepal and 103 in Bhutan (wikipedia.org). Among the wild population, about 300 Bengal tigers live in five lowland protected areas of Nepal. Although the wild tiger populations are considered more secure in India and Nepal than other tiger subspecies range countries in Asia. Tiger is an endangered animal as well as an effective flagship species in conserving other wildlife and wild lands in many parts of Asia. Besides, tiger has been admired by human society for its cultural, religious and other natural and supernatural attributes. Therefore, tigers have been considered as the high level of public concern as there have been major funds delivered to the tiger conservation efforts during last few decades (Tamang 1982). The tiger and the human society relationship was as old as the human civilization in Asia for example the oldest (dates back to 4,000-3,500 BC) man-made representation of a tiger was discovered on the rocks of the Amur river in

Siberia (Thapar et al. 1992, Khan 2004). A 5000-year-old seal from the Indus valley civilization in South Asia depicts a man sitting on a tree addressing a tiger waiting for him below (Karanth & Nichols 2002). Thapar (1992) mentioned that, for the people who lived in the forest, the tiger was the most important and most powerful representation of nature. The tiger seemed to symbolize the force that could provide life, defeat evil and act as an 'elder brother' to humans, defending crops and driving out evil spirit. It was the protector, the guardian, the intermediary between heaven and earth. It was also the symbol of fertility and regeneration (Thapar et al. 1992). The tiger is deeply rooted in the history, culture, beliefs and myths of the Indian sub-continent. One seal of the Indus valley civilization, which dates back to 2,500 BC, shows the naked figure of a woman, upside down with her legs apart and two tigers standing to one side. The tiger is widely used as the brand images or icons for many things mascots of military units and also from beer to gasoline, breakfast cereals to varnish paint (Khan 2004). Nepal and Bangladesh have the image of the tiger on banknotes. Because the tiger is a symbol of power in Nepal, India, Hong Kong, Malaysia, Singapore, South Korea and Thailand have been dubbed 'Asian tigers' because of their rapid economic advance (Nowell & Jackson 1996). The tiger is considered as an icon species of wildlife community in all ecosystems wherever it occurs. So that conservation of tiger is referred as the conservation of whole ecosystem and wildlife community including their prey. Owing to its endangered, umbrella and flagship status, accurate and reliable population estimates are critical task for implementation and assessment of conservation measures and management practices (Nowell & Jackson 1996). However, wild tigers continue to be under grave threat, and their preservation now requires, more than ever before, informed conservation interventions guided by reliable ecological knowledge. The lack of scientific rigor in the approaches to assess the status of wild tigers and prey is now clearly recognized as a serious gap in global conservation efforts (Karanth & Nichols 2002). Population estimation of tigers, like that of other felids is difficult owing to their low densities, territoriality, nocturnal and cryptic behavior

(Karanth 1995) and also there are so many controversies in methods for studying Tiger. Camera traps methods with capture and recapture model for tiger is not so suitable method in low density areas (Karanth et al. 2004a). Also, the use of plaster casts and tracing methods for pugmarks of tiger highly depends upon human efficiency with more error in individual identification (Karanth et al. 2004b). So that it demands some advance methods for the study of tiger such as DNA analysis from scats, digital pugmarks techniques which can minimize the human errors. In addition, prey abundance indicates a poor or good quality habitat that ultimately reflects the presence of breeding tigers. Predator density show positive relationship with the prey density particularly wild ungulates in most of the ranges (Smith et al. 1998; Sunquist 1999). The decline in prey population as a result of change in habitat condition, habitat degradation, wildlife-people conflict and widespread poaching are the major causes for the declination of large predator like tiger. Animal populations are the best benchmark to measure the success of management actions and conservation measures, while acting as alarm bells for ecologists in case of threats. It is therefore of great value to scrutinize animal populations using the best techniques available. The periodical monitoring of wildlife and their habitat is therefore, necessary to prioritize and identify areas for conservation interventions and assess the effectiveness of sustainable conservation and management efforts. There is greater role of habitat and its dynamics on wildlife community structure and composition. The populations of prey are decreasing and there may be lack of sufficient prey for Tiger in the wild that tend to resort them into the new prey like livestock and other minor species. The fading of large vertebrates in the tropical belt may be the next biological affront of the global extinction crisis. Large predator and their prey are at particular risk in Asia, where they are threatened by over human population, poaching and habitat loss (Nowell & Jackson 1996). It may increase in endangered species numbers. These problems in and around National Park of Nepal are seen as major problems of conservation of endangered species such as Rhinoceros and Tigers. Habitat disturbance and destruction caused by human encroachment (Bhattarai & Kindlmann 2013), natural encroachment of invasive alien plant species, high dependency of people in the forest, low economic

status of local people, large settlement of poor, marginal and ethnic communities around forest, illiteracy, illicit collection of timber and lack of conservation awareness are major problems in nature conservation. The majority of livelihood of poor people depends on the forest products. In one hand people need forest products mainly for energy and livestock feeding. On the other hand, people sneak into the forest and involve in the illegal collection of fuel wood and other forest products for their daily need. When this happens, tigers and human are forced to closer together which is dangerous for both tigers and humans. There is limited food and space for tigers, so they begin to prey on livestock, and sometimes people. Then the retaliatory killing of tiger begins. When human encroachment increases further into the forest, single population of tigers becomes separated from each other which decrease the successfulness of mating with the different population (Gurung et al. 2008). Instead they must breed with the same tigers, and cubs of those tigers, over and over which ultimately invites inbreeding depression in the population. So, if habitat loss, prey loss, poaching and inbreeding depression happen altogether at the same time, tiger no longer survive in the wild.

## MATERIALS AND METHODS

**Study area:** The study area covers the Terai Arc Landscape (TAL) in southern lowland Nepal that includes Shuklaphanta, Bardia, Banke, Chitwan and Parsa National Parks. Habitat loss and fragmentation have been a major cause of isolation of habitats and the creation of a large number of metapopulation in most of the tiger range countries. In Nepal too, single tiger population in Terai region has divided into three separate populations (*e.g.* Chitwan, Bardia, and Suklaphanta- **Figure 1**) with very limited opportunities for interaction between and among these isolated units (Smith et al. 1998). Tiger population in Trijuga forest, near Koshi Tappu Wildlife Reserve was recently extirpated. Tiger numbers declined across the Terai forest during the 1970s and tigers were last recorded in Trijuga in 1994. The repeated surveys between 1999 and 2004 confirmed that there have been no records of tigers between Bagmati River and Trijuga forest (linear distance 155 km) during (Gurung 2003). Establishing protected areas is not enough for tiger conservation because protected areas in Nepal and across most of the tiger range do

not support population of tigers of adequate size to ensure long term viability (Smith 1999; Smith et al. 1998). Due to small size, the relatively isolated existing protected areas do not ensure the long-term viability of tiger populations (Dinerstein & Wikramanayake 1993; Smith et al. 1998). Existing forests outside protected areas presents a great potential to link threatened wildlife populations in protected areas and increase regional population viability. If these lands are managed under a landscape approach that favors restoring connectivity, flagship wildlife populations will have a higher probability of long-term survival and sustainable conservation. Because the majority of potential wildlife habitat is in multiple-use national forest outside protected areas conservation measures need to be undertaken beyond the boundaries of parks and reserves (Ahearn 2001). Restoring degraded habitat and expanding the land base and connectivity will re-establish the past metapopulation structure of linked population centers that is critical to long-term survival of wildlife. A paradigm shift in conservation from species and ecosystem levels to a landscape-wide conservation initiated for long-term conservation of large mammals (*e.g.*, tiger, elephant & Rhinoceros) with greater emphasis on Terai wide management (Smith et al. 1998). In Nepal, tiger range areas lie in the Terai Arc Landscape (TAL) that includes four national parks- Shuklaphanta, Bardia, Banke, Chitwan and Parsa National Parks and other areas outside the protected areas are- Kamdi-Kapilvastu Corridor, Khata Corridor, Basanta Corridor, Karnali River Corridor, Laljhadi-Mohana Corridor, Brahmadev Corridor and Barandabhar Corridor (Figure 2).

**Methods:** This paper is based on the review of 60 published literatures that include research articles, books, book chapters, reports and records of government and non-government institutions. The literatures about the general biology of tiger, research trends and methodologies are also reviewed from publications of India, Bhutan and Bangladesh. These sources cover the ecology, human-tiger conflict, prey availability and conservation initiatives.

## RESULTS AND DISCUSSION

**Ecology of tiger habitat:** The ecology of the Bengal tiger varies in different habitats. They are mainly found in tropical evergreen and deciduous

forests of southern Asia. It also thrives in the mangrove swamps of the Sundarbans, dry thorn forests of north-western India, and the tall grass jungles at the foot of the Himalayas (Nowell & Jackson 1996). Prater (1971) reported the tracks of tiger in the winter snow at 3,000 m altitude in the Himalayas (Prater & Barruel 1971). In contrast, the tiger has been reported to about 4,000 m altitude in the mountains of Bhutan and south-eastern Tibet (Matthiessen 2001; Prater & Barruel 1971). The basic habitat requirements of the tiger are: 1) some form of dense vegetation cover, 2) sufficient large ungulate prey, and 3) access to water (Carter et al. 2013; Nowell & Jackson 1996). Studies show adaptation of tiger in a wide range of environments (Schaller 1967) through its substantial behavioural plasticity (Sunquist 1981). Today, wild tigers occupy less than 5% of the 1.5 million km<sup>2</sup> of forest habitat available. The lack of prey base and human disturbances are the major causes that prohibit existence of wild tigers in most of the forested areas (Karanth 2001). However studies suggest that the ecological densities of tigers and other sympatric predators may be governed primarily by prey community structure, with regards to abundance of different size classes of prey (Karanth 1995; Karanth & Sunquist 1995). According to their predictions, where tigers and leopards occur symmetrically, if both large and medium-sized prey is abundant, tigers would select large prey enabling the coexistence of leopards at high densities. In the areas with scarce large prey, tigers were found to be switched to medium-sized prey that cause displacement of leopards from the core areas of forest and also reduce leopard densities through competition, as hypothesized for Chitwan, Nepal (Karki 2011; Seidensticker et al. 1999; Bhattarai & Kindlmann 2012a). Besides, if there are scarcities of both large and medium-sized prey, leopards would be relatively more abundant because of their capability to survive on smaller prey (Bhattarai & Kindlmann 2012a). Earlier studies on the prey and prey selection by tigers have found that tigers usually prefer large ungulates, but availability of such prey species plays the greater role of prey preferences (Bhattarai & Kindlmann 2012a; Karanth & Sunquist 1995; Schaller 1967).

**Population dynamics:** Population viability is an important factor to ensure tiger conservation. Regular census and monitoring the population status of tigers are the fundamental tool for

studying population dynamics. Census in various years showed the increase in the population of tiger in Nepal (Figure 3). A population is considered as viable when it contains a sufficient number of individuals with sufficient genetic diversity. It indicates the differences between individuals of the same species. This variation ensures a species can adapt to the changing environment. However, nature does not always maintain such events by itself. There are two main processes by which genetic diversity is influenced. First is genetic drift which is a random process of changing the gene pool due to small and fragmented population. More specific, it changes the allele frequencies of a population due to chance events. The second process is gene flow which maintains the genetic diversity of a population by exchanging genetic material between populations i.e., if interconnecting habitats available to connect isolated habitat populations. A viable population (large and connected), then, will remain stable. In a molecular experiment of tiger specimen found that tiger showed little genetic diversity and no variation was observed among sampled tigers for the 16S RNA gene or for mtDNA-RELTP variation (Sunquist 1999; Wentzel et al. 1999). If we consider the generation time (Agrawal & Gibson 1999) and mean number of effective no of population size (11%) (Sunquist 1981), total number of tiger of CNP is 110 and over 173 and number of effective population is near to 0.70 (Sunquist 1999), then the tiger population size is sufficient to maintain the genetic diversity above 95% level after 100 years of time (Sharma et al. 2013). Here the probability of changing allele frequencies is low and thus genetic drift is not dominating factor. The life span of a tiger in the wild is estimated to be less than 20 years but the population dynamics of Chitwan tiger is also positive for its sustainable or long time conservation program (Figure 4). Though this number of tigers is not enough to maintain 100% genetic diversity but quite okay for preventing the genetic diversity over 95% marks (Karki et al. 2015).

**Prey requirements and availability:** Availability of different sized prey species play a greater role in existence of tigers with good numbers. However, it is important to monitor and analyze landscape changes and evaluate the impact of these changes on habitat integrity, tiger and its prey species

(Smith et al. 1998). Better understanding of prey distribution and abundance in relation to human activities will in turn facilitate development of management strategies for both predator and prey species. Improving habitats to encourage prey abundance is crucial for maintaining larger and more connected tiger populations in human dominated landscapes. Prey abundance is the major determinant of tiger density particularly wild ungulates (Sunquist 1999). Studies show that tigers occur in low densities in those areas with lack of large or medium sized prey (cervids or bovids) while reproduction rate of wild tigers declines in an degraded habitats with low prey base (Karanth et al. 2004a). Decline in prey base as a result of change in habitat condition, habitat degradation and widespread poaching are the major causes of making weak relationship between predator and prey (Bhattarai & Kindlmann 2018). Periodical monitoring of wildlife habitat is therefore, necessary to prioritize areas for conservation interventions and assess the effectiveness of management efforts. Moreover, a threshold of prey abundance that indicates poor or good quality habitat and ultimately reflects potential for presence of breeding tigers is important for developing necessary conservation action (Smith 1999; Smith et al. 1998). A review of tiger food habit shows that the mean weight of prey killed by tigers can be quite variable, the mean mass of prey killed by tigers in Chitwan about 62kg (Shrestha 2004). In a study of diet of tigers by scat analysis at the CNP found that most of the tiger diet was covered by the deer species and a few percentages were also covered by the domestic animal (Bhattarai & Kindlmann 2012a). A tigers requires 5-6 kg of meat a day for a maintenance diet (Sunquist 1981) i.e., 1825-2190 kg/year of meat however as 30% of each carcass is inedible that's why a tiger needs to kill about 2373-2847 kg/year of meat (considering 110 tigers in CNP) on the hoof. In another report of DNPWC (2001) the total number of tiger in the CNP is over 100 while in 2007 report the total number of tiger is more than 173. A simple analysis of McDougal and Tshering (1998) for 100 tigers food requirement of the CNP area  $(2373+2847)/2 =$  average of 2610 kg meat per tiger per year translates into the total meat requirements for all tigers equals to 261000 to 287100 kg. These data clearly indicate that the prey availability of tiger at CNP is sufficient for its total food consumption throughout the year and at best a

tiger makes 40-50 kills per year (McDougal & Tshering 1998). While (Sunquist 1999) mentioned that a tiger could just as well kill one 20 kg Muntjac every 2-3 days or one 200 kg Sambar every few weeks but they may eat together (4-6 tigers) or occasionally alone. Among the lowland protected areas, CNP has the largest population of tigers and prey species mainly cervids. Sambar deer (*Rusa unicolor*), swamp deer (*Rucervus duvauceli*), Chital (*Axis axis*), hog deer (*A. porcinus*), northern red muntjac or barking deer (*Muntiacus vaginalis*), wild boar (*Sus scrofa*), gaur bison (*Bos gaurus*), and sometimes primates as langur (*Semnopithecus entellus*) and rhesus monkey (*Macaca mulatta*) are the main prey species of tigers in Nepal. Studies on population status of major prey species of tiger in the Terai parks shows that BNP has the highest density of prey and the lowest density of prey occur in the BaNP compared to other parks (Figure 5). Quantitative studies on the tiger prey base in Nepal have been still limited to the protected areas (Bhattarai & Kindlmann 2012b; Eisenberg & Seidensticker 1976; Shrestha 2004, Wegge et al. 2009). Information on prey abundance in national forests or outside the protected areas is virtually non-existent. Furthermore, very little information on landscape level abundance and densities of tiger prey species is available even in the protected areas. Despite various conservation processes for conservation and management of tigers and its prey species, they are being seriously endangered because of habitat destruction, food and habitat competition, poaching, and human-wildlife conflict problem.

**Behavior: Social, territory and dispersal capabilities:** Bengal tigers are mainly solitary and territorial animals except females with cubs and males with females in breeding period (Nowell & Jackson 1996). Males associate with the females for breeding and have also been observed with females and cubs when feeding or resting (Schaller 1967; Sunquist 1999). Tigers have wide range of dispersal capabilities. However, little studies have been done about tiger's movement, especially through the fragmented human dominated landscapes. Smith (1993) reported that male tiger dispersed about three times higher than females while most females were philopatric and stay nearby their mothers (Smith 1993). Dispersal distances are short in those areas having high

abundance of prey *e.g.*, in Shuklaphanta, Chitwan and Bardia National Parks.. The average dispersal distance for male was 33 km, the longest was 65 km. The average dispersal distance for female was slightly less than 10 km, the longest was 33 km. Earlier studies showed that there was a record of a sub-adult male tiger of traveled 150 km from Chitwan to the Trijuga-Koshi-Tappu area in eastern Nepal (Sunquist 1981). In Bengal tiger, age of dispersal varied even within the same area, with some young leaving their natal area at 19 months, while others stayed to 28 months. Smith (1993) also found tigers did not disperse across open cultivated areas (10-20 km wide), but they did travel through degraded forest habitats (Smith 1993). Smith (1993) found four out of four young females successfully established breeding territories, whereas only four out of 10 males survived to breeding age. Male is highly dispersal and usually such dispersing sex has high mortality rate than the philopatric sex in Chitwan conditions. So, the possibility of tiger dispersal from Chitwan to other Terai area or vice versa is rare but they can easily establish their suitable new territory at any distance of CNP if habitats outside the protected areas are well managed. Most of the time the tiger dispersal had taken place to find suitable prey, habitat and establishment of new territory. So, the tiger dispersal capability is positive for its conservation of tigers in most parts of Terai parks.

**Food habit and effect on rare prey species:** The tiger makes an ambush trapping technique using every available tree, rock, or bush as cover to approach as close as possible to its prey before attack. Based on the food availability, tigers travel about 7-32 km/night (Schaller 1967; Sunquist 1981) and sometimes travel even more with no definite plan in mind (Sankhala 1978). They prey mainly on various species of deer, wild pig and gaurs (*Bos gaurus*) throughout their range. It has been reported that tigers will also attack young elephants (*Elephas maximus*) and rhinoceros (*Rhinoceros unicornis*), and take smaller species like monkeys, birds, reptiles and fish (Nowell & Jackson 1996). Tigers prefer to kill prey from a wide range of age classes, ranging from the very young to the old (Schaller 1967; Sunquist 2010). Tiger food requirements depend on abundance of available wild prey. On an average 73.63 individuals were estimated to occur per km<sup>2</sup> in the CNP (Dhakal et al. 2014). Of these group 22% are small animal (<20kg); 37.5% were of medium

sized animal (20-50 kg) and 40.5% were of large animals (> 50kg). The core habitat of CNP is now 952.61 km<sup>2</sup>, so, the number of prey availability the CNP area is sufficient for tiger's requirements. Study shows that the prey availability is not a problem for tiger conservation at the CNP compared to other factors. However, human disturbance is the major determinant of prey selection, diet and occupancy of tiger in the CNP (Bhattarai & Kindlmann 2013).

**Problem of confrontations with sympatric carnivores:** Tiger and leopard coexists in the most of the tiger range countries. Earlier studies showed the evidences of high leopard mortality due to tiger attack at the core area of the Chitwan national park. For example, in January 1988 4-5 days old carcass of adult female leopard proved to be killed by tiger was found in a patch of partially burnt grass (Mcdougal 1988). Leopards succeed in co-existing with tigers if there is availability of small to large sized prey with sufficient numbers. However, leopards are not common in those habitats or areas where tiger density is comparatively high. The study of Bhattarai and Kindlmann (2012) showed that leopards are mostly found on the peripheries of the park, sandwiched area in between prime tiger habitat (core area of park) and cultivated lands, surviving on both natural and domestic livestock prey. Under such circumstances, tigers as well as humans both contribute to leopard mortality (Bhattarai & Kindlmann 2012a; Seidensticker 1976). There were two major factors that accelerated the extermination of so many leopards by tigers. Earlier studies showed that after the establishment of CNP the number of tigers increased significantly due to effective protection and good management has led to an increase in the prey base and a commensurate rise in tiger density. Recent conservation initiatives of Global Tiger Initiative for doubling the tiger population by 2022 may lead to more killing and displacement of leopards from most parts of Terai parks and human-tiger conflict may also increase abruptly. On the other hand, very little peripheral habitat remains available for leopards at the periphery of the park. These factors would increase the likelihood of confrontation between tigers and leopards that will ultimately increase the problem of conservation of these two sympatric felids (McDougal 1988; Seidensticker et al. 1999).

**Challenges of tiger conservation:** Many earlier studies and regular tiger census in Nepal had

identified key threats to tiger such as control of illegal hunting and trade; mitigating the impacts of infrastructure development including upstream hydropower and irrigation; reducing traffic accidents with wildlife; and reducing human disturbance in tiger habitats (Dhakal et al. 2014). The current available national tiger census report emphasizes the importance of mitigating human-tiger conflict for effective conservation of tigers in the wild. This report further highlights the importance of securing dispersal of tigers and role of involvement of local communities in conservation. At present climate change also causes significant impacts on tiger conservation by affecting on habitats, prey species and ultimately on the tiger population. These studies suggests that building ecological resilience habitats and developing strategies for climate change adaptation need to be mainstreamed into tiger habitat management including integrated studies on ecological and socio-economic perspectives (Bhattarai & Kindlmann 2013; Dhakal et al. 2014).

**Poaching and illegal wildlife trade:** The main aim of poaching and illegal trade on tiger is for traditional medicines and body parts for decorative purposes (Figure 6). Efforts of several governmental and nongovernmental organizations including WWF to reduce demand for tiger-based medicines by engaging traditional medicine communities have been successful. However, the ban on international trade in tiger parts imposed by CITES and the existence of laws against domestic trade in most range and consuming countries, illegal trade continues. Bhutan, Laos and North Korea have yet to accede to CITES. Trade in tiger parts and products are evident in some countries such as Cambodia, Indonesia, Laos, Myanmar, Thailand, and Vietnam. In North Korea, which is both theoretically a range and consuming country, trade in tiger parts and derivatives is still legal. There continues to be a lucrative market for tiger-bone medicines in East Asia, North America, and in parts of Western Europe and Southeast Asia (Bhujju et al. 2009; Cheung 1995; Bhattarai et al. 2012).

**Habitat loss and fragmentation:** The current distribution of tiger encompasses some of the densest human populations on the Earth including Nepal and India. Habitat loss and fragmentation in Nepal have been started since Twentieth century after malaria eradication during 1950s in the Terai

region. Rapid increase in human population in Terai region occurred due to mass migration of people from hilly regions in search of fertile and accessible lands that caused the massive loss of tiger habitats and changed into the isolated pockets due to fragmentation of continuous habitats across Terai (Smith et al. 1998; Dinerstein et al. 2007). These trends continued until the establishment of National Parks and Wildlife Conservation Act of 1973. Human pressure including development initiatives, ranging from dam building, road construction and mining, commercial logging and the clearance of forests on tiger habitats continues to grow throughout their range and impact negatively that lead to fragmentation and decline in populations of tigers and their prey (Smith et al. 1998; Smith et al. 1999; Dinerstein et al. 2007). Since about half the world's tigers live outside protected areas, this leaves them extremely vulnerable to intrusive development. Even tiger habitats within protected areas do not yet have appropriate management plans, infrastructure and resources. Furthermore, loss in habitat heterogeneity is another serious problem to maintain sufficient prey base in the existing protected areas (Dinerstein et al. 2007; Bhattarai & Kindlmann 2012b; Bhattarai et al. 2012).

**Government policy for tiger conservation:** Nepal introduced the National Parks and Wildlife Conservation Act 1973 (NPWCA) to provide legislative provisions for the protection of protected areas and wildlife (Heinen & Kattel 1992). Poaching and illegal trade on tiger is strictly banned by the NPWCA and its international trading is also restricted by CITES (Dongol & Heinen 2012). According to this Act, the penalty for a person involved in the poaching of a tiger, or in the trade of its parts is a fine of Rs. 50,000 -100,000, or imprisonment of 5-15 years, or both (DNPWC 1973). Despite such strict acts and provision of penalties, poaching and illegal trade in tiger and its body parts are still occur due to its high demand in the international markets. In recent years, the Government of Nepal also established anti-poaching units (APUs) in some protected areas, with the active participation of local people. These units have been playing significantly role in reduction of poaching and illegal trade in tiger. Furthermore, the Government of Nepal established Buffer zones at the peripheries of the parks in 1999 to protect the core habitats and wildlife, with the aim of reconciling developments and conservation

(Budhathoki 2004). Rights to use local resources have also been established in the buffer zone areas while their rights and intervention to the core habitat of the park was strictly banned by the government. These practices imply that the Government policy and legislation are beneficial for tiger conservation in lowland protected areas Nepal (Tiger Conservation Action Plan for Nepal).

**Gaps in Conservation efforts and international cooperation:** Tiger conservation is limited by the lack of trained personnel, equipments, funds and availability of data from all possible tiger habitats. Although TRAFFIC, WWF, and CITES are working to train customs officials and authorities, much more needs to be done to combat illegal trade and hunting and also to monitor tigers and patrol inside and outside of protected areas (Bhujju et al. 2009). The tiger conservation requirements are evolving and growing day by day that demand renewal and enhancement of professional knowledge and skills. Furthermore, reliable information on poaching, habitat change, and prey status are also critical for developing effective conservation strategies for tiger but this is rarely available. Most of the world's prime tiger habitats cross international borders. Furthermore, illegal trade in tiger parts and products is international in nature and effective implementation of CITES depends on communication and networking among tiger range, transit, and consumer countries. International cooperation is also crucial for effective exchange of technology and experience in tiger conservation between countries. The current level of international cooperation is, however, far from adequate (Damania et al. 2008).

**Role of perception of local people on tiger conservation:** Most of the tiger range protected areas in Nepal is surrounded by dense human settlements and many of earlier studies stated that the main threat to tiger conservation is human encroachments into their core habitats. Losses of livestock and threat to human live from wild animals of parks resulted in the development of antagonistic behavior of local people towards the parks and negative attitudes towards wildlife conservation (Nepal & Weber 1995; Straede & Treue 2006). In practice, people living outside the park boundary have no legal right to ask any compensation for losses and damages caused by wildlife. People displayed dissatisfaction and disobeyed the park legislations. Their negative

attitudes and illegal activities severely impact on wildlife conservation (Nepal & Weber 1995). Most of the local people near the park show their negative behavior towards tiger conservation due to not being allowed to enter the park for collection of fuel wood, timber, grasses and other NTFP. Sometimes they still support the illegal activities in the park, tiger and other endanger wild animal to get some financial benefits from professional smugglers. This attitude of local people and poaching are the most destructive activities for tiger in the protected area. Therefore, the conflict between the tiger-human and park officials are the day-to-day problem of the protected areas.

**Wildlife-people conflict and its impact on tiger conservation:** Wildlife-people conflict is the major obstacle of conservation of problematic species like tiger in Terai parks with high density of people. To get rid of these problems, government of Nepal established buffer zones in protected areas. Though the buffer zone forest increases the possibility of ecotourism, it puts animals like elephants, tigers and rhinoceros in direct confrontation with the surrounding communities (Dinerstein et al. 1999). With the implementation of projects like Terai Arc Landscape (TAL), ecological status of forests has considerably improved in the buffer zones and national forests resulting in higher number of tigers around such areas (Gurung et al. 2008) that ultimately leads to increase the cases of tigers killing humans and livestock (Figure 7). Records shows that there has been a rapid increase in the number of humans and livestock killed by the tigers after the gradual restoration of habitats and forests in the buffer zones from an average of 1.2 ( $\pm 1.2$ ) persons/year before 1998 to 7.2 ( $\pm 6.9$ ) persons/year in between 1998 to 2006. Based on these findings, Nepal Tiger Conservation Action Plan and TAL-Nepal strategic plan (2004-2014) have identified human-tiger conflict as the major threat/problem for tiger conservation in lowlands (Carter et al. 2012; Gurung et al. 2008). In most parks, losses of livestock and human lives have been mostly at the individual level but their compensation has been supplied for the communities. These facilities do not separate a person who is losing at the cost of biodiversity conservation and another person who is gaining at the cost of biodiversity loss (Gurung et al. 2008). Besides, when they are not able to participate in such income generating opportunities, they can support poaching activities as a self-compensatory,

retaliatory and livelihood coping strategy. Thus community support on conservation depends on opportunities for economic benefits to a great extent. In addition, human perception regarding wildlife conservation has also been seen to be regulated by their existing livelihood strategies, impact of wildlife on them and possible compensation for losses (Islam et al. 2012).

**High dependency on funds from developed countries:** Lack or distribution of funds in conservation sector is the major obstacle for effective conservation of wildlife. Political instability is another challenge to utilize the funds in particular sector in the developing countries like Nepal. Most governments of the tiger range countries have been limited by financial resources, social and economic problems that act as the barrier to generate and use of adequate funds in tiger conservation. Nepal's latest studies showed high dependency on foreign aid and inadequate funds and the delay in distribution of these funds to the tiger range parks have been seriously hindering the conservation activities (Dhakal et al. 2014). Consequently, low budgets with ongoing Nepal's economic decline have been even more serious issue for protected areas across the tiger's range. Therefore, sustainable financing mechanisms should be developed in national level for more effective and long-term conservation of tiger and prey species inside and outside the parks.

#### **Conservation strategies: where we are?**

**Wild prey management:** Tiger is the opportunistic predators and select mainly the vulnerable prey. It can predate on wide variety of species present throughout its range, but it prefers wild ungulates rather than livestock. Studies show sufficient number of wild prey for tigers however there are still poaching and legal hunting of wild animal in the protected areas. Sambar and Chital are the main prey in the tiger's diet, so, wild prey management is very beneficial to secure tiger population for future. Even there are some ecological benefits to local farmers from tigers by helping to reduce crop and livestock losses from other problematic wildlife (Thinley et al. 2018).

**Need of Corridors: Landscape level efforts:** Corridors are narrow landscape elements that connect the isolated landscape fragments to each other. The development of new corridors between buffer zone and core habitat of protected area can

enhance the tiger territory. However, the corridors are used for dispersal of tigers between two protected areas and not for their dispersal into buffer zone forests as their presence in buffer zone forests could rather be dangerous for the local communities. Sometimes impaired or female tigers with cubs may use these corridors for their shorter stay to the buffer zone of the park. The Terai Arc Landscape is one of the best conservation instruments that establish and promote corridors to promote the dispersal of tigers among the protected areas of India and Nepal to maintain a healthy exchange of genetic diversity as well (Smith et al. 1998; Wegge et al. 2016).

**Buffer Zone Management:** A buffer zone is described as an area surrounding a park or a reserve across forests and agricultural lands including human settlements and various other forms of land use. The buffer zone area is managed officially by the Buffer Zone Management Council (BZMC) under the supervision of protected areas offices. It comprises of Government officials and local representatives (nominated by the different user groups). The buffer zone forest helps to protect the core forest habitat while in some areas forests of the buffer zone are in very good condition (Gurung et al. 2008). Bufferzone helps to minimize the human pressure to the core forest habitat of tigers. The BZMC had already implemented some strategies for its effective management, and the most important one is the buffer zone regulations that couldn't permit the local people to enter the core forest area. They also employed forest guards to monitor the activities of the people of the user groups in the buffer zone area continuously. It implies that the local community involvement is important factor to maintain the management approaches of protected areas. Following management approaches have been adopted to reduce the tiger-human conflicts in the protected areas-

*Bag Heralu:* it is a new conservation initiative to tackle with human-tiger conflicts that have been developed and initiated by members of local user groups and communities. Employment of 'Bagh Heralu' (Tiger Watchers) is being in practice in some areas of parks to monitor activities of tigers and inform local people about any potential threat for humans and their livestock. This approach has been successful to some extent. Gurung et al. (2008) have also recommended a similar approach

to tackle such problem by radio collaring of problematic tigers and developed a communication mechanism with surrounding communities to inform timely about "no go" zones.

*Compensation for livestock and human life losses:* the BZMC has been receiving the 50% net profit of the protected areas income. This money is used for the conservation and development of buffer zone forest and human settlement areas and only 10% is for administration. There is already a Wildlife Damage Relief Guideline of the government of Nepal which has provisions for compensation of losses of human life and livestock, damages to crops and physical assets and treatment in case of injuries (Dhungana et al. 2016). Such programs have been very useful and that might develop the positive attitudes of the local people towards tiger conservation.

*Lethal control:* In some extreme cases, lethal control of problematic tigers has been in practice though it is contradictory to tiger conservation. Sometimes, such activities create the positive attitude of the local people for tiger conservation and park administration. Furthermore, lethal control can be used to prevent the tiger for establishment their range in the unsuitable area or the zones higher risk of conflict (Dhungana et al. 2018).

*Using pet dog:* the dog has the capability to detect the tiger presence and the local people may notice it in well advance by the dog barking. For example in Bangladesh, the pet dogs are used as a guard of local people from the man eating tiger at the boarder of the Sundarban area (Inskip et al. 2016). So, this could be an effective management approach for the lowland protected areas in Nepal to save the human life from man eating tiger.

**Information, education and awareness:**

Provision of transferring knowledge about the conservation issues through providing public information and education can enhance the public support in tiger conservation. Most of the people at the peripheries of the tiger range parks are poor, marginalized and illiterate that possess an anti tiger conservation concepts (Gurung et al. 2008). For example in Bangladesh, the awareness campaign by different institutions and motivation program at the local household level are helpful for effective tiger conservation program. The socioeconomic

status and livelihood condition of the Bangladeshi and Nepali people are more or less similar, so, these programs are also useful for Nepal point of view (Kollmair et al. 2003). Therefore, such initiatives help to develop the positive attitudes of the local communities towards tiger conservation and that also attempt to resolve the tiger-human conflict in the protected areas.

**Involvement of national and international institutions:** As an UNESCO world heritage site and as an important part of Global Eco-region 200, CNP holds a crucial position in international conservation arena as it is the area with good tiger density (about 200) in the world (Wikramanayake 2002). Therefore, a lot of international agencies and donor organizations were involved to protect wildlife and Community Based Conservation (CBC) activities. By the 1980s, conservation focus had shifted from conventional flagship species and protected areas to broader themes like biodiversity and ecosystems as life support systems for rural communities (Fisher et al. 2008). This approach led to innovative management strategies to address livelihood issues. WWF's efforts have strategically shifted towards species conservation during 1980-1990s to eco-region and landscape level based conservation and sustainable development (Gurung et al. 2008). WWF's Terai Arc Landscape (TAL) program started in 2001 and is based on landscape approach with the main aim of conserving biodiversity, forests, soils and watersheds of the Terai and Siwaliks in order to secure the ecological, economic, and socio-cultural integrity of the region (Gurung et al. 2008). This clearly reflects the links between global conservation priorities and national alignment to it. The program itself is funded by UNDP and international development agencies like DFID, SNV and USAID. These scenarios were observed worldwide and Brosius (2004) has suggested elaborated on the importance of science and technology based conservation. The biggest problem of the protected areas was the ongoing conflict between parks and peoples' subsistence needs. These problems can be reduced by developing alternatives to parks' resources, providing compensation to communities for their exclusion from parks, and creating incentives for local peoples to modify their resource extraction practices from the park. The above evidences show that focus on conservation among international agencies has shifted from wild animal species to human communities, where local

participation has given more priority (Agrawal & Gibson 1999). The main strategy of international agencies is conservation of biodiversity and wildlife resources management of the park. However, these international agencies are mainly focusing on how to improve the local livelihood opportunities rather than wildlife conservation. At first, they need to fulfill the local people basic needs and later they can invest more funds to create even more effective buffer zone forestry of protected areas.

## CONCLUSIONS

The most of the tiger range countries suffer from over human population and the protected areas in these countries lie in the human dominated landscapes. The existing legislation strongly supports the tiger conservation in Nepal but its execution level needs more attention. Management strategies especially local people attitudes and compensations require more emphasis and local people who lives nearby tiger habitats should get higher benefits from conservation of tigers. Increase of tiger numbers in isolated pockets of protected areas creates higher degree of human-tiger conflict and therefore more attention should be given to resolve the tiger-human conflict. However, the ecological aspects are positive for its conservation. Finally, the earlier studies clearly indicate that there are possibilities of increase in tiger population and its habitat conservation. Still the Nepal Government has to go lot of miles for tiger conservation due to societal constraint around the tiger range protected areas.

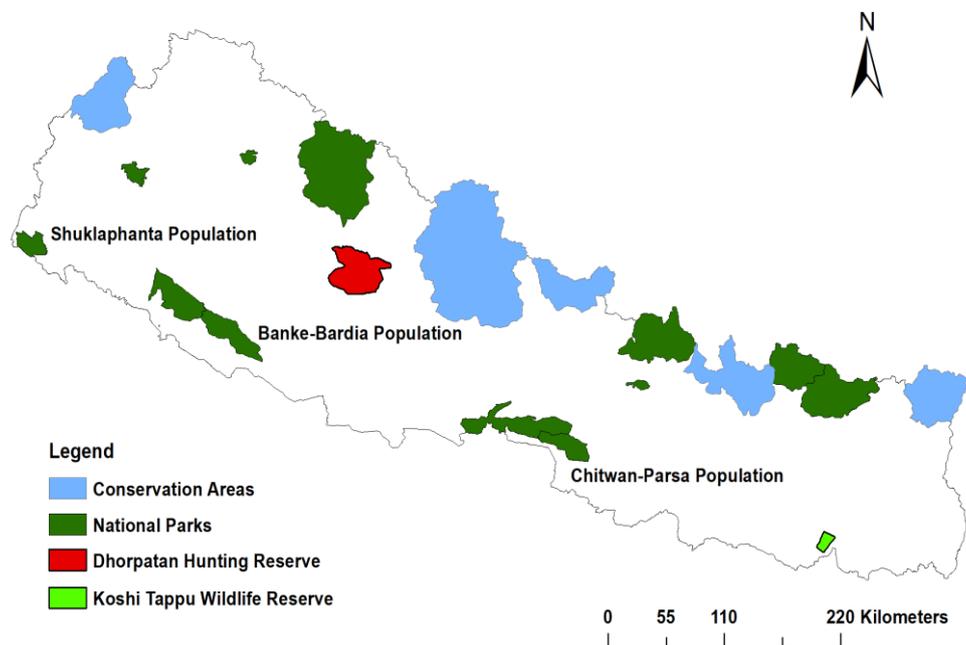
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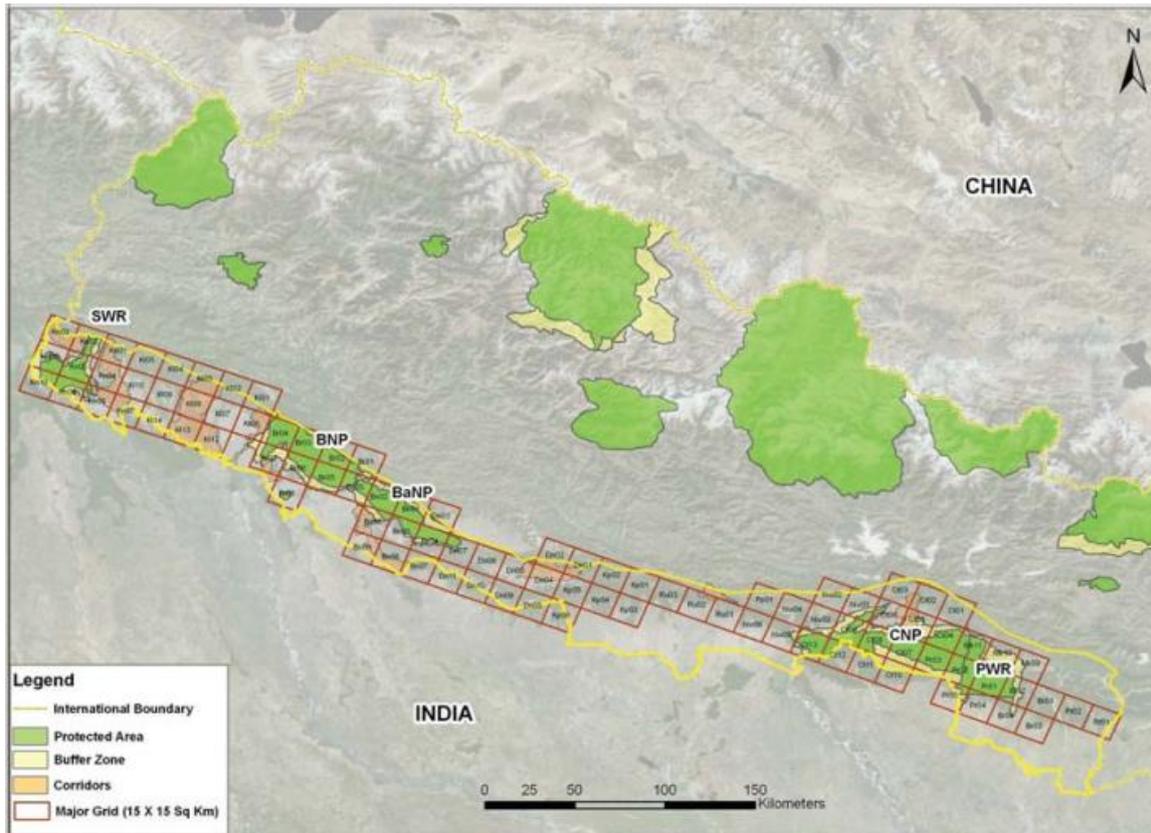
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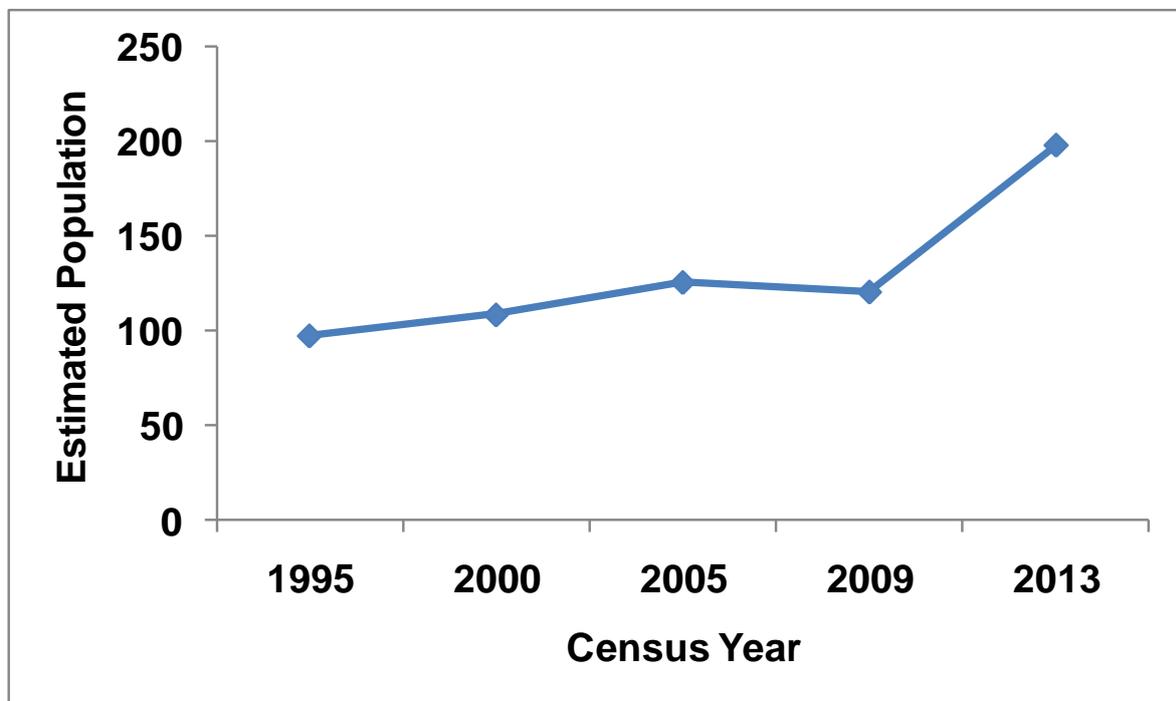


(Map source- [www.dnpwc.gov.np](http://www.dnpwc.gov.np))

**Figure 1:** Map of protected areas in Nepal showing three populations of Bengal tiger in lowland Terai region- Shuklaphanta National Park Population, Banke and Bardia National Parks population and Chitwan and Parsa National Parks Population



**Figure 2:** Tiger range areas within the Terai Arc Landscape (TAL) and tiger habitat occupancy survey design for the national tiger census of 2013 (Map Source: Dhakal et al. 2014)



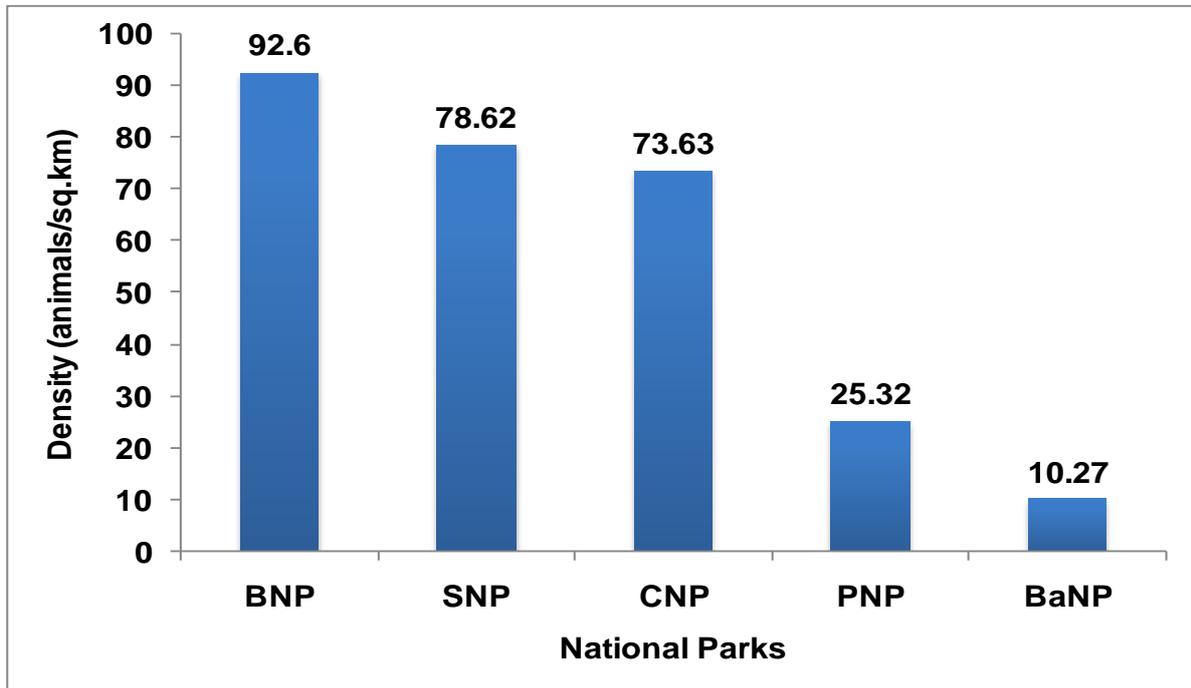
(Source: DNPWC/NTNC/WWF)

**Figure 3:** Status of Bengal tigers in the Nepal



(Source: DNPWC/NTNC/WWF)

**Figure 4:** Bengal tigers in the Chitwan National Park



(Source: Dhakal et al. 2014)

**Figure 5:** Densities of prey species in five national parks within Terai Arc Landscape (PNP- Parsa NP, CNP- Chitwan NP, BaNP- Banke NP, BNP- Bardia NP and SNP- Shukla Phanta NP)



(Source- [www.wcn.org.np](http://www.wcn.org.np))

**Figure 6:** Poaching of tigers for their skin and other body parts



(Source: Bufferzone office records)

**Figure 7:** Cattle killed by tiger in bufferzone areas of the Chitwan National Park