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Cover: ***Pipistrellus tenuis*** **recorded during the small mammalian fauna study, Manipur, India. © Uttam Saikia.**

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REVIEW

Conservation of Tiger *Panthera tigris* in Nepal: a review of current efforts and challenges

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Abstract: The Tiger *Panthera tigris* is one of the most charismatic and well known Asian big cats. In the lowlands of Nepal, Tigers along with the Greater One-Horned Rhinoceros *Rhinoceros unicornis* and the Asiatic Elephant *Elephas maximus* serve as flagship species gathering global conservation attention. Current surveys estimate a population of 235 tigers in Nepal. Tigers in Nepal are strictly protected in five protected areas located in the lowlands and their adjoining forest areas which cover 7,668.20 km^2. However, over the last century, tiger population and their distribution range drastically declined with the species heading towards extinction. The long-term survival of this charismatic species is challenging largely due to the loss and fragmentation of habitat, climate change, increasing human-wildlife interface and poaching for illegal trade of body parts. In response to this, the Government of Nepal along with conservation agencies and local communities have proceeded to execute various conservation initiatives both at national and international level. This paper tries to scrutinize the current status of tiger population, conservation efforts, and existing challenges to conserve tiger species in Nepal.

Keywords: Asian big cat, charismatic species, climate change, conservation efforts, flagship species, fragmentation of habitat, illegal trade, poaching, population.

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INTRODUCTION

The Tiger *Panthera tigris* is a keystone species, crucial in maintaining the integrity of the ecosystems in which it thrives. It is one of the biggest and most fearsome predators in the world (Dhakal et al. 2014; DNPWC 2018). Historically, Tigers existed as nine subspecies, three of which, i.e., the Javan Tiger *Panthera tigris sondaica*, the Caspian Tiger *P. t. virgat)*, and the Bali Tiger *P. t. balica,* are now considered extinct and a fourth, the South-China Tiger *P. t. amoyensis* is most likely extinct in the wild. Today the existing subspecies include the Bengal Tiger *P. t. tigris*, Indochinese Tiger *P. t. corbetti*, Sumatran Tiger *P. t. sumatrae*, Siberian Tiger *P. t. altaica*, and the Malayan Tiger *P. t. jacksoni* (Goodrich et al. 2015). However, a recent taxonomic revision by the IUCN Cat Specialist Group grouped the extant tigers into two sub species; *Panthera tigris tigris* distributed in mainland Asia, including India, Nepal, Bhutan, China, Russia, Indochina, and the Malay Peninsula and *Panthera tigris sondaica* found in Sumatra and formerly Java and Bali (Kitchener et al. 2017).

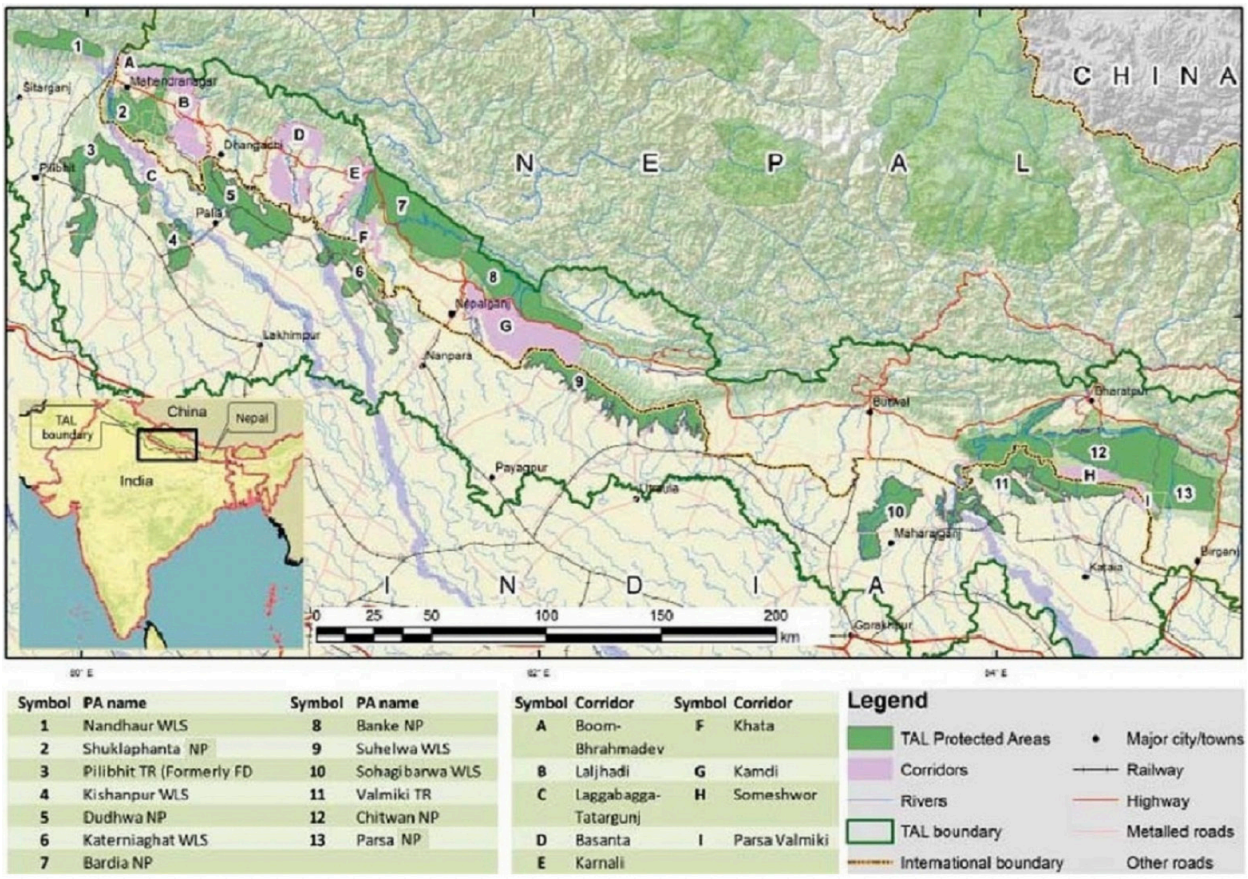
Tigers occupy a variety of different habitats which include the tropical rainforests of Sumatra, mangrove swamps of the Sunderbans of Bangladesh and western India, tropical forests and grasslands of Nepal and India, forests of Bhutan and the temperate regions of eastern Russia (GTIS 2010; DNPWC 2016, 2018) thus displaying ubiquity and adaptability across a wide range of habitats. That being said, tropical forests are considered to be the main habitat for tigers across their entire range. Just over a century ago, there were as many as 100,000 tigers living in the wild. At present, however, there are less than 5,000 wild tigers that remain (Table 1) and their range has reduced by 93% from 1990s to 2000s (Dinerstein et al. 2007; GTF 2016). Currently, suitable habitat for wild tigers covers about 1.2 million km^2 which has been categorized to include 76 tiger conservation landscapes (TCLs) across 13 tiger range countries (TRCs): Nepal, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Russia, Thailand, and Vietnam (GTIS 2010).

The Bengal Tiger is the most abundant sub-species native to the Indian subcontinent including India, Nepal Bangladesh, Bhutan, and western Myanmar. The population estimate of this sub-species currently holds at approximately 3,389 individuals (Table 1). In Nepal, tigers are distributed among five protected areas across the Terai and Churia habitats within the Terai Arc Landscape (Dhakal et al. 2014; DNPWC 2018). The tiger census conducted in 2018 estimates a population of 235 adult tigers in Nepal (DNPWC 2018). Wild Tiger populations continue to decline due to habitat loss and degradation, prey depletion, retaliatory killing of tigers and poaching for illegal trade (Ripple et al. 2014). Therefore, to conserve this species, in 2010, at the Tiger Summit in St. Petersburg, Russia, Nepal and 12 other countries with wild tiger populations committed to double their wild tiger numbers (TX2 goal) by 2022 (GTF 2016). Owing to this, various conservation initiatives were undertaken both at national and international level which resulted in an increase in tiger population especially in Indian subcontinent. Yet, the long-term survival of this endangered wildlife species remains a challenging task. It is crucial now more than ever, for Nepal to execute pertinent actions and strategies for the long-term conservation of this species. In this context, the current paper intends to present the current status and distribution of tiger population in Nepal. Moreover, this paper also strives to illustrate the conservation efforts and its related challenges to conserve this iconic species in a national context.

Tiger population status and tiger habitats in Nepal

Tigers in Nepal are distributed across the lowlands of Terai and Churia habitats within the Terai Arc Landscape (TAL). At present, the tiger distribution in Nepal is more or less restricted to five protected areas of the TAL and their adjoining forest areas (Figure 1) in three isolated sub-populations, viz.: i) Parsa-Chitwan Complex (Barandabhar corridor and protected forest; Parsa National Park (PNP) and Chitwan National Park (CNP)); ii) Banke-Bardia Complex (Kamdi corridor, Karnali corridor, Khata corridor and protected forest; Banke National Park (BaNP) and Bardia National Park (BNP)); and iii) Kailali-Kanchanpur Complex (Basanta corridor and Protected forest, Laljhadi-Mohana corridor and Protected forest, Brahmadev corridor and Shuklaphanta National Park (ShNP) (DNPWC 2018).

The tiger census of 1995/1996 estimated a total of 93 to 97 breeding adult tigers in Nepal (DNPWC 2008). In the 1999/2000 census the population was estimated around 98 to 123 breeding adults showing some growth from the previous count (DNPWC 2008). But in 2007, the population was estimated at around 105 to 123 individuals showing no signs of growth, and the cause was attributed to increased poaching (DNPWC 2008; NTRP 2010). It should be, however, noted that early tiger estimates were based largely on pugmark projection methods, which have been proven to be unreliable surveys (Karanth et al. 2003). But from 2009, tiger censuses have been based on standardized,



Symbol	PA name	Symbol	PA name
1	Nandhaur WLS	8	Banke NP
2	Shuklaphanta NP	9	Suhelwa WLS
3	Pilibhit TR (Formerly FD	10	Sohagibarwa WLS
4	Kishanpur WLS	11	Valmiki TR
5	Dudhwa NP	12	Chitwan NP
6	Katerniaghat WLS	13	Parsa NP
7	Bardia NP		

Symbol	Corridor	Symbol	Corridor
A	Boom-Bhrahmadev	F	Khata
B	Laljhadi	G	Kamdi
C	Laggabagga-Tatargunj	H	Someshwor
D	Basanta	I	Parsa Valmiki
E	Karnali		

Legend
TAL Protected Areas
Corridors
Rivers
TAL boundary
International boundary
Major city/towns
Railway
Highway
Metalled roads
Other roads

Figure 1. Map depicting tiger bearing protected areas and forest corridors in Nepal (adapted from DNPWC 2016).

science-based methods that use systematic camera trapping and transect surveys (DNPWC 2016). Thus the surveys conducted from 2009 onwards show an increase in tiger numbers in all protected areas, i.e., the population increased from 121 individuals in 2009 to 198 individuals in 2013 (Dhakal et al. 2014). The census of 2018 estimated that of the 235 individual tigers, 18 (16–24) tigers distributed in PNP and adjoining forests, 93 (89–102) tigers in CNP and adjoining forests, 21 (18–30) tigers in BaNP and adjoining forests, 87 (82–97) tigers in BNP and adjoining forests, and 16 (15–21) tigers in ShNP and adjoining forests (DNPWC 2018). The protected areas hosting tigers is presented in Table 2 along with their status. A national comparison indicates an approximate increase in the national tiger population by 19%, within the four-year period and a 94% increase within a period of nine years.

The largest population lives in Parsa-Chitwan Complex encompassing an area of 2,595 km^2 of prime lowland forest. Out of total habitat area, Parsa-Chitwan Complex encompasses 36.60% and Banke-Bardia complex and Suklaphanta Complex covers 41.60 % and 21.80 %, respectively (Table 2). Earlier information on tiger distribution in Nepal has not been reported at elevations higher than the Siwalik Hills (about 1,500 m). But recently, on 13 April 2020, a tiger was spotted at an elevation of 2,500 m in the Mahabharat range of Dadeldhura (DFO 2020). This is the first ever recorded sighting of a tiger at such altitudes. It was sighted by a camera trap which was set up by the Division Forest Office to track the presence of wildlife movement in the area. Reports such as this opens up new avenues for research in Nepal. Furthermore, a tiger was recently captured at an elevation of 3,165 m by a camera trap in the mountain forests of Ilam district in eastern Nepal, the highest proven sighting of a big cat ever in Nepal (DNPWC 2020). This finding provides the encouragement for conservation officials to continue their determined efforts to save the iconic animal which is endangered globally.

Conservation efforts

Nepal's effort to strengthen tiger conservation efforts dates back to 1970s when a tiger ecology project was launched in Chitwan in 1972 (McDougal 1977; Smith 1993). Following the endorsement of National Park and

Table 1. Current status of Tiger in tiger range countries.

	Country	Year 2010	Year 2015	Year 2018
1	Nepal	155	198	235
2	India	1411	2246	2967
3	Bangladesh	440	106	121
4	Bhutan	75	103	103
5	Myanmar	85	85	NA
6	China	45	45	34
7	Lao PDR	17	17	2
8	Thailand	200	200	189
9	Vietnam	10	10	<5
10	Cambodia	20	20	0
11	Indonesia	325	325	371
12	Malaysia	500	500	250
13	Russia	360	360	433
	Total Population	**3643**	**4215**	**4710**

NA—Not available. Source: GTF 2016; Wang et al. 2016; Aziz at al. 2017; DNPWC 2018; Jhala et al. 2019.

Wildlife Conservation Act (NPWCA) and establishment of Chitwan National Park in 1973 as the first national park of Nepal was a milestone in the history of wildlife conservation in Nepal which was well backed up by establishing Department of National Parks and Wildlife Conservation in 1980 (DNPWC 2018). After that, four more national parks, i.e. BNP, ShNP, PNP, and BaNP were set up to protect tigers and their habitats (DNPWC 2016, 2018). Since then, placing strong anti-poaching measures in the protected areas, managing habitats and providing compensation for human loss has led to the recovery of wild tiger populations.

To address the growing issue of conflict between national parks and people, the Government of Nepal in 1996 introduced a conciliatory approach called as the Buffer Zone Management System (MoFSC 1996; Ghimire 2019). They aimed to establish buffer zones around the country's national parks and wildlife reserves with the objective of making local communities self-reliant on forest products through community forestry, while also creating other livelihood opportunities for them (MoFSC 1996; Dhakal et al. 2014; Bhattarai et al. 2019). In addition, a legal provision was made to plow back a major slice of the revenue earned as a consequence of buffer zone development activities (MoFSC 1996). Over the time, the approach employed for wildlife conservation changed from protective to participatory and from species to landscape conservation (Ghimire 2019). In response to this, the Terai Arc Landscape (TAL) programme was initiated in 2001 specially to protect megafauna like tigers, rhinos and elephants. This programme is recognized by the Governments of both Nepal and India. The TAL covers an area of 51,002 km^2 which extends from Nepal's Bagmati River in the east to India's Yamuna River in the west. This landscape is identified as prime habitat of tiger population in Nepal (MoFSC 2015).

Nepal also set up strong legal provisions to control wildlife crimes particularly for protected mammals like tigers, rhinos, elephants, and snow leopards. In Nepal, tigers are strictly protected under the National Parks and Wildlife Conservation Act. For offenders and accomplices convicted of poaching and illegal trade of tiger and its body parts the Wildlife Conservation Act provisions a fine ranging from NPR 500,000 to NPR 1,500,000, or 5 to 15 years of imprisonment, or both (GoN 1973). Nepal, is one of the 13 countries, that committed to the St. Petersburg Declaration of 2010 to double the tiger population by 2022 (GTIS 2010). To support this commitment the Government of Nepal also implemented a National Tiger Recovery Program 2010 under the framework of the Global Tiger Recovery Program (2010–2022) (Dhakal et al. 2014; DNPWC 2018). In addition, frameworks such as Nepal Biodiversity Strategy and Action Plan (2014–2020), Terai Arc Landscape (TAL) Strategy and Action Plan (2015–2025), Tiger Conservation Action Plan for Nepal (2016–2020), Forest Policy 2019 and Forest Act 2019 were developed and implemented to serve as a benchmark for tackling the priority threats to the nation's mega fauna like the tiger (DNPWC 2016; MoFE 2019). Furthermore, seven additional forest habitat corridors (Table 3) covering area 2,157 km^2 were declared between the years 2010 and 2020 to facilitate movement and dispersal of wildlife, especially tigers, rhinoceros, and elephants (MoFSC 2015; Wegge et al. 2018). The Government of Nepal has also been taking proactive actions in and around protected areas including buffer zones to engage with communities and organize community based initiatives. Altogether 331 community-based anti-poaching units (CBAPUs) have been established since 2015 in different parts of the country (DNPWC 2018). With all these efforts, Nepal is set to become the first country to double its tiger population by 2022 with an impressive population of 235 individuals. The Government of Nepal is at the forefront in improving habitats, managing critical transboundary linkages, adopting latest science and technology in research, combating wildlife crime and supporting the local communities to cope with tiger conflict.

Table 2. The tiger bearing protected areas and tiger population.

Protected areas	Core area (Km²)	Buffer zone area (Km²)	Tiger population status		
			2009	2013	2018
PNP	627.39	285.30	4	7	18
CNP	952.63	729.37	91	120	93
BaNP	550	343	-	4	21
BNP	968	507	18	50	87
ShNP	305	243.5	8	17	16
Total			**121**	**198**	**235**

Table 3. Forest habitat corridors in Nepal.

	Name of Forest Corridors	Area covered		
		Forest corridor (Km²)	Impact zone (Km²)	Total (Km²)
1.	Barandabhar Corridor and Protected Forest	148	113	261
2.	Kamdi Corridor	291	159	450
3.	Karnali Corridor	149	78	227
4.	Khata Corridor and Protected Forest	74	128	202
5.	Basanta Corridor and Protected Forest	181	471	652
6.	Laljhadi-Mohana Corridor and Protected Forest	202	153	355
7.	Brahmadev Corridor	138	10	148
	Total	**1045**	**1112**	**2157**

Source: MoFSC 2015.

Conservation challenges and threats

Despite conservation measures, tigers are highly threatened and still face the threat of extinction. Of the two sub-species only *Panthera tigris tigris* is reported to exist today and is 'Endangered' while *Panthera tigris sondaica* is considered extinct (Dhakal at al. 2014; Goodrich et al. 2015; Kitchener et al. 2017). Global tiger populations are under threat from habitat degradation, prey depletion, and poaching. Some of the major impediments to effectively conserve tigers in Nepal can be summarize as below:

- Habitat degradation and fragmentation
- Depletion of prey species
- Poaching and illegal trade of tiger body parts
- Human-tiger conflict
- Spread of invasive/alien species like *Mikania micrantha*, *Lantana camara*, *Chromolaena odorata* in tiger prey habitat particularly in PNP, CNP, and BNP.
- Climate change impacts

Rapidly growing human population coupled with unsustainable agricultural practices not only degrade prime tiger habitat but also relegated the alarmingly dwindled tiger population to the confines of the wildlife habitats and adjoining forests. Settlements and linear infrastructure projects such as roads, railroads, transmission lines, irrigation canals, etc. are roughly planned inside protected areas or corridors which are responsible for fragmentation and degradation of tiger habitat in the country. The East-West highway passes through all five tiger bearing PAs of Nepal, which has resulted in the road kill of wildlife including tigers (DNPWC 2018; Bhattarai & Kindlmann 2018; Bhandari et al. 2019). Consequently, degradation and loss of tiger habitat resulted in low prey availability in both inside and outside PAs due to increased competition for food. On the other hand, continued illegal hunting outside PAs also contributes towards the depletion of natural prey-base. Moreover, collection of fodder, firewood, grasses from the forests, grazing, forest fire, and alien invasive species are major driving factors that lead to the degradation of tiger habitat. Similarly, floods, river cutting and pollution are other factors (Bhattarai & Kindlmann, 2018). Moreover, with the increase in number the problem of carrying capacity assessment is another growing issue for tiger conservation in Nepal (Bhandari et al. 2019).

Poaching and illegal trade of tigers and their body parts are a major threat to tiger populations globally. As Nepal is one of the countries that hosts a large wild tiger populations, it considered both a source and a transit point for illegal trade (Acharya 2003; DNPWC 2018). Despite the country's commitment to curb wildlife crime together with the success it achieved over the years in minimizing poaching and illegal trade, it still faces the problem of opportunistic poaching. In the past decade, skin from 49 tigers and 204 kg of tiger bones was seized, while 2,258 people were arrested in connection with their involvement in wildlife-related crime in the country (DNPWC 2018). Therefore, poaching and trade continues to be recognized as a major threat,

and combatting wildlife crime remains a priority. Furthermore, human-wildlife interface (like livestock depredation and human attack) has become one of the major threats to wildlife conservation. Conserving mega fauna like tigers in a human dominated landscape has become a challenging job. Today, *human-tiger incidents* have played a significant role in declining tiger populations globally (Gurung et al. 2008; Bhattarai et al. 2019). The trend of human casualties has increased from an average of 1 to 7 persons per year from 1998 to 2006 (Gurung et al. 2008). Despite legal provision of a hefty fine or a sentence of up to 15 years in jail, or both, for killing a tiger and a compensation scheme for crop or livestock depredation, affected locals are sometimes known to resort to retaliatory killings. Habitat shrinkage, increasing human interface along the park boundaries, and increasing dependence on park/ reserves for forest resources are some of the major underlying causes of human-tiger interface.

Likewise, invasive-alien plant species such as *Mikania micrantha, Chromolaena odorata*, and *Lantana camera* in Parsa and Chitwan and *Lantana camara* in Bardia have heavily encroached most of potential tiger habitats and community forests in the buffer zones (DNPWC 2008; 2016). Water hyacinth *(Eichornia crassipes)* is prevalent in all lowland lakes, consequently this encourages siltation and dries up wetlands. Climate change is emerging as one of the prominent threats to biodiversity globally. Although information regarding the direct impact of climate change on wildlife species in the country is limited. However, climate change induced hazards including torrential precipitation, flash floods, prolonged droughts and frequent forest fires are observed to be major issues for tigers and their prey species (Thapa & Killy 2016; DNPWC 2018).

In spite of Nepal's favourable position on the road to achieving the TX2 goal and even with the upward growth rate of the global tiger population (after decades of constant decline), policy makers and experts at the third stock-talking conference held in Delhi in January 2019 (MoEFCC 2019) have pointed out that the goal of doubling the global tiger population by 2022 may be unrealistic. In 2010, global tiger population was pegged at 3,220 and at the halfway point in the timeline, i.e., 2016, it only reached 3890, below than the expected rate of increase (MoEFCC 2019). Therefore, the need for a differential approach to reach the TX2 goal was emphasized. Tiger and prey recovery is considered to be the main issue (globally) whereas in southern Asia, managing habitats outside the critical core tiger habitat through landscape approach, i.e., safeguarding tiger corridors and community engagement to enhance livelihood opportunities for people is emerging as an area of focus. On that account, an essential challenge now lies in setting appropriate priorities to respond to the issue at hand.

CONCLUSION

Nepal has been a leader in efforts to conserve tigers within its own territory and has won widespread praise from the international arena as well. The result shows the country is close to doubling its tiger population and achieving the global commitment made in the 2010 St. Petersburg Summit in Russia. The success in tiger conservation is the result of the concerted efforts of government agencies, conservation organisations, donors and community-based organisations. The conservation policies and strategies area well implemented. This is evident when we work together, we can save the planet's wildlife, even species facing extinction. Yet, conservation in an ever changing world that demands long term persistent efforts. Despite successes, threats to tigers from poaching, human-tiger interface, climate change, habitat degradation and depletion of prey base due to unplanned developmental activities persist even today. Thus, learning from past failures, and reflecting on current success actions and strategies need to be adapted for the long-term survival of this valuable species. More than that, there is a need for massive public awareness about wildlife protection and involvement of local community in conservation strategies.

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