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Quantifying Wire Snares as a Threat to Leopards in Karnataka, India

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Abstract

Though large felids are flagship species for wildlife conservation they are threatened due to various anthropogenic impacts. Mapping spatial patterns and quantification of threats to large felines can help conservation planning and resource allocation. The Leopard *Panthera pardus*, is categorized as Vulnerable by the IUCN as it faces a variety of threats. However, quantified data on the threats faced by leopards is scant. Hunting of wildlife using wire snares is one of the severest threats in India and elsewhere. Snaring, one of the simplest and most effective hunting techniques impacts other non-target species like the leopard. In this study, we document the spatial and temporal trends of snaring of leopards from India. Through content analysis of newspapers and news portals for the period January 2009-December 2020, we documented 113 incidents of leopards caught in snares of which 59.3% (5.5 leopards/year) resulted in mortality of leopards. Most snares (97.5%) were set to catch wild prey. Of the 84 incidents for which exact location details were available, the proportion of leopards caught in snares (54.7%, n = 46) and resulted in mortality (50%) in human-dense areas was significantly higher depicting an elevated threat from snares in these landscapes. Results from Generalised Additive Model indicated that snaring incidences increased with human population density. Percentage of protected area to the geographical area within a district had little impact on the number of snaring incidents. The study results could help threat monitoring and conservation programs for leopards, especially outside the protected area system.

Keywords

content analysis, edge effect, human-dense areas, large carnivores, law enforcement, *Panthera pardus*

Introduction

Globally, large felines are some of the most revered and iconic species. They, directly and indirectly, play a critical role in regulating ecosystems and provide a variety of economic and ecosystem services (Ripple et al., 2014). Large felines are also one of the most threatened groups of wildlife species. Their distribution and populations are in continuous decline due to multiple anthropogenic impacts. Lions (*Panthera leo*) now inhabit 8% of their former ranges (Bauer et al., 2016), the population of wild tigers (*Panthera tigris*) has plummeted to about 3,000-4,000 individuals (Duangchantrasiri et al., 2016), while leopards (*Panthera pardus*) now occupy 25–37% of their historic range (Jacobson et al., 2016). They are threatened due to habitat loss, hunting for body parts, depletion of wild prey, persecution, and other causes (Ripple et al., 2014). Hence empirical studies that provide better information and data on the threats faced by large cats can help in their conservation.

Leopards are widely distributed across Asia and Africa. Despite the species being widespread, there are no range-wide estimates of its population size. However, India is estimated to have 12,852 leopards (Jhala et al., 2020). It was recently revised on the IUCN Red List to Vulnerable, highlighting an increasing concern over its conservation status (Stein et al., 2020). In India, leopards are listed under Schedule-I of the Wildlife Protection Act giving them the highest priority for conservation (WLP 1972). Some of the threats posed to leopards include

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poaching for body parts, mortality due to vehicular collisions, habitat loss, retaliatory killing, and others (Gubbi et al., 2014, 2019, 2020; Jacobson et al., 2016; Raza et al., 2012). Some threats risked by leopards have been quantified at regional scales (Balme et al., 2010; Gubbi et al., 2014, 2019, 2020; Raza et al., 2012), and any additional information would help in the preservation of leopards.

Snaring is a widespread method used to hunt a variety of wildlife especially in Africa and Asia (Aziz et al., 2017; Becker et al., 2013; Gray et al., 2018; Harrison et al., 2016; Lindsey et al., 2011; Linkie et al., 2003; Masolele, 2018). In the Save ´ Valley Conservancy, Zimbabwe Lindsey et al., (2011) documented that 63.4% of illegal hunting incidents (n = 90,670) involved snares. In Southern Cardamom National Park, Cambodia 109,217 snares were removed during 2010–2015 (Gray et al., 2017) highlighting the severity of the threat.

Snares are typically made out of automobile clutch cables, binding wire, telephone cables, and are set in paths frequently used by wildlife including farm edges. They are inexpensive, easy to obtain, set, conceal, and effective. Though they are mostly set to hunt wild herbivores, both targeted and untargeted species are caught resulting in mortality, serious injuries, permanent disabilities and stress in wildlife. Some of the by-catch species can be critically endangered, endangered or rare wildlife species (Aziz et al., 2017; Becker et al., 2013; Campbell et al., 2019; Linkie et al., 2003). Snaring also poses a serious animal welfare problem as some animals escape with serious injuries (Lindsey et al., 2011), jeopardizing the long-term survival of individual animals.

In India it is illegal to kill wildlife using snares, yet snares remain a popular method for catching wildlife. Very few studies empirically assess the effect snares have on wildlife populations in India (Gubbi & Linkie 2012; Kaul et al., 2004; Madhusudan & Karanth 2002).

The impact of snares on leopards is not assessed, though from media reports it seems to be frequent and widespread (Figure 1). In this study, we report incidents of leopards caught in wire snares and attempt to assess the threat of snares to leopards. We spatially map the threat, examine the reasons for setting the snares, understand the distribution of the threat in different leopard habitats, and the annual trend of the threat to leopards. This we hope will feed into conservation planning and management of leopards particularly outside protected areas (PAs).

Study Area

Our study area comprises the state of Karnataka (191,791 km^2), southern India, with its 30 administrative districts and 176 subdistricts or taluks. The land cover in the state comprises of forests, agroforestry plantations, orchards, rocky outcrops, grasslands, urban areas, water bodies and agricultural land (Roy et al., 2015). The state supports populations of large carnivores including tiger (*Panthera tigris*), dhole (*Cuon alpinus*), striped hyaena (*Hyaena hyaena*), the grey wolf (*Canis lupus pallipes*) and others (Jhala et al., 2020). It is estimated that Karnataka state hosts about 2,500 leopards possibly forming 15% of the country's leopard population. The state has a human density of 319 people/km^2 (NITI Aayog, 2020) and is one of the states with medium human densities in the country. It also faces high levels of human-leopard conflict (Gubbi et al., 2020).

Figure 1. A Dead Leopard in a Wire Snare. Picture copyright: Prasanna Kumar.

Methods

We carried out content analysis of newspapers and news portals for the period January 2009-December 2020 (144 months) for print and online editions of 21 publications (Table 1, Supplemental Material). The news reports were scraped using Google Alerts using keywords such as leopards, snares, captures, translocation, human-leopard conflict, Karnataka, and India in both English and Kannada. In India, media has a strong presence even in rural areas, and news about large mammal conflict attracts fairly high media attention. This makes it a reliable tool to collate data where conventional methods such as questionnaire surveys are not feasible for such a large geographical scale. In addition, patrol data, or wildlife mortality information using platforms such as SMART is rarely used or maintained in India, making such data unavailable. Such content analysis is already used in studies including human-wildlife conflict, the threat of domestic dogs on wildlife, wildlife trade, threats to leopards, and others (Corbett 1992; Gore et al., 2005; Gubbi et al., 2014, 2020; Hansen et al., 2012; Home et al., 2018).

Analysis

We used the non-parametric Theil-Sen estimates of intercept and slope parameters to identify the trend of snaring incidences. We used the Mann-Kendall test for the monotonicity of the slope parameter across the time, which holds even when the model is non-linear. The Pearson's chi-squared test was used to determine if there was a statistically significant difference between the frequencies of leopards caught in snares, and their mortality in different habitats (human-dense areas, unprotected forests, protected forests and PAs).

To understand if there was any seasonal patterns with snaring we first divided the seasons as Summer (February-May), Monsoon (June-October) and Winter (November-January). As a second step we used the Auto-Correlation Function (ACF) plot for the time series data.

Finally, a Generalised Additive Model (GAM, error family = Poisson) was fitted to study the influence of human density (hd), area of protected forests (pf), and the percentage of protected area (pa) within each district with the number of snare incidences (y) as the response variable. Bangalore Urban district was excluded from the analysis as it was an outlier with population density about 14 times higher than the national average (Table 2, Supplemental Material). All analyses were carried out using R software, ver 3.3.0 (R Core Team, 2020).

Table 1. Results of the Generalised Additive Model (GAM) With Selected Variables to the Number of Snaring Incidents.

s[a]	Edf[b]	Ref.df[c]	Chi.sq[d]	p[e]
s(human density)	7.987	8.599	50.722	<0.001
s(protected forests)	1	1	2.349	0.125
s(% protected area)	3.455	3.856	50.11	<0.001

[a]The smoothened spline for the corresponding covariate fitted by the GAM.
[b]Effective degrees of freedom.
[c]Reference degrees of freedom.
[d]Chi square relating to the GAM fit.
[e]p value relating to the GAM fit.

Results

During the period January 2009-December 2020, we recorded a total of 113 unique incidents of leopards caught in snares (Figure 2). The total of annual reports more than doubled over the 12 years with a peak of 13 reports in 2015 (Figure 2). Indeed, there was a clear non-linear trend in reported snare captures over the 12 years (Figure 2).

Each year, during the period surveyed, a mean of 9.4 leopards (min = 4, max = 13, Figure 2), were reported as

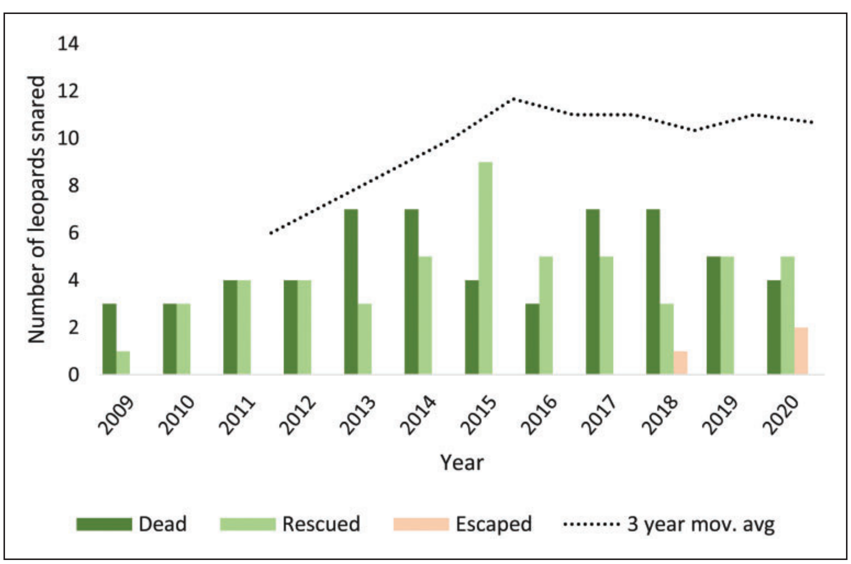

Figure 2. Average of Leopards Caught in Snares Annually in Karnataka, Southern India During January 2009–December 2020 as Reported in the Media.

snared. The Theil-Sen estimate provided the trend parameters [Intercept = 6.00, Mean Absolute Deviation (MAD) = 1.63 $p = 0.002$, slope = 0.78 (MAD = 0.40, $p = 0.002$)]. The Mann-Kendall test confirmed an increasing trend (Tau = 0.509, $p = 0.03$) even if the linearity assumption on trend does not hold.

Of these 113 incidents, 52.2% (n = 59) resulted in mortality of the animal at the location of snaring (Figure 3). Nearly half of the snared leopards (45.1%, n = 51) were rescued and taken to rehabilitation centres, and three articles (2.7%) reported that leopards were seen caught in snares, but they escaped before the authorities could free them. However, six of the 51 leopards that were taken to the rehabilitation centres died as a consequence of snaring, and two leopards that were rescued and released into the wild were found dead taking the total mortality to 67 (59.3%, 5.5 leopards/year).

Information about the sex of the animal was available for 65 incidents, where 41 males and 24 females were reported to be caught in the snares.

The reason for setting the snare was available for 78 of the incidents. Snares set to kill wild pig (*Sus scrofa*) was attributed in 66.7% (n = 52) of the incidents. Killing of other wildlife was attributed in 30.8% (n = 24) of the incidents, and only in two incidents (2.5%), the snare was attributed to protecting livestock against large cats.

Of 113 snaring incidents, 56 occurred during Monsoon, 35 during Winter and the rest (22) during summer. The ACF plot revealed a significant peak at lag 3 confirming the presence of a seasonal pattern, Summer (−1.34), Monsoon (1.54) and Winter (−0.20).

Of the 30 administrative districts in the states, seven districts accounted for the majority of incidents (77.6%). The highest snaring incidents were reported from Dakshina Kannada district (15%), followed by Mysore (14.2%), Chikmagalur and Udupi (11.5%), Hassan (10.6%), Tumkur and Ramanagara (7.1%, Table 2 in Supplemental Material).

The majority of snare incidences for which location information were available (n = 84) occurred in areas densely populated by people (e.g. plantations, farmlands, 54.7%, n = 46), followed by unprotected forests (21.4%, n = 18), protected forests (reserved/state forests, 14.3%, n = 12), and within PAs (national parks/wildlife sanctuaries/tiger reserves/conservation reserves), 9.5%, n = 8). The chi-squared test on frequencies of leopards caught in snares at different locations ($\chi^2 = 42.095$, df = 3, $p = < 0.001$), and the subsequent pairwise comparisons, reveal that the proportion of leopards caught in snares in human-dense areas is significantly higher than those in other areas.

Similarly, the exact location of mortality of leopards due to snares was available for 44 of the 59 deaths. Of this 50% (n = 22) of the mortality was in human-dense areas, 20.4% (n = 9) in unprotected forests, 15.9% (n = 7) in protected forests and 13.6% (n = 6) in PAs. The observed mortality rate in human-dense areas compared to other areas, and the subsequent pairwise comparison shows significantly higher mortality ($\chi^2 = 15.091$, df = 3, $p = 0.002$).

Most snaring incidents (59.3%) occurred within one km (mean 0.41 km, SD± 0.58) from the edge of leopards' natural habitats (forests, rocky outcrops), few (13.3%) incidents occurred within 1 to 3 km from the edge of natural habitats, and other (27.4%) incidents occurred inside natural habitats.

The GAM results demonstrated a good fit (adjusted $R^2 = 0.927$) and percentage of deviance explained 89.9% of the variations. The intercept did not contribute to the study variable (estimate = 0.118, standard error = 0.259, *p-value* = 0.646). Results are provided in Table 1, and in Figure 1 in the Supplemental Material. The model shows that number of snare incidences generally increased with increasing human density (>225 people/km^2).

Variables

human density – human population density within the district

protected forests – protected forests (reserved/state forests) in the district

% protected area – % of protected area (national park/wildlife sanctuary/tiger reserve/conservation reserve) to geographical area of the district.

Discussion

Conservation of large felids, particularly in human-dense areas is challenging, and exacerbated by poor knowledge of the impact of threats. By using media articles to document snaring incidents, this study provides vital information about the threat leopards face from snares in Karnataka. In addition, our research demonstrates how media data which are cheap and easy to access, can be used effectively to improve conservation knowledge. The method could easily be applied to improve understanding of threats faced by other large carnivores in the landscape such as sloth bears (*Melursus ursinus*) and striped hyenas, for which little data currently exist.

To our knowledge, this is the first compilation from India of information on leopards caught in snares. Findings of this study indicate high rates of mortality of leopards due to snares (n = 67, 5.5 leopards/year) over 144 months. In comparison, there were a total of 23 leopard mortalities (4.6 leopards/year) as a result of vehicular collisions in Karnataka over five years (Gubbi et al., 2014). Gubbi et al. (2019, 2020) recorded 29 leopards killed due to retaliatory actions (3.6

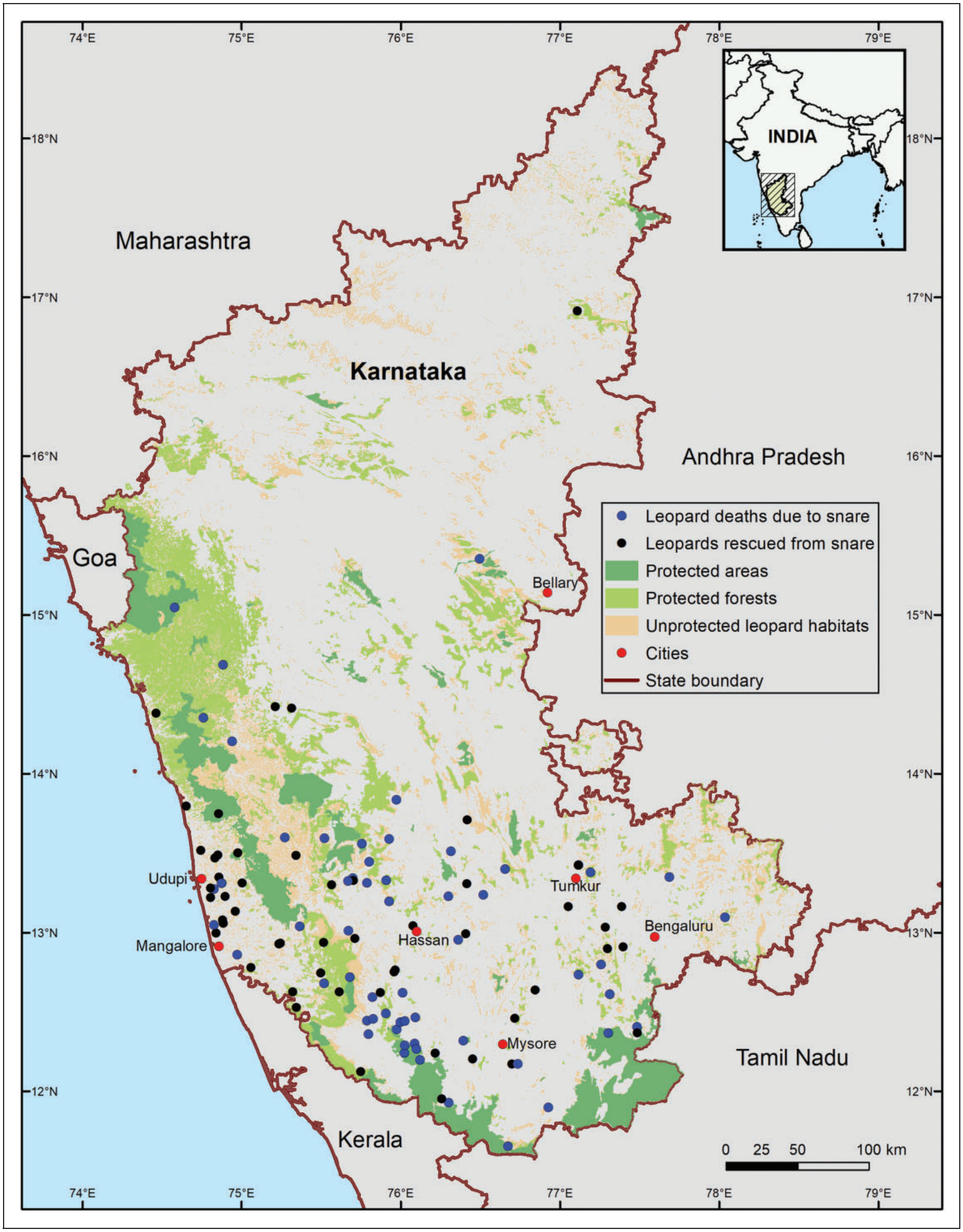

Figure 3. Locations of Leopards Caught in Snares as Per News Reports Between January 2009-December 2020 (n = 113) in Karnataka.

leopards/year), and eight leopard deaths as a result of leopards falling into open wells during 10 years (0.8 leopards/year), in the same landscape. Though mortality of ~6 leopards/year due to snares in Karnataka may look reasonably small compared to the overall population of 1,783 (Jhala et al., 2020), combined with other unnatural causes of adult mortality, deaths due to snares could be a serious cause for concern. Within India, a large proportion of crop losses are attributed to wild pigs, and wire snares set around farms is a primary means used by farmers to protect crops. As evidenced in this study, snares set to catch wild pigs were responsible for the mortality of 21 leopards making them incidental casualties.

Results from GAM indicate a highly significant influence of human population density on the number of snaring incidences. Though leopards could persist in highly human-dense areas they face a significant risk of unnatural mortality hence making natural habitats a more safer abode. Similarly PA area coverage had little impact on bringing down the number of snaring incidences. Hence, the data supports the need for more investment in long term conservation actions including increased patrolling against snares and integrated conservation activities with the local communities.

Some of the southern districts reporting higher snaring incidents (Ramanagara, Tumkur, Mysore, Udupi, Dakshina Kannada) also report other kinds of threats to leopards such as mortality due to falling in open wells and human-leopard conflict at higher levels (Gubbi et al., 2019, 2020). This is possibly due to high leopard and human population densities, hence a greater interface between leopards and humans in these areas.

Snaring incidents were high during monsoons which is the peak cropping season when farmers tend to put extra efforts to protect their crops including setting snares to stop crop-raiding herbivores. This may be the cause of higher number of leopards getting caught in snares during monsoons.

High rates of snaring incidents (59.3%) occurring within one kilometre of leopards' natural habitats suggests that the threat was high at the interface of natural habitat and human-dense areas. This could point towards snaring as one of the edge effects for leopards. Our findings corroborate with Balme et al. (2010) who highlighted high anthropogenic-induced mortalities as one of the edge effects on leopards in the Phinda-Mkhuze Complex, South Africa.

Accounting of detection probability for snares is extremely difficult. Even within a controlled experiment carried out in Keo Seima Wildlife Reserve in eastern Cambodia, the overall detection probability was estimated to be 0.2 (O'Kelly et al., 2018). Such detection probabilities would have been much lower in real-life enforcement monitoring situations. Hence the threat of snares to leopards could be at a much higher scale than documented in this study (See Biases and Caveats in the Supplemental Material).

Implications for Conservation

India is a stronghold for the subspecies *Panthera pardus fusca* as >75% of the habitat lies within India (Jacobson et al., 2016). Though leopards may be found at high densities in human dense areas (Athreya et al., 2013) it comes with serious challenges to the species such as snaring as seen in this study. With 50% of the deaths due to snares reported in human-dense areas, it calls for urgent attention and conservation action.

Our data could also point towards the direction that though PAs are relatively safe for leopards, the current coverage of PAs is insufficient for the conservation of leopard populations in India. Suitable measures to reduce negative interactions such as mitigation of crop loss from wild pigs, active removal of snares, conservation outreach about the ill-effects of snares even outside PAs are critical for improving the conservation prospects of leopards in a meta-population framework. These conservation measures should be implemented specifically during monsoon and post-monsoon seasons as snaring seem to be the highest during these seasons.

Conservation initiatives that attempt to mitigate threats to leopards could also have unintended, but positive impacts on sloth bears and striped hyaenas as they have overlapping distributions and also face threats from wire snares.

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Supplemental material

Supplemental material for this article is available online.

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