

Co-existence of large carnivores and *Dhangar* community in Maharashtra's Western Ghats: is it close to the tipping point?

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Abstract:

Gavli Dhangar are semi-nomadic pastorals scattered in small hamlets along the western ghats and Konkan area who mainly keep cattle and buffalo. The Sahyadri Tiger Reserve was established in 2010 relocating some of the hamlets while others continued to occupy their traditional habitats overlapping with three species of large mammalian carnivores. While leopard presence continued over a long time, dhole expanded their range considerably after 2019. In addition to the transient presence of some tigers, three females were relocated here in 2025-26. We studied the patterns in livestock depredation by these carnivores over six years and their effect on Dhangar livelihood. Data from 25 hamlets constituting 122 households was collected by oral histories, livestock count and compensation claims. The community harbors a small-number-high-quality pastoralism desirable for the habitat. The average household held only 4.6 cattle and 5.88 buffaloes. However, the frequency of carnivore attacks increased considerably over the last few years. Since the predation rate approaches the natural female replacement rate, the situation might be already at or close to a tipping point where the livestock cannot be sustained. The increasing carnivore attacks have threatened co-existence making the outcomes unpredictable.

Introduction:

The wildlife protection and conservation policy in India depended largely on relocating and excluding human habitations from protected areas. However, conservation by exclusion has reached its limits in India and the future of conservation depends upon the developing models of long-term sustainable co-existence of wildlife and human livelihood. Conservation management therefore needs to balance the interests of both. However, conservation philosophy has so far been mainly focussed on the wild animal component. Little, if any, thinking has gone into the micro-economics and ecology of people living in the vicinity of wilderness areas. In presence of large mammalian herbivores, damage to crops is inevitable (Dandekar et al 2025) and with the presence of large carnivore, attacks on livestock appears inevitable (Alquinta et al 2025). Prior studies on carnivore attacks on livestock have addressed the issues of economic loss, carnivore species involved, spatial patterns of predation, hotspots and correlation with their habitat characteristics, the efficacy of compensation protocols and people's perception (Tripathi *et al* 2026; Chetri *et al*, 2019; Lucas *et al*, 2025; Tharmalingam *et al*, 2020; Mishra, 1997; Miller *et al*, 2016; Mondal, 2022; Maheshwari *et al*, 2020; Sommers *et al*, 2010; Kala & Kothari, 2013; Raza *et al*, 2024; Rashid & Bhat, 2025; Dawood & Bhat, 2024

& Mishra, 2026)). Most studies use interviews and forest department records as the data source.

We address here a somewhat neglected aspect of human wildlife co-existence in the light of livestock depredation. It is possible that the dynamics of co-existence has one or more tipping points where either wild species or human communities can rapidly collapse.

Over the last few decades most species of wild mammalian herbivores and carnivores have grown their populations and expanded their ranges. In some areas, expansion of human occupation and livestock numbers have simultaneously increased (Mishra 1997). On the other hand, some human habitations have been relocated. More common but little documented is the trend of people giving up traditional livelihoods and migrating away from the proximity of protected areas seasonally or permanently. The population trend in India, except a few states has reversed over a couple of decades, going well below the replacement rate (Mishra 2026). This with continued migration towards cities has been relieving human population pressure around many wilderness areas. This is an opportunity to examine whether human population pressure has been the major cause of human wildlife conflict. Simultaneously in the co-existence dynamics, it is time to focus on the sustainability of the human livelihood component which has been neglected so far.

For minimum-invasive pastoral livelihood, a small-number-high-quality pastoralism should be desirable and needs to be encouraged. The Gavli Dhangar community along the northern western ghats are already in this mode. Dhangars are semi-nomadic pastorals of Maharashtra and neighboring states. Dhangars are a heterogenous group with at least 23 identified endogamous castes (Malhotra and Gadgil 1981). The Dhangar community along the western Ghats predominantly belong to the Gavli Dhangar or Dange Dhangar caste. They are scattered in small hamlets along the Western Ghats and Konkan area over several generations mainly keeping buffaloes and cows. Dhangars are currently cattle and buffalo owners that are forest inhabitants over several generations with some history of local movements (Gadgil and Malhotra 1982). At present, some hamlets show seasonal migration but others have settled in the form of small hamlets typically of 5-6 households only. Traditionally tolerant of wild life, their culture has rituals involving tigers or leopards as Gods. Their habitat offers good fodder quality for their animals and the health and productivity of animals is generally good. Co-operative dairy industry has made a stable market available, although they may have to walk

many kilometres every day to deliver milk. The number of animals grazed is not large and the community seems to give more importance to quality of animals than their number. In recent decades the inhabitants along with the animal numbers have further reduced with some families and the younger generation moving away from traditional livelihood.

We raise the question here whether we can identify conditions under which a continued harmonious co-existence of the Dhangar community amidst wilderness is possible. Particularly relevant is the possibility that the increasing frequency of depredation would change the relationship. There might be a threshold frequency of carnivore attacks above which the relationship would be threatened. What are the likely consequences if such a tipping point is reached? This analysis is crucial for long term conflict management on the background of the developing national park.

Methods:

Community under study:

We studied the Dhangar community from the Maharashtra Western Ghats covering Ratnagiri and Satara Districts. SP and SK have been working with the community since 2014. Our study has a background of two interventions which made the data collection smooth and reliable. One was to streamline the compensation protocol. In Maharashtra state, law enables compensation for livestock kills by wild carnivores. However, the bureaucratic protocol was out of reach of most people. We established a way to record every kill with evidence and validation and this helped the community on the one hand and created a reliable data source on the other. We also started distributing 'Dhole/Leopard/Tiger Relief Kit' to the affected families through public funding. This motivated and accelerated people to report the livestock kill cases on time with evidence and take efforts to obtain compensation. The compensation protocol involves validation by panchanama and recording the evidence. This entire process ensured data reliability. Without this intervention in most kills compensation would not have been claimed resulting into an underestimate of livestock depredation.

We also facilitated the tradition of "Wagh-baras" a festival depicting tigers and leopards as God. Researchers, wildlife lovers and wildlife managers were often invited to the festival. Revival of this tradition was helpful in breaking the barriers and creating trust and communication channels making the data flow smoother and more reliable.

SP and SK were connected to this community over a much longer time during their naturalistic expeditions and therefore no separate efforts were needed to establish contact and trust with the community. The number of settlements sampled were 25 constituting 122 households having a range of 1 to 16 households per hamlet. The houses are often well built

in stone and animal shades are often located within the house, presumably as an adaptation for long term carnivore interactions. The large animals owned per household range between 0 to 35 averaging 10.9, out of which average 4.6 being cattle and 6.25 buffaloes. Sheep and goat keeping was prevalent in history but Dhangars in this area have almost given up small animal keeping.

Study area: The study area covered parts of the Sahyadri Tiger Reserve (STR) and adjoining areas on its west. STR located in the northern Western Ghats in India, is the only tiger reserve in Western Maharashtra declared in 2008 (Jelil et al, 2020, NTCA, Govt. of India 2026). STR spreads across Satara, Sangli, Kolhapur, and Ratnagiri districts of Maharashtra, India. It covers a total area of about 1,166 km² (core area of 600.12 km²) and includes Koyna Wildlife Sanctuary (WLS) and Chandoli National Park with their buffer zones (Pant et al, 2023). Located between latitudes: 16° 58' N to 17° 49' N and Longitudes: 73° 33' E to 73° 55' E the reserve comprises western montane subtropical hill forests, west coast semi-evergreen forests and southern moist mixed deciduous forests. The most distinct feature of the Tiger Reserve is the presence of numerous barren rocky and lateritic plateaus, locally called "Sadas", with less perennial vegetation and over hanging cliffs on the edges along with numerous fallen boulders with dense thorny bushes (NTCA, Govt. of India 2026). STR has been home to the endangered species of top carnivores such as Tiger, Wild dog, and Leopard. Tiger sighting was rare in this area from the middle of 20th century, increasing recently. Additionally, three females were released in STR in 2025-26. The predominant herbivores include Gaur, Sambar, Four Horned Antelope, Mouse Deer, wild pig and Giant Squirrel. As many as 30 species of mammals have been recorded. In addition, the area is home to Vultures and Crocodiles (NTCA, Govt. of India).

Konkan region linked to Sahyadri Tiger Reserve: The Konkan region linked to STR includes three tehsils namely, Khed, Chiplun and Sangameshwar of Ratnagiri district. Adjacent to the west boundary of STR are steep slopes followed by mildly undulating konkan region. As per the forest classification given by Champion and Seth (1968), forests of Ratnagiri fall into two categories; the Bombay Sub-Tropical Evergreen Forest and the South Indian Tropical Moist Deciduous Forest. The area has recently been affected by invasive weeds including [*Chromolaena odorata*](#) (L.) R.M.King & H.Rob., locally known as *Ranmodi* and [*Lantana camara*](#) L. locally known as *Ghaneri*. Out of the two, [*Chromolaena odorata*](#) grows seasonally occupying a large area in the forests of Konkan filling all the open gaps formed after a forest fires and forest cutting. [*Lantana camara*](#) is relatively slow growing but perennial and resilient.

The Western Ghats in these tehsils rise in the East to an average elevation of about 610 mtrs; the highest point being 1390 mtrs. viz. Gherasumargad in Khed taluka. In this study, only the dhangarpadas (hamlets) coming under Chiplun tehsil were surveyed ranging between 17°35'45.22"N 73°41'48.51"E to 17°24'17.74"N 73°35'25.61"E (figure 1). The climate of Ratnagiri district is typical that of on the West Coast of India with plentiful and regular rainfall during monsoon, oppressive weather in the hot months and high humidity throughout the

year. The annual rainfall in various parts of the tract is heavy and varies from 2451 mm to 3897 mm.

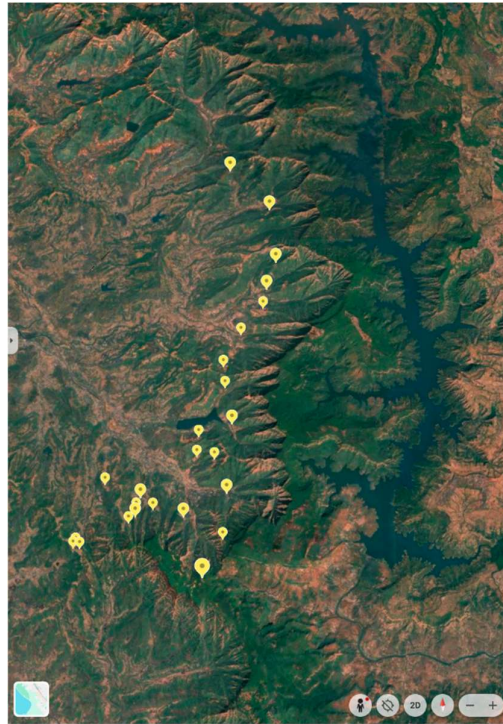


Figure 1: Map showing number of hamlets sampled for livestock & livestock predation data by large carnivores

Sampling methods:

Carnivore attack data:

During the preliminary work by SP and SK with the Dhangar community, it was observed that most residents were unaware that they could get compensation from the forest department (FD) for their livestock losses due to Dholes; unlike leopard kills, that they were aware about. In order to create appropriate awareness and information about the compensation protocol, we conducted group meetings with residents of all the hamlets under study. This resulted in establishing a network of informants to obtain timely information on livestock depredation. People cooperated because it benefitted them, but since validation with evidence was incorporated in the protocol, the reliability of the reporting was ensured. We regularly communicated and took a follow up with the forest department to facilitate smooth operation of the compensation protocol.

Since, unlike leopard (Bailey, 1993; Mills, 1990; Nowell & Jackson, 1996; De Ruiter & Berger, 2001 & Andrew Stein et al, 2015), dholes do not cache their prey (Karanth & Sunquist,

2000 & M. W. Hayward¹, et al., 2014) and devour it within few hours, it was challenging to obtain compensation with leftover bones. We communicated such issues with the higher authorities of the forest department to standardize the level of evidence acceptable for dhole kills. We set up camera traps at kill sites whenever possible, to identify and confirm the carnivore species and to observe differences between the feeding styles and other patterns.

Livestock population data: To study livestock population structure, in the 25 hamlets under study we conducted structured interviews recording total livestock per family, along with age, breed, sex, total weans/ lactation cycles, natural abortion cases, productive and unproductive adults, milk yield, practices employed for breeding (natural, crossbreeding or artificial insemination), frequency of selling or buying of livestock, causes of infant as well as adult mortality, alternate income generation sources, if any. One responsible member of each family who is actively involved in practicing pastoral livelihood was selected for conducting interview. Other member's inputs were also noted wherever needed. The observable facts such as number animals, age structure were examined directly. The interview process was designed to be as brief as possible to avoid disinterest.

Ensuring ethical standards: Since SP and SK have been visiting this community, working with them and helping them in a variety of problems for over a decade, a landscape of mutual trust was already created. When the present study started no academic institution was involved. By 2023 SP registered for PhD with Shivaji University from Yashvantrao Chavan Warana Mahavidyalay and started receiving a fellowship. As a result, no institutional committees could be involved at the beginning of the study. However, the study was perceived from many rounds of discussion with members of the community itself. The community itself upheld the concept and we felt that making a formal ethical protocol or having them sign papers would unnecessarily create a feeling of alienation leading to some resistance to the flow of information. The intention behind the study, its relevance to the community were discussed clearly with the community and since they perceived a possible benefit of the study, participation, cooperation and honesty could be maximized. Any member of the community was free to deny participation in the study at any stage.

Results:

Carnivore history as narrated by the community:

In the memory of older Dhangars the area traditionally had leopards and rarely tigers. Only leopards are said to have killed their animals occasionally. Tigers have been rare and only transiently seen in the area for several generations. This information is consistent with camera trapping studies started in this area by the forest department during the last decade. In 2025-26, three females were relocated from eastern Maharashtra in the Sahyadri Tiger Reserve and

more relocation is planned in near future. People were aware of the re-introductions. At times the introduced tigers strayed in the vicinity of the hamlets creating some tension. The tigers were being carefully monitored by the wildlife management and people cooperated. Cases of tiger kills of livestock started coming on record only recently. Dhole, that was confined to the upper ranges of western ghats, what is now core area of STR, started expanding their range and livestock kills suddenly increased from 2019. Prior to that there has been no prior record in this area of dhole killing buffalo. The older Dhangars do not remember any dhole attacks.

Prior to our intervention, the frequency of filing compensation claims was much smaller as revealed by the interviews. After the facilitation almost every case was reported with a good success rate for compensation. It is important to realize that depending only upon forest department records would have grossly under-estimated the predation rates. Many prior studies rely exclusively on the recorded incidents and these studies are likely to have substantially underestimated the conflict.

The livestock dynamics: The 122 households scattered over 25 hamlets had a total large animal livestock of 1280 comprising 563 cows and 717 buffaloes. The average animals per household was only 10.49, 4.6 being cattle and 5.88 buffalo. The sex ratio at birth was not statistically different from 1:1 but the ratio in adult cows was 0.64 males per female. In buffalo the adult sex ratio was only 0.088. This reflects on the fact that males in buffalo are not considered useful, whereas oxen are used as draught animals. The death of males in buffalo is gradual as reflected by the intermediate subadult ratio of 0.48. Selectively neglecting health appears to be the main cause of death of males in buffalo. The apparent proportion of productive females is large in both cows and buffaloes owing to good care on the one hand but also the practice of "sutki", i.e. letting the non-productive animals live a feral life. Our kill data does not include these animals.

Apart from livestock keeping, the community used to grow minor millets and rice during the monsoon. Although some rice growing continues, the practice of growing other crops has been largely abandoned owing to extensive crop damage by wild pigs and gaur. This increased the community's dependence on livestock even more.

The carnivore kills: We recorded a total of 250 kills. As reported from the 25 hamlets, livestock killing by wild carnivores has increased with time during the study years (fig 2). Leopard appears to be the only carnivore attacking livestock in early years, but dhole and tiger attacks increased with time. Attacks by all the three carnivores increased in number. There was evidence that in 14 cases leopards made the kill but dhole took over at some stage and devoured the rest of the carcass. Although the rate of attacks per animal increased to 0.063 per year per animal by 2025, the variance around it was high and some hamlets have consistently experienced higher rates reaching up to 0.146 per animal per year.

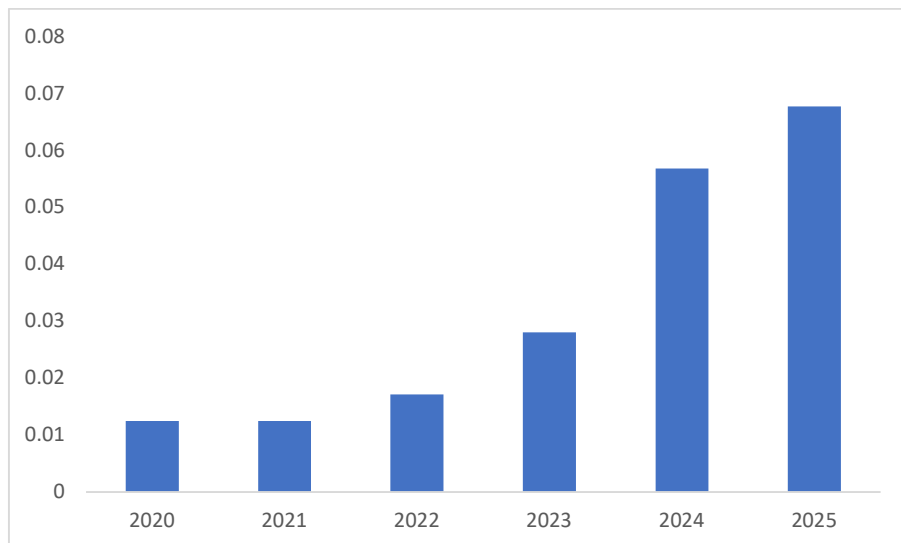
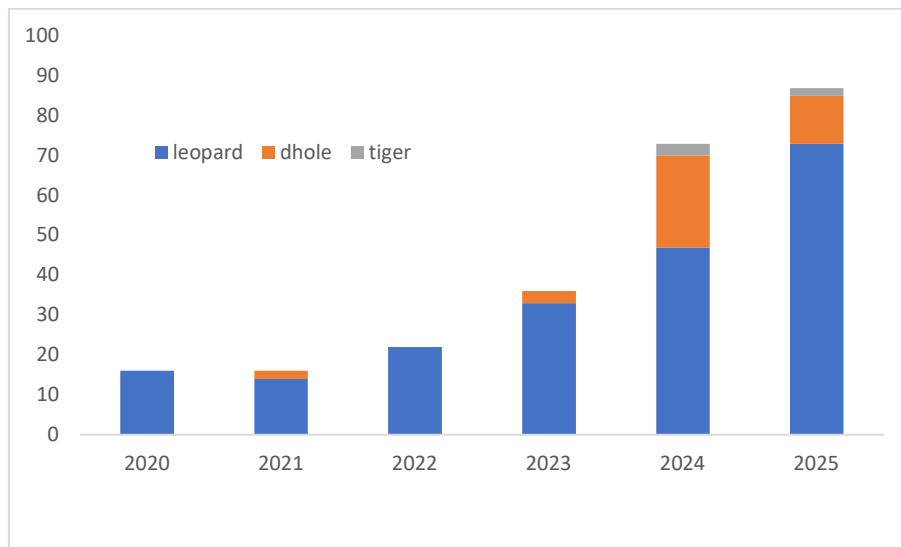


Figure 2: Temporal patterns in carnivore attack on livestock. A: The changing contribution of the three species with time B: attacks normalized per animal per year show an alarming rise in recent years.

The three carnivores are expected to interact in a complex way, that remains to be studied. The choice differed substantially between the three predators. Leopards preferentially killed cattle, dhole killed buffaloes almost exclusively but often ate cattle that a leopard had killed, tigers killed both and the total number is too small to see any significant choice (fig 3). In the animal rearing practice of the community, calves below one year are always kept within the house. Therefore, rate of carnivore attacks on calves was minimum, except rare occasions of leopard entering inside the shed. Adults were attacked at all ages. Particularly remarkable is dhole attacks on adult buffalo in spite of its large size and aggressive nature. Often dhole targeted the eyes first to make the animal vulnerable.

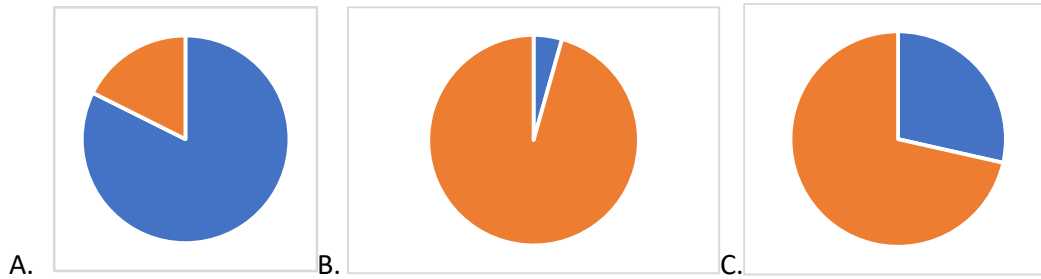


Figure 3: The proportion of cattle (blue) and buffalo (orange) in the three carnivore kills. A: leopard, B: dhole, C: tiger.

Tipping point analysis: For sustainability of a population, the female replacement rate needs to be greater than 1, i.e. a female during its lifetime should produce and successfully rear to adulthood one female offspring on an average. Naturally, if the female replacement rate is above 1, the population increases in size. Predation can reduce the replacement rate and 1 is the tipping point. If it falls below unity, the population would decline rapidly and pastoral livelihood collapse.

Cattle and buffalo are comparable in size, breeding, gestation and survival rates as well as dependence of the community on them and therefore we will treat them together in the analysis to predict the tipping point. Gupta (2019) describes the lactation specific death rates of buffalo females in India. With a female calf survival rate to be 0.8 (Jadhav and Patel 2024), the replacement rate can be calculated as in table 1.

A

Lactation No.	% of total died
Infant	
1	22.44
2	13.14
3	16.35
4	14.42
5	11.54
6	7.7
7	6.1
8	3.53
9	2.54
10 and above	2.24
Total died	100

B

Lactation No. (Infant)	% of total died (a)	Lactation No. (b)	Replacement rate: at calf survival rate (0.8) (a*b*0.8)	At 0.09 predation rate
1	22.44	0	0	0
2	13.14	1	10.512	9.56592
3	16.35	2	26.16	23.8056
4	14.42	3	34.608	31.49328

5	11.54	4	36.928	33.60448
6	7.7	5	30.8	28.028
7	6.1	6	29.28	26.6448
8	3.53	7	19.768	17.98888
9	2.54	8	16.256	14.79296
10 and above	2.24	9	16.128	14.67648
Total	100		220.44	200.6004

Table 1: Lactation specific survival rates and thereby calculation of replacement rates in Indian domestic buffalo. A. Lactation specific survival rates as given by Gupta et al (2019). B. The expected number of calves born per 100 females. Out of the total of 220 calves half are expected to be females. Therefore, the replacement rate is 1.1. This is sustainable for predation rates of less than 0.09 per lactation. Assuming one cycle in buffaloes to take 1.5 to 2 years, predation rate of 0.045 to 0.06 per year per animal is the tipping point based on average considerations.

The female to calf ratio and calf to subadult ratio in our data are compatible with rates reported by Gupta (2019) and Jadhav and Patel (2024). The female replacement rate in the absence of predators calculated from these data are of the order of 1.09 per lifetime per lactation cycle. If the lactation cycle is taken as 1.5 to 2 years, predation rate of 0.06 to 0.045 per animal per year is the tipping point. If predation rate reaches this level, co-existence is threatened and can collapse rapidly if it exceeds the critical limit even slightly. The observed average predation rate in this study appears to be increasing rapidly and (figure 2) has exceeded the tipping point in 2025. Even if we discount for some error, it cannot be denied that the predation rate has come dangerously close to the tipping point. Moreover, the variance around the average matters more. For some hamlets the predation rates during 2024 and 2025 were as high as 0.14 per animal per year. Compatible with this is the finding that three families from this hamlet gave up animal keeping during the study period. This is an alarming finding. As some persons from the community start migrating outside, the manpower required to attend and protect the animals deteriorates raising the chances of carnivore attack further. This is likely to start a vicious cycle leading to a rapid collapse. With the rate of predation observed in this study, it is likely that a tipping point is reached and the pastoral livelihood is bound to collapse. Although there are many studies on carnivore-livestock interaction in recent years, the tipping point aspect of HWC has largely escaped the attention of researchers. It is important to see whether the predation rate is bringing the replacement rate to unsustainably low levels.

The further fate of the community is unpredictable. They may have to move out as migrant labourers or they may be compelled to poison the carnivores or support poaching or any other illegal operations. Either way is not desirable for long term conservation management. The pastoralism of Dhangar community is a “small number high-quality” pastoralism that is

compatible with conservation policies. If this community collapses, the area might be invaded by more destructive models of pastoralism. Survival of the Dhangar model is likely to boost conservation and co-existence.

A legal provision and a protocol for compensating the loss caused by wild animals exists. However, the compensation that can give justice safely away from the tipping point and the compensation required to ensure sustainability at or near the tipping point needs to be qualitatively different. When safely away from the tipping point, an ex-gratia payment as an immediate relief from the damage can be sufficient. However, if the tipping point is reached, ex-gratia payments cannot save the situation. There needs to be sufficient support to be able to buy a productive female of a desirable breed from outside the community. This can be expensive and needs to be carefully calculated. The compensation protocols currently employed satisfy neither. The amounts are often arbitrarily decided without a transparent reasoning. There is an urgent need to recognize these aspects of human wildlife co-existence and focus adequate research on it so that policy supporting long term minimum-conflict co-existence can be ensured.

Our findings have wider implications. Very often the rising human and livestock population is said to be the main driver of HWC (Mishra 1997). The Dhangar community and their livestock have been declining in and around the study area. This includes the hamlets displaced by the tiger reserve as well as voluntary migration away from the area. Grazing areas of this community have shrunk during the study period and increasing intrusion in the core cannot be the cause of carnivore attacks as found by other studies (Miller et al., 2016). Carnivore depredation during our study increased rapidly in spite of the declining livestock population and grazing area. This implies that the pressure from increasing human population, livestock and land use is not the sole or major cause of HWC. Poor livestock corrals is said to be another cause of carnivore attacks (Maheshwari and Satyakumar, 2020). The Dhangar practice of sheltering the animals inside the well-built stone house for the night eliminates this possibility. Diversifying economic activities has been suggested as another measure for reducing HWC (Tharmalingam et al 2020). For the Dhangar community, the choice of growing monsoon crops has been made impossible by wild herbivores. Therefore, it is not easy to suggest quick measures to reduce the frequency of carnivore attacks. Other causes such as reducing fear of humans (Prabhulkar and Watve 2025) needs greater research attention. The stereotyped suggestions of conflict mitigation being unlikely to work, the carnivore conflict angle of HWC needs exploration of different dimension of research neglected so far.

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