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LETTER

The introduction of African cheetahs to India was planned without considering their spatial ecology

The introduction of a sub-species or re-introduction of a species into an area where this species was extinct for decades is a challenging undertaking. It is therefore crucial to plan (re-) introductions carefully and to consider all current knowledge of the species (Breitenmoser et al., 2001). This approach is particularly important when the species is threatened at a global level such as the cheetah (*Acinonyx jubatus*) (Durant et al., 2022). The Asiatic cheetah (*Acinonyx jubatus venaticus*) has been extinct in India for 70 years and its government has introduced on September 17, 2022, eight cheetahs from Namibia and on February 18, 2023, 12 cheetahs from South Africa (*Acinonyx jubatus jubatus*) into their country. The cheetahs from Africa were brought to Kuno National Park (KNP), an unfenced area of ~750 km^2 surrounded by villages with livestock farmers. The aim of this project is "to establish a free-ranging population of cheetahs in and around the Kuno NP" and for "this population to be managed as a metapopulation with other two to three established populations of cheetah in India with occasional 'immigrants' brought in from Africa, as and when needed" (Jhala et al., 2021).

Based on the prey density in the KNP, the carrying capacity for cheetahs was calculated to be 21 individuals, that is, ~3 individuals/100 km^2 (Jhala et al., 2021). Such high cheetah densities have not been recorded for other free-ranging African cheetah population roaming in unfenced areas, which typically occur at less than 1 individual/100 km^2 (Broekhuis et al., 2021; Weise et al., 2017). On October 19, 2022, a critique on the cheetah reintroduction to India pointed out that even in prey-rich landscapes such as the Maasai Mara in Kenya, East Africa, the cheetah density is ~1 individual/100 km^2 (Gopalaswamy et al., 2022). On February 16, 2023, a response was published by Tordiffe et al. (2023). A few weeks later, on March 27, 2023, one of the eight cheetahs from Namibia died, probably due to kidney failure, on March 29, 2023, four cubs were born by a female from Namibia and on April 2, 2023, a male from Namibia was walking 20 km out of the KNP into the adjacent villages.

In this letter, we focus on the socio-spatial organization of cheetahs to predict the outcome of the experimental cheetah translocation. The socio-spatial organization is an important aspect of cheetah behavior which has not been considered for the translocation so far. Here, we derive six predictions from empirical data on how we expect the introduced cheetahs to distribute themselves in the KNP. The socio-spatial organization of cheetahs is characterized by (1) adult cheetah males exhibiting two distinct spatial tactics, being either territory holders or "floaters" and by (2) territories being distributed in the landscape with distances of 20 to 23 km between territory centers (Caro, 1994; Melzheimer et al., 2018). The large areas between the territories are not defended by any males but used by females and floaters (Caro, 1994; Melzheimer et al., 2018). In Namibia, territory holders occupy ~380 km^2, while floaters roam in overlapping home ranges of ~1600 km^2 encompassing two to four territories and females use home ranges of ~650 km^2 between the male territories (Melzheimer et al., 2018, 2020). In another ecosystem, the Serengeti NP in East Africa, the territories are only ~50 km^2 in size (Caro, 1994; Caro & Collins, 1987). This difference might be based on differences in prey availability, human-carnivore conflict, predator competition or habitat composition of the two ecosystems or in the use of different collar types for recording cheetah locations. Remarkably, the centers of the territories in both ecosystems are separated by 20–23 km with large undefended areas between the territories (Caro, 1994; Caro & Collins, 1987; Melzheimer et al., 2020).

We therefore expect that the spatial tactic of cheetah males, the distribution of male territories in the landscape, and the distance between the territories is also observed in the KNP in India. The eight cheetahs from Namibia brought to the KNP comprised a solitary male, two brothers, and five unrelated females. Thus, we predict that the solitary male and the two brothers will establish a territory each which will be separated by 20–23 km (Prediction 1). We further predict that irrespective of the territory size, these three males will occupy

the entire KNP which is ~17 km × 44 km in size (Prediction 2), thus not leaving space for additional territories for males introduced from South Africa.

The process of establishing territories in a new area is currently unknown, but translocated cheetahs in Namibia have exhibited extensive exploration movements of several thousand km^2 during the first 6 months (Weise et al., 2015). We therefore predict that the eight cheetahs will conduct extensive excursions outside the KNP during their exploration phase (Prediction 3), potentially coming into conflict with livestock farmers. We further predict that it will take the males many months to adjust the distance between themselves and settle, and the females to settle between the males (Prediction 4).

Territories are valuable because their core areas function as "communication hubs" where territorial males, floaters, and females exchange olfactory information on their presence and reproductive status (Caro, 1994; Melzheimer et al., 2020). Thus we predict that additional males brought in or born in KNP will settle at a distance of ~20–23 km away from the first two established territories, coming into conflict with livestock farmers (Prediction 5). The distribution of additional territories would give the five females and additional females new opportunities to establish their home ranges between the territories. Thus we predict that females will also move out of KNP and coming also into conflict with livestock farmers (Prediction 6).

In the communication hubs, the cheetah density is much higher than between the hubs because cheetahs move in and out to exchange olfactory information (Melzheimer et al., 2020). This has consequences on livestock predation. In Namibia, cattle calf losses are highest in the communication hubs (Melzheimer et al., 2020). Shifting breeding herds away from the hubs reduces calf losses by 86% (Melzheimer et al., 2020). When territorial cheetah males are removed, floaters occupy the vacant territories quickly (Melzheimer et al., 2020). This suggests that translocating cheetahs back into the KNP might not result in a long-term reduction of livestock losses or human-cheetah conflicts.

If India further follows their plans of establishing a metapopulation in their country by introducing cheetahs to several parks in India (Jhala et al., 2021), we argue that the socio-spatial organization of cheetahs needs to be considered. Our predictive approach has the potential of tackling pro-actively farmer-cheetah conflicts, enhancing our knowledge of cheetahs establishing territories in new areas and to assess the success of potential future trans-continental introductions.

KEYWORDS

cheetah, conservation policy, human-carnivore conflict, India, Namibia, re-introduction, translocation

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CONFLICT OF INTERESTS STATEMENT

The authors confirm that they do not have any conflicts of interests to declare.

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