



Ecosystem service enhancement for the alleviation of wildlife-human conflicts in the Aravalli Hills, Rajasthan, India



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ABSTRACT

Conflict between people and ecosystem capacity is a global problem, and achievement of wildlife-human co-existence a strategic global need. Apex predators suffer disproportionately, including conflicts with human activities. Recovery of formerly declining predator populations, particularly India's Bengal tiger (*Panthera tigris tigris*), increases potential human conflict. Habitat conversion for arable production and proliferation of non-native tree species increases likelihood of conflict between wildlife, people and stock in villages in the Amlidha buffer zone between core areas of the Ranthambhore Tiger Reserve. Arresting and reversing landscape conversion in targeted zones can reduce potential wildlife-human conflict by regenerating ecosystem capacity, enabling coexistence of a 'green corridor' for terrestrial wildlife migration, a 'blue corridor' for movement of riverine wildlife, and sustainable human livelihoods. This can be achieved through informed and consensual community-based zoning of land uses, management of non-native species and regeneration of local water resources. Conversely, continuing habitat simplification will decrease ecosystem vitality and services, increasing wildlife-human conflict and insecurities. Transition to multifunctional ecosystem management doesn't require wholesale change; elective, consensual adjustments can enhance socio-ecological security. Initiatives by the NGO Tiger Watch involving village people, whose willing engagement is essential for sustainable management, support potential achievement of simultaneous wildlife conservation and human benefits.

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1. Introduction

Current human population and development trajectories are escalating potential conflicts with wildlife species, ecosystems and their many beneficial processes and services (Millennium Ecosystem Assessment, 2005a). Schipper et al. (2008) found that 25% of mammals worldwide are facing extinction, with carnivores the most threatened. Apex predators have experienced catastrophic declines throughout the world as a result of habitat loss and persecution, commonly also associated with dramatic increases in the abundance of smaller predators (Prugh et al., 2009). The tendency of large carnivores to roam exposes them to edge effects peripheral to constrained areas, such as wildlife reserves, potentially leading to human-carnivore conflicts including threats to livestock (Balme et al., 2009). Habitat conversion, particularly deforestation, exacerbates pressures on carnivores (Chávez and Ceballos, 2006).

Conservation of apex predators can be controversial, depending on attitudes towards large carnivores which vary widely between villages, regions and countries, ranging from perception of these animals as symbols of natural systems or a threat to human lives and livelihoods (Silva et al., 2013). In other localities, top predator species may have particular spiritual value (Wilson, 1990) contributing to taboos or other social protocols serving to promote their conservation. Conversely, they may also constitute lucrative targets for trade by poacher networks, generally illegally serving international markets (Abernethy et al., 2013). Illegal hunting of carnivores and their prey is one of the highest priority concerns for their conservation (Rosas-Rosas and Valdez, 2010; Treves and Karanth, 2003).

The creation of nature reserves is one societal response to protection of areas important for wildlife, geological formations and, sometimes, culturally important landscapes. The world's first such reserve dates back to the 3rd century BC in Sri Lanka (Department of Survey, 2007). A wide range of religious, sporting and nature conservation motives historically underlie the founding of reserved areas, which are often located in habitat too inhospitable

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for agricultural conversion and therefore historically left 'wild' for practical reasons. Also, the formation of nature reserves has not infrequently been associated with forced displacement of indigenous people as a form of 'environmental racism' (Merchant, 2007). A full review of the history of protected areas is beyond the scope of this paper. However, the global network of nature reserves today serves as a bulkhead of varying efficacy against human encroachment and habitat conversion for narrow ends, and as a genetic reservoir largely free of human interference beyond low-intervention tourism and, not uncommonly, traditional uses as a historic right by indigenous communities. Notwithstanding these important conservation successes, it is increasingly recognised that large animals, particularly those with migratory or territorial habits, may be restricted by reserve size. Also, under a changing climate, there is a need to enable the movement of species north-to-south and between altitudes in response to temperature regimes and east-to-west in response to changing rainfall patterns. Consequently, future development of protected areas needs to integrate landscape-scale connections and processes, and to manage fragmented wildlife under the ecosystem approach if it is to remain viable and valuable to society (Lawton, 2010). This is particularly the case where large carnivores are concerned, territory size frequently leading to straying of animals beyond protected area boundaries and so necessitating effective management to enable humans and predatory species to coexist in the long term in buffer areas surrounding reserves (Silva et al., 2013).

Beyond the need for habitat to provide cover and other behavioural purposes, loss of habitat can lead to reductions in prey that may in turn create a major limiting factor for the survival of large predators (Carbone et al., 2011). Reduced habitat extent and quality in buffer zones can thereby discourage predator movement and, due to lack of semi-natural areas and their associated concealment and potential to provide wild food, may also promote risk of attack on stock animals and other more direct human conflicts.

To address some of these pressures, particularly in response to formerly catastrophically declining populations of India's iconic Bengal tiger (*Panthera tigris tigris*) through pressures such as habitat conversion and poaching, the Government of India launched Project Tiger in 1972 during Prime Minister Indira Gandhi's tenure. The purpose of Project Tiger was to counter the decline of the Bengal tiger, ensuring viable populations in their natural habitats and also to protect them from poaching and other threats of extinction. Project Tiger was one of a set of apex species-driven conservation initiatives undertaken with the assumption that benefits would ramify for the whole food chain and habitat quality, though monitoring has been primarily driven by reporting animal censuses with little attention to assessment of habitat quality and linked biodiversity and ecosystem service values. The tiger *Panthera tigris*, and its multiple sub-species, is listed as 'Endangered: Population Decreasing' on the IUCN Red List of Threatened Species (IUCN, 2017: <http://www.iucnredlist.org/details/15955/0>). Project Tiger envisioned networks of Tiger Reserves across India, funded to protect and restore habitat, as breeding nuclei from which excess animals could migrate to adjacent forests (Panwar, 1987). The Indian government also set up a Tiger Protection Force to combat poachers and to fund relocation of villagers to minimise human-tiger conflicts. Establishing formal protection areas is important for tiger conservation, as is the effectiveness of protection in these designated areas (Chape et al., 2005). However, species with large home ranges or migratory habits present broader challenges, because their habitat requirements often extend beyond the boundaries of protected areas (Lambeck, 1997; Caro and O'Doherty, 1999; Sanderson et al., 2001). Principal threats to tigers both within and beyond protected areas include direct hunting but also

declines in their prey, exacerbated by habitat loss associated with agricultural, urban and infrastructure expansion, and extractive resource consumption such as logging and mining (Linkie et al., 2003; O'Brien et al., 2003; Dinerstein et al., 2007).

Today, a combination of pressures is increasing the potential for human-wildlife conflict:

- Increasing tiger numbers. Recent anti-poaching and wider conservation measures have seen a welcome reversal in the former decline of tiger numbers in India, NTCA (2014) showing a 30% increase in India's tiger population from 1706 in 2010 to 2226 in 2014. Estimates, on the basis of camera traps, record an increase from some 1411 individual Indian tigers in 2006 (Jhala et al., 2008) to 2226 individuals in a census report released in January 2015 (Jhala et al., 2015). As anticipated, territorial behaviour is leading to tigers straying beyond the porous boundaries of Tiger Reserves, not only into and across buffer zones and surrounding peripheral zones but also beyond them.
- Increasing human numbers. India's human population continues to grow, rising from 361 million in 1951 to 683 million in 1981 and 1.21 billion in 2011 (Government of India, 2011) and reaching an estimated 1.25 billion in July 2015 representing one-sixth of the global population (CIA, 2015). This broad trend is mirrored in the Indian state of Rajasthan, with a 2001 population of 56.5 million rising to 68.6 million by 2011 (Government of India, 2011).
- Increasing water stress and associated vulnerability to drought. This is largely related to abandonment of centuries-old localised, community-based capture of monsoon rains in favour of mechanised exploitation of available resources. Abandonment of traditional water resource recharge practices is being substantially driven by a policy environment strongly favouring individual energised pumping of receding groundwater (reviewed by Everard, 2015), as well as the damming and diversion of water to serve major population centres depriving rural catchments of natural flows (Srinivasan et al., 2009). There is a distinct lack of balancing measures to maintain or promote groundwater recharge. This pressure on water resources is also substantially amplified by the demands of a growing human population and an increasingly unstable climate. Reduced water availability across landscapes, particularly in proximity to human settlements, can only increase the potential for conflict in and around remaining resources.

Singh et al. (2015a) characterised and examined the causes of human-tiger conflicts in pastoral villages adjacent to Ranthambhore Tiger Reserve in semi-arid north-eastern Rajasthan, India, throughout 2005–2011. 113 conflicts were recorded of which 88.5% were attacks on domestic livestock and 11.5% (13) attacks on humans, with 53.4% of combined attacks occurring inside villages, 44.5% in agriculture fields and 1.9% in forests. Noting that the highest conflicts occurred in the summer and during the monsoon, Singh et al. (2015a) attributed human-tiger conflicts to tiger movements, fragmentation of corridors and human disturbance. Though literature is lacking about trends in conflict around Ranthambhore over time, evidence of current issues and increasing tiger numbers, human populations and habitat conversion suggests that human-tiger conflicts are likely only to increase on current development trajectories, necessitating novel conservation and management approaches. This paper tests whether, and how, conservation and restoration of ecosystem services can contribute to alleviating wildlife-human conflicts in a wildlife corridor through a buffer zone between two protected wildlife Reserve areas comprising key elements of the Ranthambhore Tiger Reserve.

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