



## Issues of man vs wildlife conflict- management strategies and global scenario

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### Abstract

Conflicts between humans and nature have existed from prehistory and recorded history. This battle has a number of negative consequences, including human and wildlife loss, crop loss, habitat damage and destruction, and so on. This loss has a similar impact on humans and wildlife. As a result, it is critical to control the situation with as few casualties as possible, which can be achieved by effective awareness and communication. This review article discusses the human-wildlife conflicts in India.

**Keywords:** Man, wild, global, management, lion, conflict

### Introduction

Conflict between humans and animals (HWC) is rapidly becoming a critical threat to the survival of many globally endangered species, particularly large and rare mammals such as the Sumatran tiger (*Panthera tigris sumatrae*) and the Asian lion (*Panthera leo persica*), as well as less endangered species such as the snow leopard (*Uncia uncia*) and the Red colobus monkey (*Procolobus kirki*). Human-bear conflict (HBC) is a global issue that affects all eight species of bears throughout much of Europe, Asia, North America, and the Andes. The countless incidents from throughout the world highlight the gravity of human-wildlife conflict and propose that a thorough investigation is required to grasp the problem and support the conservation chances of threatened and potentially endangered species.

Nevertheless, what is the specific definition of HWC, and when and where does it typically occur? According to the World Conservation Union, it occurs when wildlife's needs cross with those of humans, resulting in expenses for both residents and wild animals. Direct contact with wildlife happens in both urban and rural regions, although it is more common in and surrounding protected areas, where wildlife population density is higher or there is a paucity of edible food in the forest, and animals frequently wander into adjacent cultivated fields or grazing pastures.

Man, vs wild life conflict has a wide-ranging environmental impact. Species most exposed to conflict have also been shown to be more vulnerable to extinction due to human injury and death, which can be accidental, such as road traffic and railway accidents, capture in snares set for other species, or falling into farm wells, or intentional, such as retaliatory shooting, poisoning, or capture. Human-induced mortality has a wide-ranging impact on ecosystem equilibrium and biodiversity preservation, as well as the population viability of some of the most endangered species. Conflicts between humans and wildlife also have negative effects on human wellbeing, health, and safety, as well as economic and societal consequences. Nuisance encounters with small animals, exposure to zoonotic diseases, physical injury, or even death caused by large predator attacks all have significant financial costs for individuals and society in the form of medical treatments to cure and prevent

infections transmitted from animals through human contact. Humans can be economically harmed by destruction and damage to property and infrastructure (e.g., agricultural crops, orchards, grain stockpiles, water installation, fences and pipelines), cattle depredation, and transfer of domestic animal diseases, such as foot and mouth.

Adverse societal repercussions include missed school and work, increased labor costs, sleep loss, fear, travel restrictions, and pet loss. Such extensive environmental, human health and safety, economic, and social consequences urge that governments, wildlife managers, scientists, and local communities must identify the issue and take action to address it in the interests of human and environmental well-being. This chapter gives insights into HWC based on an examination of chosen case studies and a summary of major lessons proposed. It identifies common problems and solutions across biogeographical regions, demonstrating that conflicts have similar causes and effects, and that detailed information is essential for developing appropriate strategies for resolving the problem and conserving various ecosystems and their inhabitants.

### Wildlife conservation and its types

The safeguarding of endangered species, the sensible use of plentiful wildlife, and the reduction of wildlife damage. The first of these is the primary objective of parks. However, success in wildlife preservation frequently necessitates dispute resolution. Many human activities, including hunting, logging, animal husbandry, collecting non-timber forest products (NTFP), agricultural expansion, and development projects, have a negative influence on animals and parks. In India, the growing human and cattle populations have put a strain on all-natural resources. The majority of protected areas have been split, degraded, or affected by human activity. To meet rising demand for cereals and other food supplies, forests, meadows, and wastelands have been converted into agricultural land. Unsustainable land use habits in rural regions have exacerbated landscape changes. This habitat change has resulted in the ecological displacement of numerous wildlife species. Although some animals have adapted to people and become locally overabundant, others trespass from protected

regions and cause varied degrees of damage to human lives and property. During the twentieth century, as India's population grew rapidly, so did the demand for arable land. Large expanses of marginal lands, meadows, and woodlands were turned to cultivated areas, regardless of their potential for long-term agriculture. Even today, rural regions are characterized by unreasonable and unsustainable land use patterns. With rising illogical conversion of and subsequent encroachment on forest lands, wildlife in the country has been dramatically diminished due to habitat loss and degradation, and as a result, several species have become ecologically dislocated over time.

This has resulted in confrontations between humans who live on subsistence agriculture in the vicinity of possible animal areas and the remaining species. Even in distant places, protected woods are not immune to human activity, cattle grazing, and resource overexploitation. The problem is exacerbated in many locations where significant expanses of forest have been split by faster shifting cultivation and developmental initiatives such as hydro and irrigation projects, among other things, bringing animals into conflicts with humans owing to confinement. Although improvements in agricultural technology and practices, rural community development, and approaches to integrated forest management techniques are improving, these measures alone will not assist achieve long-term solutions to the aforementioned concerns, which will lead to balanced natural systems.



**Fig 1:** A Women with child rescued herself from elephant attack by fence

The threat for both wildlife and rural communities is dire, particularly in and around many protected areas and managed forests. There is an urgent need to create measures that can reduce man-wildlife conflict to manageable levels. Rural communities cannot afford to have their crops ravaged by elephants, deer, nilgai, blackbuck, wild boar, and other large carnivores, much alone livestock damage. It is more than just an issue of mindset; it is ultimately about survival. Seidenstecker *et al.* researched the subject of tiger man-killing and cattle depredation in 1970. While the tiger population is only a fraction of what it was estimated to be at the turn of the century, tigers continue to kill people and steal cattle year after year. Lions in Gir slaughter a large number of cattle each year, and man-killings have recently increased. Similarly, leopards and wolves have been observed to lift livestock and children in a number of places. Crop raiding by elephants is reaching frightening proportions, and the number of people killed in interactions

with elephants while safeguarding their crops appears to be rising.

Crop raiding is widespread in areas where elephants live in fragmented and degraded habitats. Crop damage caused by deer, nilgai, blackbuck, and wild boar is widely reported in several states, including Uttar Pradesh, Bihar, Rajasthan, Gujarat, Haryana, Punjab, Madhya Pradesh, West Bengal, Karnataka, Tamil Nadu, Maharashtra, and others, but data on the nature and extent of the damage is scarce. Because of these damaging issues, conflict between man and animals is on the rise, affecting people's acceptance of conservation ideas. Another major problem is the impact of forest fires on rural communities and wildlife. Forest fires are one of the most common types of disasters, and they can cause significant environmental concerns for Nature. They are easily identifiable and avoided. When a wildfire goes out of control, the losses can be virtually unfathomable. Such a tragedy might damage millions of trees, as well as structures, animals (wild and domestic), and human lives. Early detection of wildfires is one of, if not the most essential, methods of protecting forests.



**Fig 2:** Poaching threat conservation in Africa and subsequent loss of human lives

The first possible discovery allows for a quick response to prevent the spread. Furthermore, information about the location of the incident is critical for the prompt deployment of firefighters. As a result, early discovery, containment, and extinguishment of a fire before it spreads are critical for wildfire management. Many alternative forest fire detection and management systems have recently been developed and implemented with great effectiveness. It is true that forest fire detection and management should be distinguished in order to understand how to implement new fire detection and containment systems. As a result, we classified forest fire detection and management systems into various categories. In recent years, a wealth of research on forest fire management has been published, giving a wide range of answers and management strategies. Some studies have merged forest fire management and detection techniques. One set of researchers investigated forest fire prevention by analyzing the causes.

Crop, dairy, and timber losses (forest fires), increased unemployment, and biodiversity loss are all common outcomes. The research of forest fire occurrence and repercussions will aid in the development of mitigation techniques that will assist both people and wildlife conservation. The primary notion of this chapter is to highlight the wildlife damage concerns and conflicts

between rural people and wild animals in future. Conservation efforts can be significantly reduced by combining resource planning, habitat management, community education, and protection measures.

### Forms of Human-Wildlife Conflict

Human populations surround or are located within the majority of South Asian parks. In the wider landscape matrices that contain these parks, there is frequently a long "edge" where natural habitats meet human settlements. Conflicts unavoidably occur at this interface as a result of animals' dietary, ecological, and behavioral demands. There is evidence that larger animals are more likely to clash with people than smaller ones. Species with large ranges, such as elephants or Panthera cats, may invade human settlements during daily foraging, seasonal migrations, or territorial and dispersion movements. Nutritionally, both cultivated plants and cattle are appealing resources for wild herbivores and carnivores. Contact with such animals might cause economic losses in crops, property, or livelihood possibilities. Human limbs and lives are often lost.



Fig 3: Leopard attacking people in India

### Wild life damage to crops and range lands

Crop destruction by wild animals is probably the most common and persistent form of human-wildlife conflict in the tropics. Such damage has a negative influence on staple food grains (rice, wheat, maize, sorghum, and millet); non-grain food crops (potatoes, peanuts, vegetables, sugarcane, bananas, cassava, coconuts, and cocoa); and commercial crops. Animals eat crops, but trampling, roots, and other forms of waste can cause damage. Crop raiding animals come in a variety of taxonomic categories. Elephants (grain crops, sugarcane, and fruits), wild pigs (almost all crops), nilgai and black buck antelopes (sorghum, wheat, and millet), gaur (rice and rubber), sloth bears and black bears (maize, sugarcane, and peanuts), jackals (sugarcane, maize, and fruits), bonnet and rhesus macaques (most crops and vegetables), giant fruit bats (all orchard crops and areca nuts), and porcupines (areca nuts, coconuts, and vegetables). Crop damage causes the loss of staple meals for the poorest class of rural people as well as the destruction of commercial crops that may take several years to re-establish. Because agriculture employs a considerable number of rural workers, crop losses result in indirect loss of livelihood possibilities on a larger scale. Although most people do not tolerate crop losses to wildlife, a few groups in northwestern India have a cultural tolerance for crop

damage caused by wild antelopes. Even within these communities, historic levels of tolerance appear to be fading as a result of recent cultural and economic developments.



Fig 4: Monkey damage to maize and causes huge loss to overall yield

### Wild life conflict and Loss of domesticated Animals

Keeping animals is an important economic and subsistence activity in many parks. Carnivores frequently kill domesticated livestock, which is a severe concern. Domesticated bovids, equids, sheep, and goats have been killed by tigers, lions, leopards, snow leopards, wolves, dholes, striped hyenas, brown bears, and black bears. The conflict has resulted in retaliatory killing of "problem predators" by people. The locals' impressions of the losses, however, frequently appear to surpass the real value of the animals lost to predators.

Ducks, geese, and chickens were among the domestic animals killed by predators in South Asia, including smaller felids, viverrids, canids, mustelids, and raptors. Otters and crocodiles are viewed as severe dangers to inland fisheries in several locations. The shift in sloth bear predatory behavior appears to be caused by the Nilgiri Range's increasingly degraded and fragmented environment, as well as a lack of natural food for bears. Yellow-throated martens destroy expensive apiaries in Karnataka, India. The transmission of deadly illnesses to livestock by wild ungulates, which is a serious problem in parts of Africa, is not reported to be widespread in South Asia.



Fig 5: Leopard damage to sheep in Poonch Jammu and Kashmir



**Fig 6:** Snow leopard killed calf

### Impact of wild life on human deaths

Human-wildlife conflict reaches its peak when wild animals injure or kill people. Although huge cats, bears, and wolves are easily identified and targeted for such crimes in southern Asia, wild elephants are likely to murder more people than other carnivores in this region. The most serious kind of conflict is persistent predation on humans. Man-eating tigers, leopards, and (occasionally) child-lifting wolves, instill fear over large regions, resulting in massive retaliatory kills and animosity toward wildlife. The endemicity and endurance of man-eating tigers in some areas, such as the Sundarbans of India and Bangladesh, show that this acquired behavior is being passed on culturally via animal generations.

### Major man vs wildlife Conflict Issues

In the nation of India, traditions and cultural/religious attitudes toward wild animals make locals more tolerant of wildlife, despite the damage it causes to crops and livestock. Monkeys, for example, are considered sacred animals by Orthodox Hindus, who revere and preserve them. This religious conviction and customary devotion to monkeys have a significant impact on people's perceptions of the conflict, leading to partial acceptance. The general veneration for flora and animals in several Indian regions has frequently been stated to be the main cause for people not persecuting large carnivores and a positive attitude toward wildlife and environment reserves. A number of kinds of wild herbivores are blamed for crop raiding in the region: Nilgai (*Boselaphus tragocamelus*) and wild boar (*Sus scrofa*) are said to be responsible for at least half of the damage, while other species such as sambar (*Cervus unicolor*), chital (*Axis axis*), common langur (*Presbytis entellus*), rhesus monkey (*Macaca mulatta*), and parakeets (*Psittacula krameri*) accounted for the rest. Nilgai frequently assaults farms in the evenings, preferring the degraded borders of forest communities. Wild boar hunts at night, whereas other ungulates such as sambar and chital are typically restricted to forest cores. Some crop damage study results found that annual crop losses vary depending on the crop produced. In general, depredation rose as you got closer to the reserve. Tigers and leopards have been identified as the primary livestock predators among wild carnivores, with the former feeding on large domestic animals such as cattle and buffaloes and the latter on smaller animals such as goats, sheep, and calves. Tigers were believed to pose a significant threat in communities within and near the reserve; leopards, on the other hand, avoided conflict with tigers and frequented places further away from

the settlements. The economic impact was calculated using domestic animal prices provided by agro-pastoralists interviewed during the survey, which revealed that this is significantly less than crop losses and is undoubtedly boosted by villagers bringing their domestic animals into the reserve for grazing throughout the year.

### Snow Leopard and Tibetan Wolf

Despite the fact that conflict between agro-pastoralists and wildlife is increasing as the livestock population grows in Himachal Pradesh, locals have not resorted to shooting the major cause of the problem: the snow leopard. In 1995, wild carnivores destroyed 18% of the entire livestock holding, resulting in a 12% annual loss for livestock-owning families. Almost all of the fatalities were caused by the snow leopard, which is not hunted. However, retaliatory action is taken against the Tibetan wolf, whose pups were reported to be captured and slaughtered nearly every year in the 1980s. Nonetheless, such a response has been documented elsewhere.



**Fig 7:** Tibetan wolf is known for its huge damage impact on agro-pastoralists

### Lion and Leopard Conflict

In Gujarat, India, near Gir National Park and Sanctuary, the Asian lion (*Panthera leo persica*) and leopard (*Panthera pardus*) use huge sugarcane and mango plantations for shelter and water, as well as to hunt prey such as buffaloes, cows, pigs and dogs. Several lions have been reported to have gone outside the park limit and into plantations for more than a week, while leopards have made it their permanent habitat, breeding in cultivated fields surrounding the park's edge. Once again, the overlapping of wild animal home ranges with human settlements has resulted in cow depredation and attacks on farmers and workers. The situation in this area is similar to the ones stated above: rural people's safety is jeopardized, livestock depredation is prevalent, and the general ability to address the conflict is limited.

### Tiger Conflict

In the Sunderbans, the tiger had long been central to people's economic, social, cultural, and religious lives. This was the situation in the past and is so today. The antagonism between humans and tigers in the Sunderbans stems from the locals' socioeconomic status and the tigers' man-eating behavior. The overall annual loss due to large feline (tiger

and leopard) depredation is estimated to be around 12% of total family cattle. A noteworthy aspect is that, despite the fact that huge carnivores had a significant detrimental influence on the cow population, the settlements compensated for the loss through purchases.

### **Elephant Conflict**

The resulting conflict is frequently marked by elephant devastation of crops, homes, or property, human injury and mortality, and human retaliation against elephants. In India, around 400 people are killed by elephants each year, while approximately 100 elephants are slaughtered in retribution. In their report *Gajah*, the Elephant Task Force (ETF) of the Ministry of Environment and Forests describes the consequent stress, suffering, and loss as "all too real". Crop destruction incidents have occurred inside elephant habitats since man began agriculture. One of the first allusions to crop raiding by elephants may be found in Nilakantha's *Matanga-Lila* (The Elephant-Sport), when distraught villagers complain to the monarch of Anga, Romapada, that all their grain crops have been destroyed by wild elephants. To this day, farmers continue to lose millions of dollars each year as a result of crop raids, in addition to the genuine risk of death. Furthermore, cultivated crops offer a concentrated supply of food for elephants, and crops like succulent finger millet or sweet sugarcane are not only very appetizing, but they also contain significantly more protein and other elements such as minerals than coarse, wild grasses. According to *Gajah*, elephants annually disrupt crops spanning 0.8 to 1 million hectares in India, threatening the livelihoods of at least 500,000 cultivators.

### **Bear Conflict**

In the Indian subcontinent, all four-bear species are in direct conflict with humans, resulting in human mortality as well as economic damage due to crop and animal devastation. Bears are currently endangered due to poaching for bear parts and retaliatory killings to reduce crop/livestock damage. In some places of north-east India, black and sun bears are hunted for food. Habitat loss, degradation, and fragmentation are largely the result of development projects, encroachment, and human reliance on forests for fuel wood, fodder, and other resources. *Jhum* (shifting cultivation) and conversion to commercial plantations have had a significant influence on black and sun bear habitats in northeastern Indian states. Villagers living on the outskirts of the forest were prone to bear fighting. This type of finding could be due to the continual deterioration and fragmentation of habitat, the availability of unsuitable habitat, and the scarcity of food for sloth bears. The majority of bear habitats are also subjected to anthropogenic pressures, and many bear habitats that exist outside of the PA network but serve as corridors or linkages to protected bear populations are not protected.

### **Ungulate Conflict**

According to a 1997 survey, livestock graze in 73% of Indian parks and around 39% of protected areas. Intense livestock grazing may have two consequences on wild ungulates. Alien competition for food within the park may cause wild ungulates to seek a more nutritious diet in the fields around the park. This is not always the case, as livestock can operate as lawnmowers, boosting the quality of feed in parks and allowing ungulates to stay and browse.

Nevertheless, when open grasslands at the borders of forests and protected areas are transformed into crop fields, each ungulate species has a preferred crop, as demonstrated by a Tadoba research. Wild boar, which prefers sugarcane, would raid throughout the season, whereas nilgai, who prefer soybean, would raid just after fruiting. Moreover, Blackbuck enjoys cereal. In times of famine, the nutritional importance of staple (cereal) crops attracts large numbers of foraging wild ungulates. Furthermore, throughout the summer, crop fields around the parks provide superior sources of water and food, prompting ungulates to attack the fields.

### **Primate Conflicts**

Most monkey species are forced by their lives to stay inside the little forest portions that humans have designated for them; however, a few are less polite and voluntarily enter our crops and homes to ravage and pillage them. Many Asian macaques fit into the latter type, as they are robust and highly adaptable, having lived in close contact with humans for generations. The bonnet macaque and the lion-tailed macaque can be found in southern India, the rhesus macaque in central, northern, and north-eastern India, the Assamese macaque, pig-tailed macaque, stump-tailed macaque, and Arunachal macaque in north-eastern India, and the crab-eating macaque in the Andaman and Nicobar Islands. To varying degrees, all macaque species in India are under threat from anthropogenic pressures such as hunting, trapping, and habitat loss. In turn, humans are subjected to a variety of problems caused by macaques, including crop and kitchen raiding, damage to domestic items when they enter homes, and occasional bites and injuries.

### **Crocodile Conflict**

Throughout the mid-1970s, communities, conservationists, and the government have worked tirelessly to safeguard the area's decreasing crocodile population. However, villages have grown concurrently and have moved closer to the animals' habitats in the crocodile-inhabiting zones; most villages along the river and its branches rely nearly entirely on these waters for bathing, washing clothes, and drinking water. There are little safety precautions in place, and there have been multiple reports of deaths and near-misses. Global Scenario

### **Driving Forces**

A number of global trends have contributed to the rise in HWC worldwide. These include human population growth, land use transformation, species habitat loss, degradation, and fragmentation, increased interest in eco-tourism and access to nature reserves, increasing livestock populations and competitive exclusion of wild herbivores, abundance and distribution of wild prey, and increased wildlife populations as a result of conservation programs, climatic factors, and stochastic events.

### **Human Population Growth**

Demographic and social changes increase people's direct interaction with wildlife: as human populations grow, settlements extend into and around protected areas, as well as in urban and suburban regions. Human population expansion in India has resulted in encroachment on wildlife habitats, species confined to marginal habitat regions, and direct competition with local communities. Conflicts in

British Columbia, Canada, are not limited to natural reserves or rural areas, but frequently occur in urban conglomeration as well. In recent years, human population expansion has been proportional to the number of contacts and significant events with cougars (*Puma concolor*), black bears (*Ursus maritimus*), and grizzly bears (*Ursus arctos*).

### Land Use Transformation

This driving force is closely related to the previous one, as the conversion of forests, savannah, and other ecosystems into agrarian areas or urban agglomerations is a result of rising demand for land, food production, energy, and raw resources. Conflict in Kenya's abundant wildlife areas, including as Samburu, Trans-Mara, Taita, and Kwale, is exacerbated by land use fragmentation and the development of small-scale agriculture. In fact, state and trust ranches have been subdivided and marketed as smallholdings, where commercial horticulture products are grown. In the year the Indian state of Gujarat, on the outskirts of Gir National Park and Sanctuary, intense and escalating conflicts with Asian lions (*Panthera leo persica*) and leopards (*Panthera pardus*) are the result of a rapid and extensive change in land use associated with the conversion of groundnut (*Arachis hypogea*) and great millet (*Pennisetum typhoides*) fields into sugarcane (*Saccharum officinarum*) and mango cultivation. These crops provide ideal homes for predators and have a significant impact on the natural distribution and abundance of wildlife communities.

### Habitat loss, and degradation

Biodiversity loss of habitat, degradation, and fragmentation are also linked to population expansion and land use change. Again, in Sumatra, the conversion of forest areas into agricultural and grazing land has reduced the Sumatran tiger's (*Panthera tigris sumatrae*) native range to a few patches of forest. Currently, just about 500 people live on the island.

### Eco-tourism and Increasing Access to Nature Reserves

Leisure pursuits, as well as growing public interest in charismatic species like large predators and endangered species, have increased human presence in protected areas, raising concerns about the capacity to manage and regulate public access and wide-scale use. A fifth cluster is linked to the four global trends and is concerned with the transformation of natural food and water supplies.

### Livestock Populations and Exclusion of Wild Herbivores

Increasing the number of animals can lead to diet overlap and fodder competition with wild herbivores, resulting in overgrazing and the decline or extinction of wild herbivore populations. Domestic animals frequently exceed wild ungulates in India's protected regions, reaching numbers of up to 1,500/km<sup>2</sup>, and it has been shown that livestock graze in 73% of wildlife sanctuaries and 39% of protected areas. In such cases, cattle become a valuable source of prey for predators.

### Abundance and Distribution of Wild Prey

Several researchers acknowledge that when native prey is available, wild predators prefer it over livestock, and that prey population depletion is one of the primary drivers of carnivores shifting their diets to livestock. Clearly, this is owing to the ease with which animals may be captured and

their poor escape abilities. In Venezuela, at the Hato Pinero commercial cattle ranch, the highest depredation rates have been recorded in areas with low prey abundance and diversity. Beyond the current issues with HWC, additional questions have developed. In recent years, the effective recovery of falling or near-extinction species populations through wildlife management and protection from overexploitation has resulted in new conflicts. Between 1970 and 1993, effective preservation and habitat management in Gujarat's Gir National Park and Sanctuary doubled the Asian lion (*Panthera leo persica*) population. The species' social organization, habitat, and prey requirements were challenging to accommodate within the human-defined home range, resulting in many lions leaving the reserve and entering surrounding settlements. Wolf populations in North American ranches were nearly extinct due to European settlement. Recent recovery programs, however, have contributed to wolves' recolonization of their historic home range, including rural areas, and in the process have raised the possibility for conflict, especially where domestic cattle are a key economic activity.

### Climatic Factors

Although they are rarely highlighted, possibly because they cannot be controlled, climatic patterns are a major cause of HWC. In Kenya, seasonal variations in rainfall are directly connected with predation intensity. It is found a positive relationship between monthly rainfall and attacks in Tsavo National Parks, indicating that lions are more likely to attack livestock during seasonal rains. During droughts, ungulates spend the majority of their time at a small number of water sources, making them readily discovered and killed; when rain fills seasonal pools, lions disperse into their area, modify their diets, and hunt on easier targets. In Zimbabwe, in the Sengwa Wildlife Research Area, there is a clear correlation between seasonal fluctuations and cattle depredation intensity. However, as in the Kenya Tsavo scenario, wild predators are more likely to attract attention and attack domestic animals during the dry season, when vegetative cover does not facilitate lion and leopard hunting techniques predicated on surprise.

### Stochastic Events (e.g., Fire)

These rare events are difficult to predict and prevent, but they also have an impact on human-wildlife conflict. During 1997-1998, the El Nino Southern Oscillation produced drought and fires, resulting in the devastation of large tracts of Sumatran forest. During that time, tigers fleeing burning areas near Berbak National Park were said to have murdered someone.

### Management

Given the current human population growth rate, increasing demand for natural resources, and increased pressure for access to land, it is evident that the human-wildlife conflict will not be resolved in the near future; nonetheless, it must be controlled quickly. A variety of management tools have been developed worldwide to combat HWC, however the majority of these are site and species/genera specific and not generally or easily accessible.

### Artificial and Natural Barriers (Physical and Biological)

Barriers serve to prevent spatial overlap between wild animals and local communities; they are mostly man-made,

but natural barriers such as rivers, beaches, or mountain ranges may exist along a nature reserve's border. It is demonstrated that spatial isolation is effective when physical barriers encircle a big reserve. However, spatial isolation is not always a viable solution; in India, for example, in the state of Gujarat, chain link fencing along the eastern edge of Gir National Park was anticipated to keep lions and leopards from leaving the park while also preventing illegal grazing. Instead, it was shown to be unprofitable and only partially successful. Other forms of obstacles are being tested in the same area, such as rubble walls and barbed wire fence, which have been built along some of the reserve's boundaries. Finally, all barriers have limitations because they cannot dissuade every kind of animal and can be overcome by particularly powerful or agile target species. However, they are an optional tool for conflict resolution and must be utilized in conjunction with other methods of preventing transgression.

### Guarding

Guarding is also a common preventative method in various parts of India, as demonstrated by a research conducted in Rajasthan's Sariska Tiger Reserve. Despite the fact that guarding requires extra labor at night, the majority of farmers in this region selected it as the most efficient and common way to preserve their crops. Researchers found that using domestic guard dogs is a viable technique for managing predation risk.

### Relocation

Where alternative land and incentives are available, relocating local residents to places with better access to natural resources and socioeconomic prospects can be an effective HWC option. In fact, resettlement schemes aimed at preventing overlap between wildlife and people can be successful in the long run if certain conditions are met: first, the villagers should receive substantial benefits such as better access to resources; second, they should be relocated to an area where the risk of losing property is lower; and third, they should face no political, social, or cultural opposition.

### Waste Management Systems that Restrict Wildlife Access to Refuse

Good waste management standards are essential for avoiding bringing wild animals to human settlements and preventing wild populations from being enhanced and artificially supported by human-induced food availability. Waste management should be managed at every stage, from collection to transportation to disposal.

### Compensation Systems

HWC carries significant economic costs to humans and compensation is a measure which aims to alleviate conflict by reimbursing people for their losses. Compensation systems rely on giving out monetary payments.

### Insurance Programmes

Livestock and crop insurance are frequently advocated as an innovative method to minimizing the effects of HWC, but it has yet to be widely tested. It protects crops and animals from wildlife attacks and requires villagers and local governments to pay a premium portion of the insurance, allowing rural residents to pay a minimal annual fee and be

reimbursed in the event of agricultural or livestock losses. Furthermore, avoiding having to administrate compensation systems saves major financial costs for local governments or the forest department.

### Conservation Education for Local Populations

Education and training efforts at various levels, such as in schools or adult education settings like farmer field schools, would aim to disseminate innovative ideas, strengthen local conflict resolution ability, and increase public understanding of HWC. Educating rural villagers in practical skills would assist them in dealing with harmful wild animal species as well as acquiring and developing new instruments for protecting their crops and animals.

### Wildlife Translocation

Translocation is the process of relocating a particular number of animals from a difficult area to a new location. Despite the fact that it appears to be the least reasonable of the options given above, and the possibility of exporting the problem to another site, it may be a feasible and acceptable approach in some situations, particularly provided a suitable ecosystem with territorial vacancies exists.

### Habitat Restoration

Forest areas on the edges of protected reserves and isolated habitats must be maintained specifically for species-specific plantation. Regeneration of forests outside reserves and restoration of degraded habitats through afforestation programs will considerably increase habitat for species in the ecosystem.

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