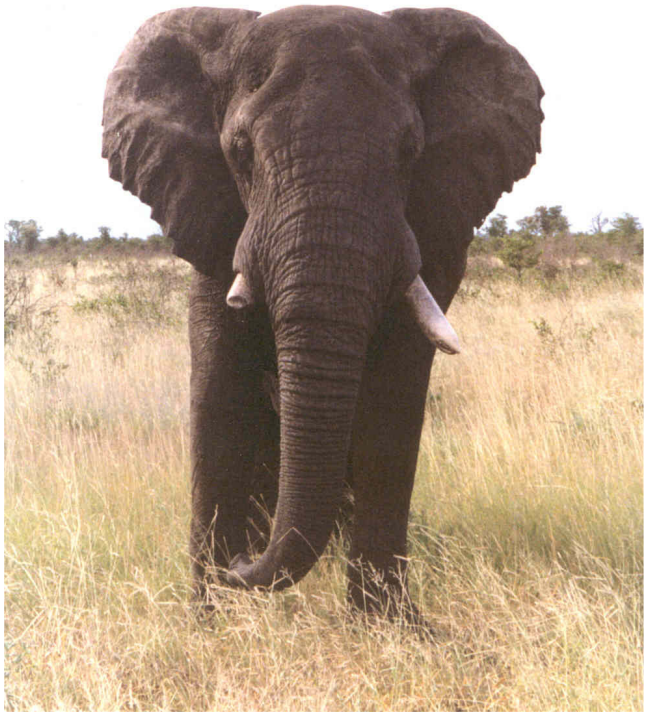
Human-Wildlife Conflict worldwide: collection of case studies, analysis of management strategies and good practices



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Front cover and second page photos, elephant (*Loxodonta africana*), spotted hyena (*Crocuta crocuta*), chacma baboon (*Papio ursinus*). Taken by Elisa Distefano in Kruger National Park, South Africa.

Abstract

Human-Wildlife Conflict (HWC) is fast becoming a serious threat to the survival of many endangered species in the world. The case studies from countries all over the world demonstrate the severity of the conflict and suggest that greater in depth analysis of the conflict is needed in order to avoid overlooking the problem and undermining the conservation of threatened and potentially endangered species.

This report provides an insight into the HWC issue, based on a selection of relevant case studies and gathers together the key lessons learned. This is a comprehensive review covering a wide array of the available literature on wild mammal-human conflict, with the exception of human-elephant, written over the last ten years. It highlights common problems and solutions across bio-geographical regions in order to provide a better understanding of the HWC issue worldwide. It also shows that these conflicts have similar causes and impacts, and that accurate and detailed information, scientific research and stakeholder commitment are key to the development of appropriate and sustainable strategies for both resolving the problem and conserving different ecosystems and their wildlife inhabitants.

The case studies illustrate that HWC is a growing global problem, which is not restricted to particular geographical regions or climatic conditions, but is common to all areas where wildlife and human population coexist and share limited resources. Dense human populations in close vicinity to nature reserves seem to pose the greatest challenges in many countries. Conflicts become more intense where livestock holdings and agriculture are an important part of rural livelihoods. Competition between rural communities and wild animals over natural resources is more intense in developing countries, where local human populations tend to suffer higher costs.

Considering the current human population growth rate, increasing demand for resources and the growing demand for access to land, it is clear that human wildlife conflicts will not be eradicated in the near future. For this reason a better understanding of conflict management options is crucial. The second part of the report reviews a collection of management practices currently used under diverse demographic, economic and social circumstances; it highlights the costs, benefits and constraints of each option and identifies which techniques could be best implemented under similar conditions.

The review reveals that the problem is multifaceted: some management practices are ineffective, others are financially unsustainable or too technologically complex and costly for underprivileged rural communities to adopt. However, HWC can be minimized through good management practices and approaches involving low cost technologies. A number of innovative strategies, such as electric fencing, natural resource use compensation systems, community based natural resource management schemes and incentive and insurance programmes also seem to be sustainable and should be scaled up.

The study recommends two different approaches to resolving HWC: short-term mitigation tools need to be combined with longer-term preventive strategies, along with techniques that are effective with diverse species. When low environmental impact strategies and traditional low cost deterrents are not effective, more invasive approaches such as regulated harvesting, wildlife translocation or human relocation should be considered. Irrespective of the approaches adopted, there is a need to implement those designed specifically for local species and if possible these should be empirically tested for cost-effectiveness and any potentially negative impacts on the ecosystem equilibrium.

The report provides practical recommendations to better design future HWC interventions and improve already existing techniques. The most sustainable approaches should ensure the development of a local economy derived partially from wildlife and the revenue collection from nature reserves, as well as a reduction in the vulnerability of rural communities to depredation by wildlife. In order to make wildlife protection more effective, conservation should be based on sound scientific knowledge, combined with indigenous knowledge, practical local knowledge and collaboration. Integrated community development and wildlife conservation promoted by both national park managers and local populations is the desired scenario. Community-based conservation should give local residents the right to limited and sustainable use of natural resources while promoting tolerance towards wildlife, responsible interaction with their natural environment and the recognition of the value or natural heritages.

In conclusion, protected areas and the presence of wild animal populations inflict costs on local communities. In turn, local residents can develop negative attitudes towards reserves and wildlife, exacerbating the conflict and undermining conservation efforts. In order to break this cycle, there is a need to protect rural livelihoods, reduce their vulnerability, counterbalance losses with benefits and foster community-based conservation. Both people and wildlife suffer tangible consequences and the different stakeholders involved should commit themselves to tackle and resolve such conflicts in the future.

Chapter 1: Background introduction

Human-wildlife conflict (HWC) is fast becoming a critical threat to the survival of many globally endangered species, in particular to large and rare mammals such as the Sumatran tiger (*Panthera tigris sumatrae*) and the Asian lion (*Panthera leo persica*), but also to less endangered species such as the snow leopard (*Uncia uncia*) and the Red colobus monkey (*Procolocus kirkii*). The numerous cases from countries all over the world demonstrate the severity of human-wildlife conflict and suggest that an in depth analysis is essential to understand the problem and support the conservation prospects of threatened and potentially endangered species.

However what is the exact definition of HWC, when and where does it usually occur? According to the World Conservation Union (World Park Congress 2003), it occurs when wildlife's requirements overlap with those of human populations, creating costs to residents and wild animals. Direct contact with wildlife occurs in both urban and rural areas, but it is generally more common inside and around protected areas, where wildlife population density is higher and animals often stray into adjacent cultivated fields or grazing areas.

HWC has far reaching environmental impacts. Species most exposed to conflict are also shown to be more prone to extinction (Ogada *et al.,* 2003) because of injury and death caused by humans; these can be either accidental, such as road traffic and railway accidents, capture in snares set for other species or from falling into farm wells, or intentional, caused by retaliatory shooting, poison or capture. Such human-induced mortality affects not only the population viability of some of the most endangered species, but also has broader environmental impacts on ecosystem equilibrium and biodiversity preservation.

Human-wildlife conflicts also undermine human welfare, health and safety, and have economic and social costs. Nuisance encounters with small animals, exposure to zoonotic diseases, physical injury or even death caused by large predators' attacks have high financial costs for individuals and society in the form of medical treatments to cure and prevent infections transmitted from animals through human contact (Ministry of water, land and air protection, British Colombia, 2003). Humans can be economically affected through destruction and damage to property and infrastructure (e.g. agricultural crops, orchards, grain stores, water installation, fencing, pipes), livestock depredation, transmission of domestic animal diseases, such as foot and mouth. Negative social impacts include missed school and work, additional labour costs, loss of sleep, fear, restriction of travel or loss of pets (Hoare, 1992; Human-Elephant Conflict Working Group, HECWG).

Such broad environmental, human health and safety, economic and social impacts suggest that governments, wildlife managers, scientists and local communities need to recognize the problem and adopt measures to resolve it in the interest of human and environmental well being.

This paper provides insights into HWC, based upon a review of selected case studies and provides a summary of key lessons learned. It highlights common problems and solutions across bio-geographical regions and demonstrates that conflicts have similar causes and effects and that detailed information is the key to the development of appropriate strategies for resolving the problem and conserving different ecosystems and their inhabitants.

Driving forces:

A set of global trends has contributed to the escalation of HWC worldwide. These can be grouped into human population growth, land use transformation, species habitat loss, degradation and fragmentation, growing interest in ecotourism and increasing access to nature reserves, increasing livestock populations and competitive exclusion of wild herbivores, abundance and distribution of wild prey, increasing wildlife population as a result of conservation programmes, climatic factors and stochastic events.

1.1 Human population growth

Demographic and social changes place more people in direct contact with wildlife: as human populations grow, settlements expand into and around protected areas (IUCN, World Park Congress 2003), as well as in urban and sub-urban areas. In Africa, human population growth has lead to encroachment into wildlife habitats, constriction of species into marginal habitat patches and direct competition with local communities (Siex *et al.,* 1999). In the state of British Colombia, Canada, conflicts are not restricted to nature reserves or rural areas but often occur in urban conglomerates as well. In the last few years, human population growth is correlated proportionally with the number of encounters and serious incidents with cougar (*Puma concolor*), black bears (*Ursus maritimus*) and grizzly bears (*Ursus arctos*) (Ministry of water, land and air protection, British Colombia, 2003).

1.2 Land use transformation

This driving force is very much associated with the previous one, as the transformation of forests, savannah and other ecosystems into agrarian areas or urban agglomerates is a consequence of the increasing demand for land, food production, energy and raw materials. In Kenya, in many areas with abundant wildlife, such as Samburu, Trans-Mara, Taita and Kwale, conflict is intensified by land use fragmentation and the development of small-scale farming. In fact, state and trust ranches have been subdivided and sold as smallholdings and cultivated with commercial horticultural crops (Kenya Wildlife Service, 1996). In the Indian state of Gujarat, on the periphery of Gir National Park and Sanctuary, intense and escalating conflicts with Asian lions (*Panthera leo persica*) and leopards (*Panthera pardus*) are due to the rapid and extensive change in land use associated with the conversion of groundnut (*Arachis hypogea*) and great millet (*Pennisetum typhoides*) fields into sugarcane (*Saccharum offinarum*) and mango (*Mangifera indica*) cultivation. These crops create favourable habitats for predators and play a major role in influencing the natural distribution and abundance of wildlife communities (Vijayan and Pati, 2002).

1.3 Species habitat loss, degradation and fragmentation

Species habitat loss, degradation and fragmentation are also interconnected with population growth and land use change. Again, this is a further aspect of the issues discussed above. In Sumatra, the alteration of forest areas into agriculture and grazing land has restricted the Sumatran tiger's (*Panthera tigris sumatrae*) home range to a few patches of forest. Currently, only about 500 individuals remain on the entire island (Nyphus and Tilson, 2004b).

1.4 Growing interest in ecotourism and increasing access to nature reserves

Recreational activities and growing public interest in charismatic species, such as large carnivores and endangered species, have increased the human presence in protected areas and raised concern about capacities to manage and regulate public access and large-scale use of protected areas.

Associated with the four global trends is a fifth cluster connected to alteration of natural food and water availability.

1.5 Increasing livestock populations and competitive exclusion of wild herbivores

Growing densities in livestock populations can create an overlap of diets and forage competition with wild herbivores, resulting in overgrazing and decline or local extinction in wild herbivore populations (Mishra *et al.*, 2003). In India, domestic animals often outnumber wild ungulates within protected areas, reaching densities of up to 1,500/Km^2 and it has been ascertained that livestock graze in 73% of wildlife sanctuaries and 39% of protected areas (Mishra, 1997). Under these circumstances, livestock becomes an important source of prey for predators.

1.6 Abundance and distribution of wild prey

Many authors recognize that when native prey is abundant, wild predators consume it in preference to livestock and that impoverishment of prey populations is one of the major causes of carnivores shifting their diets to livestock. Clearly, this is due to the ease of capture and limited escape abilities of livestock (Mishra, 1997, Mishra *et al.*, 2003; Butler, 2000). In Venezuela, in Hato Piñero commercial cattle ranch, the correlation between alteration of prey availability and local livestock depredation is evident by the fact that the highest depredation rates have been recorded in areas where prey abundance and diversity are relatively low (Polisar *et al.,* 2003).

1.7 Increasing wildlife population as a result of conservation programmes

Beyond the ongoing problems of HWC, new questions have emerged. In recent years, the successful recovery of declining or near extinct species populations (Fall and Jackson, 2002) through wildlife management and protection from overexploitation (Messmer, 2000) has also led to new conflicts. Effective protection and habitat management within the Gir National Park and Sanctuary in the Indian state of Gujarat doubled the Asian lion (*Panthera leo persica*) population between 1970 and 1993. The social organization, habitat and prey requirements of the species were difficult to accommodate within the human-defined home range, and resulted in many lions straying out of the reserve into local villages (Vijayan and Pati, 2002). In the ranches of North America, European settlement almost exterminated wolves. Recent recovery programmes, however have contributed to the recolonization by wolves of their original home range, including rural areas; and in the process have increased the potential for conflict, especially where domestic livestock is a major economic activity (Musiani *et al.,* 2003).

1.8 Climatic factors

Although not often mentioned, perhaps because they cannot be controlled, climatic trends are an important cause of HWC. Seasonal changes in rainfall are directly correlated with predation intensity in Kenya. In Tsavo National Parks, Patterson *et al.* (2004) quantified a positive association between monthly rainfall and attacks, demonstrating that in this region lions are more likely to attack livestock during seasonal rains. During drought periods, ungulates spend most of their time

near a limited number of water sources and thus they are easily found and killed; when rain fills seasonal pools, lions disperse into their habitat, change their diets, and prey on easier targets (Patterson *et al.,* 2004). In Zimbabwe, in proximity to the Sengwa Wildlife Research Area, the correlation between seasonal changes and intensity of livestock depredation is also found to be strong. However, contrary to the Kenya Tsavo case, wild predators are more likely to attract attention and attack domestic animals in the dry season months, when the vegetative cover does not facilitate the hunting strategies of lions and leopards that are based on surprise (Butler, 2000).

1.9 Stochastic events (e.g. fire)

These sporadic events are difficult to forecast and prevent, yet also have an impact on human wildlife conflicts. During 1997-1998, an El Niño Southern Oscillation caused drought and fires, a combination of factors, which resulted in the destruction of large areas of Sumatran forests. During that period, tigers fleeing burning areas near Berbak National Park were reported to have killed a person (Nyhus and Tilson, 2004a).

Chapter 2: Overview of the Human-Wildlife Conflict worldwide

This chapter reviews a selection of species-site specific cases to provide a better understanding of HWC worldwide and to highlight common problems across local, regional and national levels. The case studies cover Europe, Africa, North America and Asia and demonstrate that HWC is more intense in the tropics and in developing countries where livestock holdings and agriculture are an important part of rural people's livelihoods and incomes. In these regions, competition between local communities and wild animals, for the use of natural resources, is particularly intense and direct and resident human populations are very vulnerable. Of course, the relative impact of wildlife damage on farm production and household income varies greatly according to the amount of land owned and people's economic dependence on rural activities (Messmer, 2000). Clearly, indigenous people with a low standard of living are particularly at risk, as are agro-pastoralists who depend exclusively on production and income from their land.

This overview confirms that conflict is particularly common in reserve borders, where species that rely on extensive territories come into contact with human settlements. In effect, border zones of protected areas may be considered population sinks: critical zones in which conflict is the major cause of mortality (Woodroffe & Ginsberg, 1998). These case studies also demonstrate that conflict is most acute in zones in which a wide range of species coexists with high-density human populations (Ogada *et al.,* 2003). Nature reserves that encompass densely populated human settlements seem to pose the greatest challenge. Many of the cases reported here are from India, where 69% of the reserves support an estimated local population of more than three million people, who engage in agriculture, livestock grazing and extraction of forest products (Madhusudan, 2003), or Kenya, where the largest park system of the country, Tsavo National Park buffer zone (ca. 20,000 Km^2), supports almost 250,000 people (Patterson *et al.*, 2004).

The cases briefly described below are sorted by geographical regions, take into consideration many different species and subspecies and help to explain a specific issue, dimension or aspect of HWC. A small paragraph before each case study explains the reasons for their inclusion in the review. When the species' conservation status is of particular interest, it is specified according to the World Conservation Union (IUCN) Red List of threatened species (2003). The review focuses only on mammals, and excludes human-elephant conflicts, which are analysed in great depth elsewhere (Conservation International and an FAO project)[1].

It is important to note that most of the species concerned are carnivores and large home range species, which are important from a conservation point of view. In fact, they have a profound influence on biological communities and often alter the structure and function of entire ecosystem via interspecific competition and regulation of prey population density (Treves and Karanth, 2003b). If large home range and keystone species are not protected the entire biodiversity conservation is undermined.

In addition to the species discussed in this report, there are some well-known groups of invasive vertebrates such as rodents, dogs, birds (blackbird, pigeon) and snakes causing problems in urban and rural areas; they will not be mentioned because numerous comprehensive overviews of conflict, technical information and management options have been recently published (Fall and Jackson, 2002).

[1] "Ensuring farmers' livelihoods and food security around protected areas: with specific reference to Kakum Conservation Area in Ghana" (TCP/GHA/2905).

2.1 Africa

Many communities in Africa bear the costs of coexisting with wildlife without receiving any benefits (O'Connell-Rodwell *et al.,* 2000) and often the costs are very considerable in relation to their standards of living.

2.1.1 **Lion and other carnivore conflict in Zimbabwe**

[Lion (*Panthera leo*), vulnerable; Leopard (*Panthera pardus*), endangered]

In Zimbabwe, many areas of traditional agro-pastoralism bordering protected areas suffer from livestock depredation. In particular, in the Gowke communal land, neighbouring the Sengwa Wildlife Research Area, rural villagers experience a negative impact from the close proximity to the reserve, wild carnivores attack domestic livestock and the conflict is severe. It was reported that, between January 1993 and June 1996, in a study area of 33-Km^2, 241 livestock were killed by baboons, lions and leopards, which contributed respectively to 52%, 34% and 12% of the kills. Their predation techniques are different, as baboons attack by day and usually kill small-stock such as goats and sheep, while lions and leopards attack at night, with lions killing larger prey such as cattle and donkeys. The average loss in that time period was quite consistent, with an annual loss per household equivalent to 12% of the total family's income. It is worth pointing out the fact that despite baboons killing more animals, lions caused the greatest economic loss because of the high value of cattle (Butler, 2000).

2.1.2 **Lion and other carnivore conflict in Kenya** [Lion (*Panthera leo*), vulnerable; Cheetah (*Acynonyx jubatus*), vulnerable; Spotted hyenas (*Crocuta crocuta*), lower risk: conservation dependent]

HWC not only affects rural and vulnerable communities, but also commercial cattle ranches. In this regard, Patterson *et al.* (2004) evaluated the level of impact of two private cattle ranches that lie adjacent to the boundary of the Tsavo East National Park in Kenya. In this study area, three carnivores species were determined to be responsible for attacks: lions and spotted hyenas, which target large domestic animals such as cows, bulls, steers; and cheetahs, which take only smaller adult stock and young cattle. In a four-year study the ranches have lost an average of 2.4% of the total herd per annum, which represented 2.6% of their economic value and amounted to US$ 8,749.

A local population's perception of conflict does not always correspond to reality; in some cases negative impact is only perceived and may result from confounding ecological factors (monkey conflict in Zanzibar case study below) or exaggerated by socio-economic variables (wildlife conflict in Uganda case study).

2.1.3 **Monkey conflict in Zanzibar** [Red colobus (*Procolocus kirkii*), endangered]

Of particular interest, in this regard is the red colobus (*Procolocus kirkii*) conflict in Zanzibar. On this island, farmers consider most medium and large-size mammals as a threat to their crops and name the red colobus as the third most serious vertebrate pest. This case deserves particular attention because the red colobus is one of the most endangered primates in Africa and in Zanzibar its presence is limited to only 1,500-2,000 individuals, which reside on the island of Unguja. (Siex *et al.,* 1999).

A study was undertaken because villagers in agricultural areas adjacent to the southern border of the Jozani Forest Reserve, claimed the red colobus' consumption of coconuts (*Cocos nucifera*) to be the

cause of serious crop yield losses. The authors found out that, contrary to villagers' perceptions and predictions, the monkeys are not a limiting factor, but instead contributed to a slight increase in the final coconut tree yields. In fact, they accounted for a 2.8% increase in the potential harvest through pruning small and immature coconuts. In addition, the primates are a source of income through tourism. It has been concluded that farmers may have incorrectly blamed the red colobus monkeys for crop damage caused by another less visible species, the Sykes monkey (*Cercopithecus mitis albogularis*); or have intentionally exaggerated their losses in order to receive a greater percentage of the Jozani Forest Reserve's tourism revenue (Siex *et al.,* 1999).

2.1.4 **Wildlife conflict in Uganda** [(*Loxodonta africana*), endangered]

Naughton-Treves (1997) analysed the incidence of socio-economic variables on local perception of the conflict around the Kibale National Park, where 54% of the land within 1 Km from the National Park's border is cultivated. The study area was almost entirely confined within 200 m from the edge of the park where farmers lost an average of 4-7% of their crop per season and reported the use of defensive strategies (mainly guarding and to a lesser extent fencing and trenches).

The researcher compared the farmers' assessment of crop losses with systematic measurements of crop damage by wildlife and found that their perception did not correspond closely to the monitored records. The main factors influencing local risk perception were labour investment, potential for total loss, gender identity and an animal's ability to destroy large crop areas. Farmers ranked maize and sweet potato as the two most vulnerable crops out of ten different cultivated plants, despite monitored records demonstrating that banana suffered the highest percentage of damage. Their perception was influenced by the fact that maize and sweet potato crop could have been destroyed in a single depredation event, while banana fields were never entirely devastated. Moreover, women were principally responsible for cultivating food crops and complained more often about damage to cassava, while men dedicate themselves to cash crops and identified banana as one of the most vulnerable crops. Likewise, the most damaging animals identified were olive baboons (*Papio cynocephalus*), bushpig (*Potamochoerus sp.*) and elephants (*Loxodonta africana*), in reality the redtail monkey (*Cercopithecus ascanius*) was the species most frequently visiting agricultural fields, while the species mentioned were those capable of causing the greatest percentage of damage (Naughton-Treves, 1997).

The following case reveals that the conflict can be exacerbated by local people's lack of access to natural resources, substantiating the concept of conflict co-management as a means to achieve sustainable wildlife conservation (Weladji &Tchamba, 2003).

2.1.5 **Wildlife conflict in Cameroon** [Elephant (*Loxodonta africana*), endangered]

In the North of Cameroon, the creation of the Bénoué National Park, in 1968, imposed great restrictions on land use, which was formerly a hunting wildlife reserve owned by local communities and controlled by village leaders. At present, local people's activities, such as small-scale agriculture, livestock rearing, fishing, hunting and gold mining, are restricted to a transitional area surrounding the park's border. The communities surveyed had limited rights to land and lost an estimated 31% of annual crop income and 18% of annual livestock income per household. The most affected crops were reported to be maize (*Zea mays*), millet (*Sorghum* spp.), yam (*Dioscorea rotundata*) and cotton (*Gossipium* spp.), while the species inflicting most of the losses were elephants, baboons (*Papio anubis*), green parrots (*Poicephalus senegalus*) and warthog (*Phacochoerus aethiopicus*).

In an area where wildlife is causing major damage to crops and livestock, the most affected crops are staple foods, and bush meat constitutes about 24% of the animal protein intake; the people are attempting to secure their livelihoods through illegal encroachment of farms and poaching (Weladji & Tchamba, 2003). The authors provide evidence that excluding local populations from access to land and resources, such as fuelwood, fish, bushmeat and pasture, may have long-term negative effects on conservation and result in an intensification of the conflict. They suggest that the strategy for conflict resolution is to involve local communities in wildlife management and to deliver a greater number of tangible benefits to communities.

The selection from Africa will be concluded by a case study demonstrating the conflict that can arise from protected areas that are unable to sustain the actual number of large home range animals. This seems to be a typical situation in many African countries (O'Connell-Rodwell *et al.,* 2000).

2.1.6 **Elephant and lion conflict in Namibia** [Elephant (*Loxodonta africana*), endangered; Lion (*Panthera leo*), vulnerable]

The Caprivi region of Namibia is of particular interest because of its high density of human and elephant populations, which are relying on and competing for the same water and land resources. The conflict in this region is so problematic because it maintains a population of 5,000 elephants, which is the single largest free ranging population of elephants in Africa and is aggravated by the fact that elephants are not confined to the two East Caprivi National Parks, but often stray onto areas outside the park. Most of the conflict occurred in villages bordering those reserves and elephants were responsible for twice as much aggression as lions and attacked over a larger area, however lions caused the greatest financial impact. Elephant crop damage, between 1991 and 1995, amounted to a total economic loss of US$ 39,200, while lion depredation between 1991 and 1994, totalled US$ 70,570 (O'Connell-Rodwell *et al.,* 2000).

2.2 Asia

In India, traditions and cultural/religious attitudes towards wild animals make local people more tolerant towards wildlife, despite the damage to crops and livestock it causes. Orthodox Hindus for instance consider monkeys to be sacred animals, to be revered and protected. This religious belief and traditional attachment to monkeys greatly influences people's perception of the conflict, resulting in its partial acceptance (Imam and Malik, 2002).

The general reverence towards plants and animals in some Indian regions has often been reported to be the main reason for people not persecuting large carnivores and a positive attitude towards wildlife and nature reserves, (Madhusudan, 2003; Sekhar, 1998; Mishra *et al.*, 2003; Vijayan and Pati, 2002), as the research below demonstrates.

2.2.1 **Snow leopard conflict in India and Mongolia** [Snow leopard (*Uncia uncia*), endangered; Tibetan wolf (*Canis lupus chanku*), vulnerable]

In the Indian state of Himachal Pradesh, around Kibber Wildlife Sanctuary, despite the fact that conflict among agro-pastoralists and wildlife is increasing in relation to the growing livestock population, villagers have not resorted to killing the main source of the problem: the snow leopard. In 1995, wild carnivores killed 18% of the total livestock holding; this amounted to an annual loss of 12% for families with a livestock holding. Almost all the deaths were caused by the snow leopard, which is not persecuted. However, retaliatory action is performed against the Tibetan wolf, whose pups were reported to have been captured and killed almost every year in the 1980s (Mishra,

1997). Never the less, such a response has been reported elsewhere. In Mongolia where encounters with snow leopard and wolf are common and losses economically serious, the pastoralists retaliate by killing and persecuting both species (Mishra *et al.*, 2003).

2.2.2. **Lion and leopard conflict in India** [Asian lion (*Panthera leo persica*) critically endangered; Leopard (*Panthera pardus*), endangered]

In India, in the state of Gujarat, in the proximity of Gir National Park and Sanctuary, the Asian lion (*Panthera leo persica*) and leopard (*Panthera pardus*) use the extensive plantations of sugarcane and mango to find shelter and water and to hunt prey such as buffaloes, cows, pigs and dogs. Several lions are reported to have strayed outside the park boundary and into plantations for more than a week, while leopards have chosen it as permanent habitat and even breed in cultivated fields bordering the edge of the park (Vijayan and Pati, 2002).

Once again, the overlapping of wild animals' home ranges with human settlements has resulted in cattle depredation and attacks on farmers and labourers. The problem in this area is of similar nature to the others described above: the safety of rural people is threatened, livestock depredation is common and the overall ability to address the conflict is weak.

The following case illustrates a situation where integrated wildlife habitat conservation and rural community development has played an important role in reducing the pressure of indigenous people on elephant habitats.

2.2.3 **Asian elephant conflict in China [**Asian elephant (*Elephas maximus*), endangered**]**

In the mountain area of Simao, China, in proximity to Xishuang Banna Nature Reserve, a group of 19-24 Asian elephants is responsible for large-scale crop and property damage. The conflict arises from the degradation and fragmentation of the elephant's habitat, the evergreen forest, which at present sustains only a few plant species that the elephants rely on. As a consequence of natural food shortages, the elephants forage on food crops such as wheat, rice, banana and bamboo.

In 2000, rural inhabitants claimed that elephant damage accounted for 28% to 48% of the community's annual income and the total economic losses between 1996 and 1999 amounted to US$ 314,600.

In this context, the International Fund for Animal Welfare (IFAW) implemented an elephant habitat conservation and local community development project aimed at enhancing the coexistence of indigenous people and wildlife. The project entailed micro-credit loans, environmental education, dissemination of alternative farming techniques, human safety awareness and habitat conservation. At completion of the pilot phase, the loans had been paid back, indigenous people had shifted to alternative farming and reduced the pressure on forests, while better tolerating elephants' damage (Zang and Wang, 2003).

Tigers and Asian elephants are a principal source of conflict in much of Asia (Nyhus & Tilson, 2004a) and, as the following research confirms, have a consistent impact on the livelihoods of local populations.

2.2.4 **Tiger and Asian elephant conflict in India [**Tigers (*Panthera tigris*), endangered; Asian elephants (*Elephas maximus*), endangered**]**

In the Southern Indian state of Karnatake, the Bhadra Tiger Reserve hosts a large number of mammalian fauna as well as a population of 3,000 people. Data collection and surveys performed in the region between 1996 and 1999 provided evidence of resident villagers suffering from a high level of economic impact due to HWC. The overall annual loss due to large feline (tigers and leopards) depredation is reported to be approximately 12% of the total family livestock holding, which is equivalent to 16% of the average annual household income in the region. An interesting detail is that although large carnivores had a considerable negative impact on the cattle population, the villages over compensated the loss with purchases. Besides, elephant damage to crops accounted for an average loss of 14% of the total annual production (0.82 tonnes per family), which in monetary terms is equal to 30% of the average annual household income in the region (Madhusudan, 2003).

A very interesting case study has been carried out by Nyphus & Tilson (2004b), who characterized the extent, distribution and impact of the human-tiger conflict in Sumatra, by means of analysing data on incidents that occurred throughout the island over a 20 year period.

2.2.5 **Tiger conflict in Sumatra** [Sumatran tiger (*Panthera tigris sumatrae*), critically endangered]

Nyphus and Tilson's study revealed that the tiger conflict is more common in intermediate disturbance zones such as isolated human settlements surrounded by extensive tiger habitat than in high and low disturbance zones. In fact, as the authors underline, the overlap between tigers and humans is less common in logged, degraded and heavily used areas, or in protected forests such as in the Way Kambas National Park, where tigers are unable to leave the forest and human access is discouraged by natural barriers and the presence of forestry guards. However, this lack of conflict seems to be an exception in Sumatra, as numerous reports of attacks by tigers have been recorded around different national parks where a spatial separation is not assured by natural barriers: Gunung Leuser, Bukit Barisan Selatan, Berbak, Kerinci, and Bukit Tigapuluh (Nyhus & Tilson, 2004a). The same authors conclude that priority should be given to large carnivore conflict around reserve borders and in buffer zones around protected zones that are playing an increasingly important role in the conservation of species like tigers.

The selection of cases from Asia will be concluded by the following case study, which provides well-defined figures on the economic losses faced by rural populations in Northern India. It has been included in the collection because it gives evidence in support of the opinion that losses can vary according to the type of crop cultivated and the distance from a protected area.

2.2.6 **Wildlife conflict in India** [Tigers (*Panthera tigris*), endangered; Leopard (*Panthera pardus*), endangered]

In the Indian state of Rajastan, the Sariska Tiger Reserve supports a population of about 107,770 people, distributed in 117 villages, which are located in and around the protected area. The study quantifies the cost of living in close proximity to a nature reserve and estimates the extent of crop and livestock losses, given that agriculture and livestock keeping are the main economic activities. Many species of wild herbivores are blamed for crop raiding in this region: Nilgai (*Boselaphus tragocamelus*) and wild boar (*Sus scrofa*) are reported to be responsible for at least 50% of the damage, while other species as sambar (*Cervus unicolor*), chital (*Axis axis*), common langur (*Presbitys entellus*), rhesus monkey (*Macaca mulatta*) and parakeets (*Psittacula kremeri*) accounted

for the rest. Nilgai usually raids crops in the evening and tends to favour the degraded edges of forest villages. Wild boar instead, acts at night, while other ungulates such as sambar and chital are usually confined to forest cores. The data on crop damage relevant from 1996-1997, revealed that the annual crop losses varied according to the type of crop grown, in fact the annual loss for chickpeas (*Cicer arietinum*) 10-27% per hectare (ha), maize (*Zea mays*) 12-24% per ha and mustard (*Brassica campestris*) 10-27% were higher than for wheat (*Triticum aestivum*) 6-14% per ha and pearl millet (*Pennisetum typhoideum*) 6-15% per ha. The percentages ranged so broadly because the distance between the reserve border and the household surveyed varied from 0 to 3 Km and in general the depredation increased with closer proximity to the reserve. In monetary terms, the annual average value of crop losses in that period of time, corresponded to 3,280 Indian Rupees (Rs.) (US$ 91) per household located inside the reserve, and Rs. 2,430 (US$ 67) per household located 2.5 Km away (Sekhar, 1998).

Among wild carnivores, the main livestock predators were reported to be tigers and leopards, with the former preying on large domestic animals such as cattle and buffaloes and the latter on smaller animals like goats, sheep and calves. Tigers were reported to be a major threat in villages located inside and close to the reserve, leopards instead, avoided competition with tigers and frequented areas further outside the villages. The calculation of the economic impact was based on domestic animal prices provided by those agro-pastoralists interviewed during the survey, which revealed that between 1994 and 1996, the annual family loss amounted to Rs. 270 - 610 (US$ 7 - 17). This is much less than crop losses and is certainly enhanced by the villagers taking their domestic animals into the reserve for grazing throughout the year (Sekhar, 1998).

2.3 South America

A positive correlation between distance from a protected area and level of wildlife damage has been previously noted (Sekhar, 1998); in this regard the case study below is of additional interest and confirms this relationship.

2.3.1 **Wildlife conflict in Peru** [Brazilian tapir (*Tapirus terrestris*) vulnerable]

In Peru, in the Amazon Province of Tambopata, a population of 3,200 people live inside the northern border of the 1.5 million ha protected area of the Tambopata-Candamo Reserve. The villagers are engaged in different activities such as slash-and-burn agriculture, fishing, hunting and logging and as a result they experience a certain level of conflict with wildlife. The principal wild herbivores responsible for the damage are the Brazilian tapir (*Tapirus terrestris*), tayra (*Eira barbara*) and capybara (*Hydrochaeris hydrochaeris*); less harmful, but very frequent visitors are the collared peccary (*Tayassu tajacu*), paca (*Agouti paca*) and brown agouti (*Dasyprocta variegata*). Among predators ocelot (*Leopardus pardalis*), hawks (*Accipiter spp., Leucopternis spp.*), jaguars (*Panthera onca*) and pumas (*Puma concolor*) were blamed for causing most of the depredation (Naughton-Treves *et al.,* 2003).

During July 1998 and January 2000, the average value of crop loss per planting season was US$ 13, while the annual reported loss was, respectively, US$ 45 and US$ 148 for livestock attacks by small and large carnivores. These figures represent only a rough calculation of the total losses, because those farmers living in remote areas suffered a consistent level of impact compared to farmers neighbouring degraded habitats. This is due to the fact that the largest animal species are often the most devastating species, as they thrive in undisturbed habitats, and encroach onto adjacent agricultural lands. However, farmers living in remote forests managed to compensate their losses with bushmeat gains. Unfortunately hunting big game in degraded habitats was not rewarding

enough as anthropogenic activities have reduced the biomass and diversity of wild animals. This demonstrates that conflict occurs at a negligible level in more degraded agro-forest habitats (Naughton-Treves *et al.,* 2003).

2.4 North America

Competition between humans and wolves for ungulates is an ancient struggle originating in hunter societies (Musiani *et al.,* 2003) and nowadays continuing where livestock is raised for household and commercial income.

2.4.1 **Wolf conflict in Canada and USA**

In Alberta, Canada, over a period of 14 years (1982-1996) wolves (*Canis lupus*) caused 2,086 deaths among domestic animals, mainly cattle and to a lesser extent dogs, horses, sheep, chickens, bison, goats, geese and turkeys. In Idaho, Montana and Wyoming (USA), during a similar time period (1987-2001) wolves killed fewer animals (728), which mainly consisted of sheep and cattle. Interestingly, in both countries there is a positive correlation between the number of domestic animals killed each year and the number of wolves eliminated by government authorities. However human tolerance was greater in the United States where 14 wolves were killed for every 100 livestock deaths, compared to Canada where the ratio was 38/100 (Musiani *et al.,* 2003).

2.5 Europe

The following case demonstrates that predator problems could be greatly reduced with simple foresight and common sense such as livestock protection at grazing areas or in a predator's habitat.

2.5.1 **Wolf conflict in Italy**

Predation of domestic livestock by the wolf (*Canis lupus*) is a problem in some parts of the Abruzzo region in Italy, where the rural economy is characterised by small-scale farming and cattle, sheep, goats and horses are the main stock-rearing activities. Despite both wolves and bears (*Ursus arctos*) being present in these areas, wolves are alleged to cause most of the killings (94%). Notably the majority of sheep and goats (68.7%) horses (76.7) and cattle (73.5) that fell prey when grazing in proximity to shrub or woodland cover. In particular, a significant proportion of the attacks (13%) took place when the animals were lost or drawn away from the main grazing route. Obviously, a great proportion of the losses in Abruzzo occur at pasture and pastoralists' vulnerability is associated with their inability to keep predators away from herded animals.

Little attention has been paid to the socio-economic dimension, in which the conflict happens and the amount for economic losses relative to the average family's income is not known (Cozza *et al.,* 1996).

2.6 Middle East

The following research demonstrates that the increased food availability from agricultural production and illegal refuse dumps can disturb ecological equilibriums through maintenance of a large predator population above a habitat's natural carrying capacity.

2.6.1 **Golden Jackal conflict in Israel**

In Israel, a third of the Golan grassland plateau is managed as pasture for grazing cattle and it is inhabited by farmers who produce cereals, fruits, turkeys, hens and diary products. The farmers claim to lose an average of 1.5-1.9% of the calves born each year to golden jackal (*Canis aureus*) predation. The economic value of the total cattle losses in 1993 was estimated to be about US$ 42,000 (Yom-Tom, 1995). This high predation rate is actually indirectly caused by the farmers themselves, through the illegal dumping of domestic animal carcasses, a primary source of food for the jackals, whose population has in turn thrived and augmented. As a matter of fact, in the decade 1978-1988, the number of jackals increased from a density of 0.2/Km^2 to 2.5/ Km^2 and the current amount of meat dumped by farms is calculated to be enough to support a population density of 3.8/ Km^2 predators. This means that the conflict is expected to escalate if illegal waste dumping is not prohibited and the predator population is not controlled (Yom-Tom, 1995).

Chapter 3: Management of conflict situations and different approaches: local solutions with global application

Considering the actual population growth rate of humans, increasing demand for natural resources and the growing pressure for access to land, it is clear that the human wildlife conflict will not be eradicated in the near future, however it needs to be managed urgently. A wide range of different management tools has been developed worldwide to address HWC, but most of these are strongly site and species/genera specific and are not widely or easily accessible (IUCN, World Park Congress 2003).

This chapter gives an overview of some of the most common management practises, describing their applications, examining how the methods were tested, highlighting lessons learned and successful local solutions, which could be replicated under similar conditions.

To better understand why many different remedial measures have been developed around the world but have not been implemented globally, it is essential to underscore that although the management strategies have similar goals, they are embedded in different ecological, social, cultural and economic realities; they are also targeted towards different taxonomic groups. Mitigative strategies attempt to reduce the level of impact and lessen the problem; while preventative strategies endeavour to prevent the conflict occurring in the first place and take action towards addressing its root causes. Some are efficient in the short-term while others show results only in the long-term; others are more effective within defined geographic regions or specific taxonomic groups. For each of the strategies listed below, a brief description is provided, detailing information on the species involved in the scheme, the geographical region and whether the strategy has been successful or unsuccessful. In some sections proposed potential improvements have been highlighted, as well as strengths and weaknesses.

Good management practices and workable and competitive measures that could be replicated across a wider spectrum are highlighted in a table (please see annex). In this table, a strategy is defined as "successful" not only when it has promoted coexistence and minimized the conflict, but also when it has mobilized greater local participation and support for conservation, brought about positive changes in the villagers' attitudes towards wildlife, improved the relations with local authorities and conservation managers or raised awareness on the value of protecting nature. "Mixed results" implies that the implementation of the strategy has delivered a partial solution, having a tangible impact on only a few specific, target species. A strategy is defined as "sustainable" if it is a definitive solution and does not need any additional inputs such as financial investment or labour. "Short-term", in this context, is used as the opposite of sustainable.

The idea is to build a collection of a wide range of management practices, evaluated in the field, with the aim of highlighting methods that have been successfully experimented in some regions, but not always widely publicized. The categorization of different approaches is very simple, but detailed information and explanatory comments can be gathered from the following discussion as well as from the original scientific articles.

3.1 PREVENTATIVE STRATEGIES:

3.1.1 Artificial and natural barriers (physical and biological)

Barriers have the function of preventing spatial overlapping among wild animals and local communities; they are usually man-made, but natural barriers such as rivers, coasts or mountain ranges may occur along a nature reserve boundary. Spatial separation has been proved to be a successful strategy when physical barriers enclose a large reserve. Nyphus & Tilson (2004b), for example, recorded limited tiger conflict around the Way Kambas National Park in Sumatra, owing to the presence of rivers along more than two-thirds of the park's boundary, which discouraged tigers from leaving the park. Polisar *et al.,* (2003) in suggesting how to promote coexistence of jaguars and pumas with cattle in Venezuela, advised on excluding cattle from the forest and maintaining adequate distance between calving areas and the big cats' territory.

However, spatial separation is not always a satisfactory solution; in India, for instance, in the state of Gujarat, chain link fencing of the eastern boundary of Gir National Park was expected to stop lions and leopards from straying out of the park and to prevent illegal grazing at the same time. Instead, it was proved not to be economically viable and was only partially successful. In the same area, other types of barriers are under experimentation, such as rubble walls and barbed wire fencing, which have been constructed along some sections of the reserve's boundary (Vijayan and Pati, 2002).

Some concern about the negative impacts of physical barriers on the ecological equilibrium of the region has been expressed by different authors, Sekhar (1998), Vijayan and Pati (2002), Hoare (1992) point out that fencing reserves may affect the population dynamics of animals and hinder their natural migratory and dispersal behaviour, especially in the case of highly territorial species like lions. It is also essential to take into consideration the different, unexpected effects that fencing may have on a wide range of non-target species.

Another option is the construction of physical barriers in human settlements to protect crop fields and livestock, while defining properties and gathering farm animals. Fencing homestead areas instead of an entire reserve boundary is not only less expensive, but allows greater wildlife dispersal. Farmers often build pens, which are small enclosures with 1.5-1.8 m high walls and with no ceiling. They can be walls made from different materials such as stone, mud, brushwood, or high rubble, barbed wire or mesh-wire fences. The type of fence depends on locally available materials, as the farmers generally use local products.

A remarkable study was undertaken by Ogada *et al.* (2003), who looked at Eastern African traditional systems of livestock husbandry and explored the effectiveness of various types of fencing. In Northern Kenya, Laikipia District, pastoralists used to gather their herds and keep them inside enclosures at night, when most carnivore attacks take place. They use different traditional techniques, which are popular among Maasai and Samburu local communities. The enclosures can be made of stone or wooden posts (solid), of Acacia brush (acacia), branches woven around cedar poles (wicker) or made with 10 cm wire mesh (wire).

The effectiveness of the different enclosures in defending livestock from predator attacks was investigated; it was discovered that not only did domestic animals experience a lower depredation rate when penned in corals over night, but also that the type of pen was a significant factor associated with a lower total loss for sheep and goats, being kept in wire, acacia, wicker or solid enclosures (listed from the most effective to the least). Good husbandry practices based on

traditional approaches demonstrate the ability to limit depredation by large carnivores (Ogada *et al.,* 2003).

Fladry barrier is a technique traditionally used in Eastern Europe and Russia to hunt wolves. It consists of hanging flags from ropes, placed a short distance above the ground and spaced 0.5 m apart; nowadays it is employed to protect domestic animals from wolf attacks (Musiani *et al.,* 2003). To evaluate the potential ability of fladry barriers in deterring wild wolves from livestock depredation, the authors conducted field and captivity experiments in Western North America: Idaho, Montana, Wyoming (USA) and Canada. They documented the avoidance of fladry by wolves for a period of two months and demonstrated its capacity to impede the natural foraging behaviour of wolves. These findings confirm that wolves fear the fladry and do not attempt to access food sources located on the other side of the barrier.

However, concern is expressed on the practical aspects of applying fladry over a large-scale because of the maintenance required to reposition wrapped flags and to substitute flags that have been removed by cattle. Besides, it is suspected that other external variables, such as habituation or an extended period of food deprivation due to lack of alternative prey, could induce wolves to cross the barrier. To conclude, this anti-predator technique is advantageous only for managing wolf predation risk and it has never been successfully employed with other species. As Shivik *et al.* (2003) demonstrated with an experiment in a wolf territory in Wiscosin (USA), fladry barriers (red flagging strips of 1m x 7.5 cm) had limited success in deterring wolves and no effect with other big predators such as black bears (*Ursus maritimus*) and bald eagles (*Haliaeetus leucocephalus*).

Alternative barriers have been sought, for instance planted hedgerows of various spiny cacti and moat. Plant hedges have the positive aspects of being a low cost solution and are effective with both carnivores and ungulates. On the other hand, they are very slow to establish, do not deter baboons and elephants and are often made of exotic species, which can spread uncontrollably (Hoare, 1992).

It is clear that physical barriers are not always an economical management practice. They frequently require additional labour from farmers and their family members and never ensure complete protection. The reason for this failure can be explained by the behaviour of different animal species. Burrowing animals for instance, breach the barrier and permit access to other species, as Hoare (1992) mentions, lions can use holes that have been dug by warthogs (*Phacochoerus* spp.). In Rajasthan, India, where stone wall, mud and brushwood fences were constructed, farmers claimed that nilgai (*Boselaphus tragocamelus*) could easily jump over fences of 1.5 m in height and wild boar (*Sus scrofa*) were able to dig beneath them to get into fields (Sekahr, 1998).

In Zimbabwe, in the areas of land neighbouring the Wildlife Research Area, the conflict is serious, despite the reserve being fenced and livestock being penned into fortified enclosures at night. This is because baboons, lions and leopards can pass through the reserve fence and jump into the enclosures. Improving fences with the addition of a roof would substantially reduce the economic losses (Butler, 2000). In fact, the simple act of improving defences against predators can make a substantial difference in rural livelihoods; in India, for instance, in the state of Himachal Pradesh, farmers have covered their livestock pens with chain-link fences and reported that this chain-link ceiling is one of the anti-predator management techniques that is significantly reducing livestock kills inside rural villages (Mishra, 1997).

In addition to these conventional types, electric fencing can be considered as a more sophisticated solution. It is more durable, due to the reduced physical pressure from animals, it deters a wider range of species and is more aesthetically appealing. However, the cost of installation is higher

compared to the simple fences and the maintenance implies a need for constant insulation (Hoare, 1992).

In Kenya, in Endarasha and Ol Moran villages located in Nyeri and Laikipia Districts, electric fencing is successfully being used to separate wildlife from human settlements and agricultural areas (Kenya Wildlife Service, 1996). In Namibia, in the East Caprivi region, electric fencing is an effective strategy in reducing the human-elephant conflict on a large-scale. Electric fencing has proved to be the only long-term deterrent to elephants. In fact, an entire village of 31 farms was successfully protected during the first year of experimentation, in spite of close proximity to a national park and a high density of elephants. Despite the high cost of maintenance and installation, it was demonstrated that electric fencing is cost-effective to the community by means of reduced elephant attacks, which in turn resulted in crop increases and an increased income for farmers. It is anticipated that it will take four years for a return on investment to be realised (O'Connell-Rodwell *et al.,* 2000).

In conclusion, all the barriers discussed above have some limitations as they cannot deter every single species of animal and they can be breached by particularly strong or agile target species. However, they are an optional technique for mitigating the conflict and must be used in conjunction with other approaches preventing transgression (Treves and Karanth, 2003b).

3.1.2 Guarding

Monitoring herds and active defence are essential features of animal husbandry in East Africa, where human herders are effective and fearless in warding off predators. In this region, herders are reported to challenge and scare away dangerous carnivores such as lions, hyenas and cheetahs with nothing more than simple weapons like spears, knifes or firearms (Patterson *et al.*, 2004). In Northern Kenya, the presence of human guards, dogs and human activity were associated with lower rates of livestock attacks by large predators (Ogada *et al.,* 2003).

Guarding is also a popular preventative strategy in some parts of India as a study in the Sariska Tiger Reserve, Rajasthan, demonstrates. In this region, the majority of the farmers ranked guarding as the most efficient and common measure to protect their crops, despite requiring additional labour at night (Sekhar, 1998).

According to Treves and Karanth (2003b) the utilisation of domestic guard dogs appears to be a successful strategy for managing predation risk from coyotes, black bears (*Ursus maritimus*) and even cheetahs, but less effective with wolves and grizzly bears (*Ursus arctos*). Although the effectiveness of this defence practice is dependent on humans also being present to ensure that the dogs remain with the livestock. In North America dogs are often left alone to safeguard domestic animals and are not as effective as in Europe and North Asia where shepherds and ranchers work directly with their dogs (Musiani *et al.,* 2003).

3.1.3 Alternative high-cost livestock husbandry practices

Movement activated guard (MAG) devices and electronic training collars (EC) are deterrent systems based on aversive stimuli, they are very high-cost and cutting edge techniques. The first one relies on disrupting a predator's attack through stimuli that disturb the animal's normal behaviour; these stimuli can be gustatory (chemical), visual (light), olfactory or auditory (siren) and are activated by the animal approaching protected resources. In order to reduce the ability of wild animals becoming accustomed to the device, it is usually equipped with a variety of different

recorded sounds and other alternative responses; however its usefulness is still limited because, over time, animals can become accustomed to the disruptive stimuli (Shivik *et al.,* 2003). The second device relies on an animal's ability to learn and it causes discomfort, pain or other negative experiences when the animal enters human settlements or livestock areas. The device becomes effective when the animal learns to associate the occurrence of a negative stimulus with a particular behaviour (Shivik *et al.,* 2003).

The effectiveness of these two disruptive stimuli approaches was tested in a multi-predator area in Wisconsin and also on captive wolves in Minnesota. The MAG devise used a strobe light and 30 recorded sound effects including yelling, gunfire and helicopters. It was activated by the movement of proximal, large animals. The EC devise was instead activated by wires buried underneath the perimeter of the area to be protected. It was found that, in the field, the MAG devise reduced the daily consumption of carcass by wolves, black bears (*Ursus americanus*) and bald eagles (*Haliaeetus leucocephalus*) by 68%, while the consumptive behaviour of captive wolves was effectively controlled by MAG but not by EC. The latter device was difficult to use with wolves, because of their unpredictability in terms of response; some wolves were disturbed by the stimulus and ran away while others found it mildly annoying and continued in their activity. Moreover, the EC device entails some logistical, animal care and maintenance problems. In conclusion, the experiment demonstrated that the MAG device gives a greater degree of protection, is easier to manage and has a wide-scale potential application, providing the stimuli is varied and random (Shivik *et al.,* 2003).

It is clear that high-technology devices are much more expensive and complicated to use than the traditional management options discussed up until now. In addition, supplementary research is needed to better define the long-term potential contribution of high-technology devices to husbandry practices.

3.1.4 Relocation: voluntary human population resettlement

Where alternative land and incentives are available, relocation of local communities to areas offering better access to natural resources and socio-economic opportunities can be an adequate solution to HWC (Madhusudan, 2003). In fact, resettlement schemes aiming to prevent the overlap between wildlife and people, can be successful in the long run if some essential assumptions are met: firstly the villagers should gain substantial benefits, such as better access to resources, secondly they should be relocated to an area where the risk of losing property is lower and thirdly they should not face any political, social or cultural opposition (Treves and Karanth, 2003b).

3.1.5 Waste management systems that restrict wildlife access to refuse

Good standards of waste management are important to avoid attracting wild animals to human settlements and to prevent wild populations being augmented and artificially sustained by human-induced food availability. Each stage of waste handling should be addressed, from collection to transportation to disposal.

3.2 MITIGATIVE STRATEGIES:

3.2.1 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 or licenses to exploit natural resources, allowing the hunting of game or the collection of fuel wood, timber and fodder from inside protected areas. Of the two methods, financial compensation is a very contentious issue and the least popular due to its inefficiency and low rate of reimbursement. This is a reality in many developing countries, which face budget constraints and usually pay on an irregular basis and to a limited extent. The second compensation scheme, also known as the "settlement of rights" to use natural resources, appears to be a more practical solution, as the following case studies demonstrate.

In India, in the state of Karnataka, financial compensation schemes are not very effective. The process of claiming compensation and the verification and approval procedures are very bureaucratic and often result in only a small portion of the claims being paid. In a survey undertaken between 1996 and 1999 an overall 11% of the total claims for livestock depredation and 26% for crop losses were refunded. Secondly, the reimbursement can take up to 6 months to be released and usually undervalues the losses, covering an average of 5% of the total loss claimed for livestock kills and 14% for crop damage (Madhusudan, 2003).

Such problems have been reported elsewhere in India, in particular in the state of Himachal Pradesh, where people are discouraged from claiming compensation because of the time and costs involved in the process. In this region, in 1995, economic losses were again marginally compensated: in that year, only half of the agro-pastoralists claiming compensation for losses from snow leopard attacks received monetary reimbursement, which covered only 3% of the total annual loss (Mishra, 1997).

In Kenya, compensation schemes are very problematic. The government has not provided any reimbursement for crop and livestock losses since 1989 and it neither replaces nor repairs any installations that are destroyed by wild animals. Moreover, the compensation received for loss of human life or injury is not sufficient to cover funeral expenses or hospital bills. It also does not take into consideration the impact of such incidents on dependent children who are often taken out of school because of the lack of funds to pay their fees (Kenya Wildlife Service, 1996).

Obviously, this type of compensation scheme can do little to reduce the HWC and needs to be modernized in order to become less bureaucratic, more reactive and transparent. The calculation of the amount of cash to be reimbursed should be proportional to the loss, the number of family dependants, their schools fees, and hospital and burial costs (Kenya Wildlife Service, 1996).

However, there is some concern about improving and enforcing this system because it is suspected that a well-develop compensation scheme would result in inflated claims and attract people from outside the affected areas thus increasing the pressure and the problem (Sekhar, 1998). In addition, this is not a sustainable solution as it depends heavily on the final budget of the local governing bodies and it does not encourage villagers to protect their holdings and to coexist with wild animals.

An alternative approach, the "settlement of rights", appears to be a better strategy. It fixes a quota of commodities that can be exploited, it clearly demarcates reserve zones that are accessible to local villagers and it legitimises their rights to those resources. Indeed, the benefits derived from the legitimate collection of natural resources influence the attitudes and perceptions of rural residents towards wildlife and conservation, while promoting responsibility and awareness (Sekhar, 1998).

3.2.2 Insurance programmes

Livestock and crop insurance is often proposed as an innovative solution to mitigating the impact of HWC, but it is yet to be experimented broadly. It covers crops and livestock from the risk of wildlife attacks and involves the villagers and local governing bodies paying a premium share of the insurance and allows rural inhabitants to make a minimum annual cost and to be refunded in the event of crop or livestock losses. In addition, the local governing bodies or the forest department are relieved of significant financial expenses, from not having to administer compensation schemes (Madhusudan, 2003).

Despite the fact that this approach has not yet been experimented over a large scale, a collaborative insurance programme is in progress in the state of Himachal Pradesh, India, where it seems to be implemented successfully. In fact, villagers contribute monthly to the insurance programme and receive compensation in proportion to the total number of livestock killed and the total amount paid into the insurance fund during the year. Moreover, they get monetary rewards for better anti-predatory herding and have learned simple rules to reduce domestic animal vulnerability, such as being aware of sick, young or pregnant animals and not to collect the carcasses of killed yaks, horses, cattle or donkeys. As a result they have become progressively more responsible in safeguarding wildlife and have modified their husbandry and guarding behaviour (Mishra *et al.*, 2003).

3.2.3 Incentive programmes

Incentive programmes are based on subsidies. They offset the cost of conservation and demand the adoption of conservation-friendly practices, creating tolerance towards wildlife through the exchange of benefits.

Two interesting incentive programmes have been developed in India and Mongolia, where agro-pastoralists and pastoralists live within the snow leopard's territory (Mishra *et al.*, 2003). In India, in the state of Himachal Pradesh, the programme succeeded in reducing the forage overlap among wild herbivores and livestock through the clearance of an area of 500 ha from livestock grazing and other human use. The villagers received financial benefits for their loss of herding land and the money was used for collective work. As a consequence, wild herbivore densities increased, resulting in more naturally available prey for predators and thus reducing the pressure of carnivores on livestock (Mishra *et al.*, 2003).

In Mongolia, the programme did not permit pastoralists to poach the snow leopard and its prey. The loss of income from poaching was offset by the sale of wool handicrafts, made by the women, to the Snow Leopard Enterprises. Income generation from handicrafts is growing in popularity because families have been able to increase their monthly per capita income by 25%. The programme itself is expected to grow rapidly, also because marketing opportunities for the handicrafts are opening. However one weakness of the incentives programme is the need for subsidies from external sources, from either conservation funds or governments (Mishra *et al.*, 2003).

3.2.4 Community based natural resource management schemes (CBNRMS)

A CBNRMS has been established in the Caprivi region of Namibia, where the eco-tourism industry and hunting concessions are potentially valuable for developing a local economy based on wildlife related revenues. This scheme entails a system of returning benefits to rural communities in order to motivate them to protect wildlife outside protected areas and to discourage poaching; it is still at an

early stage, but it is expected to have a real potential in mitigating the conflict (O'Connell-Rodwell *et al.,* 2000).

3.2.5 Regulated harvest

In many regions, HWC is managed by hunting. This is a low cost technique and has the potential to raise public tolerance towards wildlife. The money raised from the sale of licences can fund conservation activities and the protection of human settlements (Treves and Karanth, 2003b). To be viewed as a legitimate management practice, hunting needs to be based on scientific monitoring that ensures sustainable harvests and it needs to be regulated by policies that address the timing, location and methods of hunting, as well as the distribution of benefits to all stakeholders. In reality, lethal control is considered to be an expedient to satisfy the aggrieved party and reasons for scientific scepticism are due to the lack of selection of target animals to be eliminated. As a result the individual animals killed are often not responsible for depredation and after their removal other individuals can cause trouble in the same location. It is assumed that regulated harvest is not effective in reducing crop and livestock losses and it is also likely to increase the risk of further losses when dangerous carnivores are wounded instead of being killed (Treves and Karanth, 2003b).

3.2.6 Wildlife translocation

Translocation consists of moving a certain number of animals from a problematic zone to a new site. In spite of seeming to be the least sensible of the solutions listed above and the risk of exporting the problem to another site, it may be a practical and acceptable approach in some cases and where there is the availability of a suitable habitat with territorial vacancies. Translocation works well when isolated individuals are unable to survive or reproduce because they are too distant from the main population and need to be moved back to their own group; or when a high density population needs to be reduced through the relocation of individuals (Treves and Karanth, 2003b).

An interesting case study is from Northern India, where about 260,000 rhesus monkeys (*Macaca mulatta*) live in areas of human settlement and translocation has been reported to be the best non-destructive control measure. In the state of Uttar Pradesh, Vrindaban, where the density of rhesus monkeys was extremely high (304 individuals per square kilometre), their presence caused a serious nuisance to inhabitants. They reported suffering from monkeys biting, stealing, damaging and destroying property, such as cars, gardens, house furnishings, television antennaes and electric poles. In 1997, 600 rhesus monkeys were moved from the urban area of Vrindaban to eight different semi-natural forest patches. Their density was reduced by 45% of the total original population and this reduced the conflict. The programme was successful as the monkeys that had been moved, did not show any sign of stress and the villagers and their spiritual leaders in the site that received the monkeys accepted and tolerated their presence. Moreover, after four years the translocation took place, the monkey population in Vrindaban remained low and the conflict were resolved (Imam and Malik, 2002).

In spite of this successful programme, translocation can cause numerous problems in the case of carnivores, for example translocation into areas already occupied by individuals of the same species can lead to aggression and infanticide and a much higher death rate (Treves and Karanth, 2003b).

In most cases the conflict cannot be avoided and translocation does not seem to be an immediate and straightforward solution. However, it is encouraging that the conflict can be minimised through good management practises and housekeeping principles, such as livestock protection at night,

property guarding or avoidance of a predator's hometerritory. It is also reassuring that some of the successful measures involve low technology tools and low cost approaches such as pens with chain-link ceilings, man-made salt ponds, fladry barriers and insurance programmes. The strength of this analysis lies in the fact that all the strategies have been tested in the field and their evaluation originates from practical experimentation; the weakness is that it overlooks some management options like chilli crop barriers, fire (fires lit on periphery of fields or smoke from burning) or missiles (stones, spears).

The most sensible approach to addressing HWC is to implement a combination of two different approaches: short-term mitigation tools along with long-term preventative strategies, so as to reduce the current problems while fostering the rapid development and use of innovative approaches to address future issues and eradicate the problem. When low environmental impact strategies and traditional low cost deterrents are not successful, some invasive approaches, such as regulated harvest, wildlife translocation or human relocation may need to be implemented. Among the innovative strategies discussed in this chapter, electric fencing, natural resource use compensation systems, CBNRMS, incentive and insurance programmes seem to be the most sustainable.

Irrespective of the approaches adopted, there is a need to test them against any possible side effects, such as the restriction of an animal's requirements, effects on non-target species and the environment as a whole and last but not least its cost-effectiveness. The best approach should ensure the participation and involvement of local populations, as their goodwill and support in wildlife conservation plays a crucial role for preventing and mitigating HWC. Co-management by rural villagers, researchers and local governing bodies has proved to be the wisest strategy for nature conservation (Weladji &Tchamba, 2003). A local community's acceptance of the problem is essential, because these case studies suggest that, although HWC can be reduced it will never be fully eliminated.

Chapter 4: Recommendations and conclusion

Although the assortment of case studies and management practices described in chapter 3 is by no means exhaustive, it nevertheless encompasses a wide range of taxa and management options, which have been applied in diverse economic and cultural contexts. Some invaluable lessons can be learnt from each of the cases described in the previous chapter and practical recommendations can be inferred in order to design better interventions and to improve existing conflict management practices. Therefore, this final chapter suggests and discusses potential areas of improvement.

4.1 Conservation education for local populations

Education and training activities at different levels, for instance in schools or in adult education arenas such as farmer field schools, would have the objective of disseminating innovative techniques, building local capacity in conflict resolution and increasing public understanding of HWC. Educating rural villagers in practical skills would help them to deal with dangerous wild animal species and to acquire and develop new tools for defending their crops and livestock. Over time it would result in a change of behaviour amongst local populations and would contribute to reduced risks, improvements in local livelihoods and a reduction in their vulnerability. In an optimistic scenario, education and training would promote commitment towards conservation, raise awareness on the essential role of wildlife in the ecosystem functioning and its ethical and economic value, as well as its recreational and aesthetic importance.

4.2 Better definitions and prediction of hot spots, data collection and evaluation of the impact

There are currently no national summary statistics defining the magnitude of the damage caused by different wildlife species. Outstanding deficiencies include little or no data on 1) actual versus perceived economic losses for agricultural producers, 2) incidence of human diseases transmitted from wildlife, 3) damage to rural and urban households and 4) the magnitude of socio-economic costs associated with the restriction of hunting and trapping wild animals (Messmer, 2000).

Likewise, this literature review demonstrates that existing data from many study areas is not comprehensive, despite the fact that the true severity of social and economic losses can only be estimated with accurate data. Good-quality and high-value information could be gathered through archival records, questionnaires, and interviews with women, community groups, village leaders, household heads, local government officials and other seasonal forest users. The challenge would be to develop and maintain an updated database containing the broadest array of records documenting the type and location of the incidents. Such a database would provide a detailed overview of the impact on local populations, better identify which geographical zones are more vulnerable to HWC and which species are commonly involved in the conflict. As a result, it would ensure adequate use of resources, help identify high-risk areas and allow effective responses to emergencies (Nyhus & Tilson, 2004b).

The categorisation and quantification of the level of incidence is generally carried out through common indicators such as the number of livestock kills in a year or the annual economic loss. However, the use of this kind of information is constructive only if it is taken in the context of the specific social, economic and ecological dimensions of the study area; for example the number of livestock killed over a period of time is an inconsistent figure and it would be more informative if it were related to the total family livestock holding or total village units. The quantification of the economic losses should also be related to annual household income or the economic value of the family holdings (cattle, agricultural fields). Information gathered should include: dimension of the

study area (village, province, region), number of people injured or killed over a fixed period of time, wild animal mortality induced by humans as well as species responsible or suspected to be involved in the conflict. Appropriate research should also take into account a family's land tenure, crops grown and yields, damage calculated as percentage of crop loss per hectare or percentage of crop loss per annual production; livestock ownership and percentage of domestic animals killed and their current market price. With the aim of providing a complete scenario, it should be specified which protection measures were adopted, the time and money spent on defending the property, any additional damage to it (pipelines, fences, etc) and any suggested measures to reduce the losses.

However, there are some factors that may affect the accuracy of the information collected, for instance agro-pastoralists are not always able to determine the exact cause of death of an animal (diseases, poor nutrition, poisonous bites) and may blame predators instead. Another case is when the local government underestimates the problem whilst not taking into account isolated and unreported attacks (Mishra, 1997; Polisar *et al.,* 2003). A different issue, of broad concern, is intentional exaggeration of information by farmers, which is quite common but can be easily overcome by cross-checking suspicious declarations with field assistants' local knowledge or field quadrat sampling survey (Sekhar, 1998).

There are obviously many ecological variables that influence HWC and make each case very specific, for instance climatic factors, wildlife density, water, natural prey and forage availability and quality (abundance and distribution), competition with other species and ecosystem equilibrium. Other factors include the distance from a nature reserve, livestock density and land use pattern, which affects the degree of wildlife habitat degradation and fragmentation; they all vary widely among sites and must be evaluated locally.

There is a need to improve the understanding of the ecological, social and cultural dimensions of conflict situations, to better integrate the general overview of HWC at present (International Symposium on Society and Resource Management, 2004). Understanding the context in which the conflict is embedded, requires the exploration of different aspects of regions and countries where it occurs; some elements such as human population density, proportion of urban and rural population and religious beliefs are often overlooked and would be helpful in identifying appropriate solutions.

4.3 Better sharing of information

One of the five recommendations of the IUCN World Park Congress (2003) is to establish an international forum that should act as a global network for sharing information and expertise in addressing HWC. Furthermore, the development of a web-based portal including conflict databases, remedial technologies, good management practices, innovative solutions and their outcomes would be beneficial. The portal should also provide educational material, information on high-risk areas and links to other relevant and useful web sites. It would provide valuable support to different partners dealing with the problem, granting access to information, recommendations and effective management principles. Considerable up to date technical information on prevention and control of elephant damage is available from the Human-Elephant Conflict Working Group (HECWG) at http://www.iucn.org/themes/ssc/sgs/afesg/hectf/.

4.4 Promotion of dialogue and cooperation among different stakeholders

The success of wildlife conservation and HWC reduction largely depends on the ability of managers to recognize, embrace and incorporate differing stakeholder values, attitudes and beliefs (Messmer, 2000). The commitment and coordination of different stakeholders: local governments, Wildlife

Services or Forestry Departments, non-governmental organization (NGOs), conservation organizations, wildlife managers, the scientific community, tour operators and the tourism industry, rural villagers and other participants, is expected to enhance the participation, contribution and support of each counterpart. Encouraging the creation of partnerships and diverse stakeholders' compliance and collaboration will make any strategy more successful, will foster mutual assistance and strengthen the possibility of resolving the HWC issue.

In Sumatra, HWC falls under the jurisdiction of wildlife conservation authorities, which often ends at the boundary of protected areas. When wild animals cross the boundary, the question of who should be responsible for dealing with the conflict and addressing the issue is not often clear, resulting in the problem remaining unresolved (Nyhus & Tilson, 2004a). The lack of government commitment often produces resentment among indigenous people, which in turn develops into a negative and uncooperative attitude towards wildlife.

4.5 Better commitment by governments to address the problem:

4.5.1 Improved policy

In many situations, strategies or methods for addressing the HWC issue are often constrained by local, national or international regulations, laws or treaties (Fall & Jackson, 2002). Moreover, the ineffectiveness of some of the management practices is directly dependent on the establishment and application of policies and guidelines on a wide range of human activities. In various countries, existing wildlife policies are outdated, contradictory and require clarification, in particular those regarding land development planning and its impact on wildlife habitats. Policies on land tenure, controlled utilization of wildlife through hunting and the trade of wildlife products, game farming, tourism development and compensation schemes should be strengthened and made to conform to the present national state of affairs and population requirements (Kenya Wildlife Service, 1996; Ministry of water, land and air protection, British Colombia, 2003; Hoare, 1992).

4.5.2 Better control of hunting: limitation of persecution and poaching

Hunting is undertaken as a means to supplement household food consumption, for financial gain through the sale of animal products (meat skin, furs, ivory etc.) or for retaliatory killing. The latter is a real problem where HWC occurs. Persecution by humans in response to a problematic coexistence with large carnivores has been the cause of the elimination of several species from a large part of their former home ranges, this is true for species such as the tiger (*Panthera tigris*), lion (*Panthera leo*), puma (*Felis concolor*) and the snow leopard (*Uncia uncia*) (Mishra, 1997 and 2003).

In Northern Kenya, the number of predators killed by farmers has been reported to be positively correlated with the number of livestock killed by lions, hyenas and leopards (Ogada *et al.,* 2003). Moreover, Naughton-Treves *et al.* (2003) demonstrated that hunting has a strong detrimental impact on large mammals in the heavily forested Tambopata Province in the Peruvian Amazon. They verified that the common practice of hunting big game prevents jaguars and pumas from surviving near human settlements despite the ability of these species to exploit degraded habitats. Besides, herbivores, carnivores and most primates >2kg in size are unlikely to reside in multiple-use zones in Amazonian forests unless hunting is effectively restricted.

A satisfactory solution would involve the protection of the principal prey that wild carnivores depend, by preventing poaching and the commercial harvest of natural prey. This would maintain

adequate populations and restore the natural balance between predator and prey thus preventing carnivores from relying on a diverse diet that includes domestic livestock (Polisar *et al.,* 2003). In addition, hunting concessions could be sold to operators organising game safaris and the money invested in protected areas.

4.5.3 Better sharing of income from tourism

Wildlife is a generator of income through tourism and in many developing countries it is one of the most significant sources of national revenue generation. The tourism industry can increase employment within local communities by creating additional job opportunities. This approach would compensate the cost of maintaining wildlife and contribute to changing local people's negative perceptions of conservation. The managers of Kibale National Park in Uganda, for instance, intend to foster positive attitudes towards the park and supportive conservation behaviour by the local populations, though sharing revenues from tourism with the local populations (Naughton-Treves, 1997).

4.6 Conclusion

This report supports the broadly recognized inference that the human wildlife conflict is escalating and illustrates that it is a worldwide issue, spanning Asia, with elephants destroying agricultural fields, tigers and leopards preying on domestic animals; Africa with numerous carnivores killing cattle and monkeys threatening the food security of rural people; and Europe and North America, with wolves and bears taking livestock and damaging property. The conflict is not restricted to specific geographical regions or climatic conditions but is common to all areas where wildlife and dense human populations have to coexist and share limited resources.

It is obvious that the problem is collective but there is an important distinction between the level of vulnerability of agro-pastoralists in developing countries and that of well-off inhabitants in developed nations. Smallholder subsistence farmers face potentially catastrophic losses. They can lose an entire season's crop production in one single raid by big and voracious animals such as elephants, chimpanzees, baboons or bushpigs. Their capacity to cope with losses varies even among farmers inhabiting the same region; as Naughton-Treves (1997) points out the level of impact of crop depredation on rural villagers of the edge of Kibale National Park, in Uganda, depends on farm size. The owners of large farms can employ guards or create a crop buffer zone to separate vulnerable yields from the forest edge, through cultivating less palatable plant species or using the land for pasture. These options are not available to subsistence farmers, who have less choice in their land use and can not afford to pay for guards (Naughton-Treves, 1997).

This report reviewed most of the management practices that are being applied under diverse demographic, economic and social circumstances. It highlighted the costs, benefits and constraints of each option and intended to clarify which techniques could be best implemented under specific conditions.

The overall picture is very multifaceted: some management practices turned out to be unsustainable (physical barriers around reserve borders), others need to be heavily subsidised (financial compensation system) and others are very costly and complicated devices to use (MAC, EC), which will not be affordable to most individuals in disadvantaged rural communities. On the other hand, the review of the case studies demonstrated that the conflict can be reduced through good management practices (livestock protection at night, pens with chain-link ceiling), traditional husbandry techniques (guarding and the use dogs) as well as low technology tools, based on local

experience (man-made salt ponds) and low cost approaches (fladry barriers). Obviously, some of these practices are only effective with some animal species and need to be combined with other methods.

There is also a need to bring to light and disseminate innovative practices such as electric fencing, insurance programmes, compensation systems (natural resources) and CBNRMS that have proved to be practical and cost effective in the field. Further experimentation should be undertaken to develop additional science-based techniques and innovative approaches that could make a meaningful contribution to resolving the long-term problem.

In conclusion, the simultaneous application of different management practices and the implementation of those designed for local species are recommended. There is no single solution to the conflict and every preventative and mitigative strategy should be empirically tested for its cost-effectiveness and possible impact on the ecosystem equilibrium before adoption.

The best scenario would imply integrated community development and wildlife conservation promoted by national park managers and supported by local populations. Community-based conservation should give indigenous people the right to limited and sustainable use of natural resources while promoting tolerance towards wildlife, responsible interaction with their natural environment and the recognition the value of natural heritages. Hans (2003) proved that rural villagers, who live in proximity to Waza National Park in Cameroon, appreciate nature's intrinsic value and agree with the necessity to protect forests and their wildlife inhabitants for future generations. Their positive attitude towards conservation arises from the use of natural resources such as regulated harvesting of non-timber forest products, the use of waterholes and fishing.

Local peoples' participation is now widely advocated in development and conservation (Zang and Wang, 2003), participatory protected area management is becoming increasingly common throughout Africa (Hans, 2003) and the development of a system of returning benefits through resource exploitation is often advocated in multiple areas surrounding the parks (O'Connell-Rodwell *et al.,* 2000; Hans, 2003). The most sustainable approach should ensure the development of a local economy based on wildlife and revenue collection from nature reserves, as well as a reduction in the dependence of rural communities on agriculture and farming. In order to enhance protected area effectiveness, conservation should be based on sound scientific knowledge, practical local indigenous knowledge and collaboration.

Protected areas and the presence of wild animal populations inflict costs on local communities and can erode local support and tolerance. In turn, indigenous people can develop a negative attitude towards reserves and wildlife, exacerbating the conflict and undermining conservation efforts. In order to break this cycle, there is a need to protect rural livelihoods, reduce their vulnerability, and counterbalance losses with benefits and foster community-based conservation. Both people and wildlife suffer tangible consequences and different stakeholders involved should commit themselves to tackle and resolve the conflict in the near future.

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